Integrating Data Mining and Social Network Techniques into the Development of a Web-based Adaptive Play-based Assessment tool for School Readiness

by

Iyad SULEIMAN

**Submitted in accordance with the requirements
for the degree of Doctor of Philosophy**

**In Computer Science
The University of Bradford
Bradford, United Kingdom
Electrical Engineering and Computer Science**

2013

The candidate confirms that the work submitted is his own and that appropriate credit has been given where reference has been made to the work of others.

ACKNOWLEDGMENTS

This study is conducted as a part of PhD Studies, under the supervision of *Mick Ridley* from the Dept. of Computing, School of Computing, Informatics and Media at the University of Bradford, UK and *Professor Reda Alhajj* from the Faculty of Computer Science at the University of Calgary, Canada.

I want to thank *Mick Ridley* from the Dept. of Computing, School of Computing, Informatics and Media at the University of Bradford, UK and *Professor Reda Alhajj* from the Faculty of Computer Science at the University of Calgary, Canada for the personal guidance, which helped me in planning and execution of this study and supporting and encouraging me to complete this study, they had been a constant source of support, suggestions, and encouragement throughout my thesis, and this thesis would not have been possible without them.

Special thanks to:

- *My wife Maha*, for discovering patience and tolerance during the time I spent in research and study. I wouldn't be who I am today without her love and affection! I wouldn't forget her struggle to convince me to apply for Ph.D. Studies, She has believed in me more than I did in myself! Without her motivation and encouragement, I wouldn't be doing a Ph.D. or research.
- *My lovely daughters*: Jouna, Aram-Baghdad and Kenda and *my naughty son*, Reda.
- *My Parents* Mohammed and Radia, and *my mother-in-law* Hekmia for the support and encouragement along the way.

Special greetings to:

- *My eldest sister Maha* and *her husband Dr. Khaled*, who was suffering from cancer and I wish him to recover as soon as possible and to find an appropriate donor bone marrow to cure from this disease. (05/2014)
- *My brothers Yazeed* and *Maan* for helping to pay some of my debts.
- *My cousin Ali* for suffering from the financial difficulties of the Education Center I run for the last three years, doing his job without claims and complaints.
- *My brothers and sisters and all of my cousins* for giving me a sense of security and calm in these very difficult days.

DECLARATION

Parts of the original work proposed in this thesis have appeared in the following publications and presentations.

PUBLICATIONS AND TALKS

- I. Suleiman, T. Salman, S. Gao, F. Polat, M. Arslan, R. Alhajj and M. Ridley, "The power of genetic algorithm in automated assessment of school readiness," *Proceedings of IEEE International Conference on Information Reuse and Integration,* Las Vegas, pp.280-285, Aug. 2010.

- Suleiman, I., Gao, S., Salman, T., Polat, F., Arslan, M., Alhajj, R., & Ridley, M., Effectiveness of Automated Learning in Assessment of School Readiness. In *Recent Trends in Information Reuse and Integration.* Springer-Verlag, 2011.

- P. Peng, M. Nagi, O. Sair, A. M. ElSheikh, I. Suleiman, S. Gao, T. Özyer, K. Kianmehr, G. Naji, M. Ridley, J. Rokne, and R. Alhajj, "From Alternative Clustering to Robust Clustering and Its Application to Gene Expression Data", *Proceedings of the International Conference on Intelligent Data Engineering and Automated Learning,* Springer-Verlag LNCS, Norwich, UK, Sep. 2011.

- M. Nagi, A. ElSheikh, M. Rifaie, I. Suleiman, P. Peng, P. Karampelas, R. Alhajj and M. Ridley, "Association rules mining based approach for web usage mining", *Proceedings of IEEE International Conference on Information Reuse and Integration,* Las Vegas, Aug. 2011.

- M. Nagi, A. Elhajj, O. Addam, A. Qabaja, O. Zarour, T. Jarada, S. Gao, J. Jida, A. Murshed, I. Suleiman, T. Özyer, M. Ridley, R. Alhajj, Robust Framework for Recommending Restructuring of Websites by Analyzing Web Usage and Web Structure Data, *International Journal of Business Intelligence and Data Mining*, Vol. 7, Nos. 1/2, 2012.
- Suleiman I., Arslan M. Integrating Genetic Algorithm into the Development of Computerized Play-Based Assessment tool for School Readiness. *Procedia - Social and Behavioral Sciences* 82 (2013) 852 – 857.

ABSTRACT

A major challenge that faces most families is effectively anticipating how ready to start school a given child is. Traditional tests are not very effective as they depend on the skills of the expert conducting the test. It is argued that automated tools are more attractive especially when they are extended with games capabilities that would be the most attractive for the children to be seriously involved in the test. The first part of this thesis reviews the school readiness approaches applied in various countries. This motivated the development of the sophisticated system described in the thesis. Extensive research was conducted to enrich the system with features that consider machine learning and social network aspects. A modified genetic algorithm was integrated into a web-based stealth assessment tool for school readiness. The research goal is to create a web-based stealth assessment tool that can learn the user's skills and adjust the assessment tests accordingly. The user plays various sessions from various games, while the Genetic Algorithm (GA) selects the upcoming session or group of sessions to be presented to the user according to his/her skills and status. The modified GA and the learning procedure were described. A penalizing system and a fitness heuristic for best choice selection were integrated into the GA. Two methods for learning were presented, namely a memory system and a no-memory system. Several methods were presented for the improvement of the speed of learning. In addition, learning mechanisms were introduced in the social network aspect to address further usage of stealth assessment automation. The effect of the relatives and friends on the readiness of the child was studied by investigating the social communities to which the child belongs and how the trend in these communities will reflect on to the child under investigation.

The plan is to develop this framework further by incorporating more information related to social network construction and analysis. Also, it is planned to turn the framework into a self adaptive one by utilizing the feedback from the usage patterns to learn and adjust the evaluation process accordingly.

DEDICATION

To *my wife Maha (my Soul mate)*, for the support and encouragement along the way.

To *my brother-in-law who is also my cousin: Khaled* (RIP) *and his wife (my sister, May God prolong her age) Maha,* for what they experienced of pain and agony.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES AND ILLUSTRATIONS

Abbreviations Used in this Thesis

A2	- Complete A Level Qualification (UK)
ACPHSASR	- Adaptive Cross-Platform Hypermedia System for Assessment of School Readiness
AEHS	- Adaptive Educational Hypermedia System
ARA	- Assessment and Reporting Arrangements
AS	- Advanced Subsidiary Level or Advanced Supplementary Level
ASP	- Active Server Pages
ASQ	- Ages and Stages Questionnaires (Assessment tool)
ASQ-SE	- Ages and Stages Questionnaires- Social Emotional
BIA	- Brief Intellectual Ability (Woodcock–Johnson Test)
CA	- Curriculum Authority
CAMHS	- Child and Adolescent Mental Health services (UK)
CATSR	- Computerized Assessment Tool for School Readiness
CBS	- Central Bureau of Statistics
CBTS	- Computer-Based Tutoring Systems
ECEC	- European Consortium Emergency Contraception
CE1	- cours elementair première année - France
CE2	- cours elementair deuxième année - France
CM1	- cours moyen première année - France
CM2	- cours moyen deuxième année - France
CMC	- Combination of Multiple Classifiers
CP	- cours preparatoire- France
CP	- Cerebral Palsy
CTBS	- The Comprehensive Test of Basic Skills
DfES	- Department for Education and Skills (UK)
EA	- Evolutionary Algorithm
ECD	- Early Child Development

ECD	- Evidence-cantered assessment design
ECCE	- Early Childhood Care and Education (Lebanon)
ECE	- Early Child Education
ECLS-B	- Early Childhood Longitudinal Study-Birth Cohort
ECLS-K	- Early Childhood Longitudinal Study-Kindergarten
ECM	- Every Child Matters (UK)
EDM	- Educational Data Mining
Edini	- Educare-Internet-Interaction (Finland)
EEC	- Education Evaluation Council
EfA	- Education for All
EIM	- Evaluation, Inspection and Management Services
EP	- Evolutionary Programming
ES	- Evolution Strategies
FEEC	- Finnish Education Evaluation Council (Finland)
FNBE	- Finnish National Board of Education (Finland)
GA	- Genetic Algorithm
GAP	- Global Assessment Profile
Gc	- Comprehension-Knowledge (Woodcock–Johnson Test)
GCSE	- General Certificate of Secondary Education (UK)
GDP	- Gross Domestic Product
GER	- Gross Enrolment Rate
Gf	- Fluid Reasoning (Woodcock–Johnson Test)
GIA	- General Intellectual Ability (Woodcock–Johnson Test)
GIFT	- Generalized Intelligent Framework for Tutoring
GIRFEC	- Getting it Right for Every Child (Scotland)
GS	- Grande section (France)
Gs	- Processing Speed (Woodcock–Johnson Test)
HC	- Hard Constraints

ICT	- Information and Communication Technologies
ID3	- Induction Decision Trees
IEP	- Individualized Education Plan-Program
INRP	- The Institute for Education Research in France
IRT	- Item Response Theory
ITBS	- The Iowa Test of Basic Skills
ITS	- Intelligent Tutoring
JSON	- JavaScript Object Notation
K-ABC	- Kaufman's Children's Test
KDD	- Knowledge Discovery in Databases
KG1	- Kindergarten – Year 1
KG2	- Kindergarten – Year 2
KS1	- Key Stage 1
KS2	- Key Stage 2
LO	- Learning Outcome (South Africa)
LMS	- Learning Management System
MAP	- Miller Assessment for Preschoolers
MDGs	- Millennium Development Goals
MEHE	- The Ministry of Education and Higher Education (Lebanon)
MEXT	- Ministry of Education, Culture, Sports, Science and Technology (Japan)
MI	- Multiple Intelligences
MOH	- Ministry of Health (Lebanon)
MS	- Moyenne section (France)
MVPT-3	- Motor-Free Visual Perception Test-3rd Edition
NAA	- The National Assessment Agency
NAEP	- National Assessment of Educational Progress
NAEYC	- The National Association for the Education of Young Children

NAFCC	- The National Association for Family Child Care
NASBE	- The National Association of State Boards of Education
NBE	- National Board of Education (Finland)
NCLB	- No Child Left Behind Policy
NECPA	- The National Early Childhood Programme Accreditation
NEETS	- Not in Education, Employment or Training Systems
NEGP	- National Educational Goals Panel
NEILS	- National Early Intervention Study
NESS	- National Evaluation of Sure Start (UK)
NGO	- Non-Governmental Organization
NQF	- National Qualification Framework (South Africa)
OBE	- Outcomes Based Education (South Africa)
OCenW	- The Dutch Ministry of Education and Science
OECD	- Organisation for Economic Co-operation and Development
Ofsted	- The Office for Standards in Education, Children's Services and Skills (UK)
OPEPD	- The Office of Planning, Evaluation and Policy Development
OSEP	- Office of Special Education
OSP	- Out of school time provision
PAJE	- Prestation d'accueil du jeune enfant
PASS	- The Personalized Achievement Summary System
PCER	- Preschool Curriculum Evaluation Research
PDA	- Personal Digital Assistants
PDD	- pervasive developmental disorders
PE	- Physical Education
PEELS	- Pre-Elementary Education Longitudinal Study
PISA	- Program For International Student Assessment
PLS-3UK	- Preschool Language Scale-3

PPP	- Purchasing Power Parity per capita
PS	- Petite section
QCA	- Qualifications and Curriculum Authority (UK)
QRS	- Quality rating systems (USA)
RNCS	- Revised National Curriculum Statement (South Africa)
SAQA	- South African Qualifications Authority
SAT	- The Stanford Achievement Test
SC	- Soft Constraints
SCP	- The National Office for Cultural and Social Planning – Holland
SEN	- Special Educational Needs
SES	- Socio Economic Status
SHEEP	- Safe, Healthy, Enjoy/Achieve, Economic, Positive contribution (UK)
SNA	- Social network analysis
SPW-3	- Undergraduate Degree (3 years)
SSLP	- Sure Start Local Programmes (UK)
STAKES	- The development branch of the Ministry of Welfare and Health in Finland
TBA	- Technology-Based Assessment
UNICEF	- United Nations Children's Fund
VB	- Visual Basic
VMI	- Visual-Motor Integration
WAHS	- Web-based Adaptive Hypermedia System
WBES	- Web-based Educational Systems
WEKA	- Waikato Environment for Knowledge Analysis
WFfC	- World Fit for Children
WIAT	- The Wechsler Individual Achievement Test
WISC-IV	- Wechsler Intelligence Scale for Children 4^{th} Edition

WISC-R95	- Wechsler Intelligence Scale for Children – R95
WJ-III	- The Woodcock-Johnson III Tests of Cognitive Abilities
WM	- Web Mining
WPPSI	- Wechsler Preschool and Primary Scale of Intelligence
WPPSI-III	- Wechsler Preschool and Primary Scale of Intelligence-3rd edition
WYE-Elul	- Test for identifying learning difficulties
XML	- Extensible Mark-up Language

GLOSSARY OF TERMS

Ability- The capacity to perform an act, either innate or as the result of learning and practice.

Achievement- A measurement of what a person knows or can do after training.

Adaptive- Adaptive behavior is a type of behavior that is used to adjust to another type of behavior or situation. This is often characterized as a kind of behavior that allows an individual to change an unconstructive or disruptive behavior to something more constructive.

Adaptive Hypermedia- A disputed research field where hypermedia is made adaptive according to a user model.
http://en.wikipedia.org/wiki/Adaptive_hypermedia.

Aptitude- The ability of an individual to acquire a new skill or show the potential for acquiring a skill when given the opportunity and proper training.

Assessment- Essentially a measurement process of the learning that has either taken place or can take place. Usually measured against stated learning outcomes:
- Predictive assessment attempts to measure what the learner might achieve given suitable training.
- Attainment assessment attempts to measure what the learner knows or can do, and is usually related to the syllabus of a course the learner has followed.

Attitude- A persisting feeling or emotion of a person that influences choice of action and response to stimulus. Defined as a disposition or tendency to respond positively or negatively towards a certain thing (idea, object, person, and situation). They encompass, or are closely related to, our opinions and beliefs and are based upon our experiences. Training that produces tangible results starts by changing behaviour...which ultimately changes attitudes. Training often uses the term attitude to identify the psychological term "affective domain."

Behaviour- Any activity (either covert or overt) the learner will be expected to exhibit after training. The activity should be observable and measurable. It is the primary component of an objective.

Brokerage theory- View the network as an opportunity for entrepreneurs to exploit by seeking partners that are non-redundant and bring new and diverse information.

Case Study- A printed description of a problem situation that contains enough detail to enable the learners to recommend a solution. The learners encounter a real-life situation under the guidance of an instructor or computer in order to achieve an instructional objective. Control of the discussion comes through by the amount of the detail provided.

The Cattell–Horn–Carroll theory or CHC theory- A psychological theory of human cognitive abilities that takes its name from Raymond Cattell, John L. Horn and John Bissell Carroll. Recent advances in current theory and research on the structure of human cognitive abilities have resulted in a new empirically derived model commonly referred to as the Cattell–Horn–Carroll theory of cognitive abilities.

Cognitive- From the Latin cogito; "I think". The mental processes of perception, memory, judgment, and reasoning. Cognitive also refers to attempts to identify a perspective or theory in contrast to emphasizing observable behaviour.

Cognitive Domain- Involves mental processes. The Taxonomy of categories arranged in ascending order of difficulty are:

- Knowledge: Recognition and recall of information.
- Comprehension: Interprets, translates or summarizes given information.
- Application: Uses information in a situation different from original learning context.
- Analysis: Separates wholes into parts until relationships are clear.
- Synthesis: Combines elements to form new entity from the original one.
- Evaluation: Involves acts of decision making based on criteria or rationale.

Competency- (1) Areas of personal capability that enable people to perform successfully in their jobs by completing task effectively. A competency can be knowledge, attitudes, skills, values, or personal values. Competency can be acquired through talent, experience, or training.
(2) Competency comprises the specification of knowledge and skill and the application of that knowledge and skill to the standard of performance required in employment.

Computer-Assisted Instruction (CAI)- The use of computers to aid in the delivery of instruction in which the system allows for remediation based on answers but not for a change in the underlying program structure.

Computer-Based Training (CBT)- Interactive instructional experience between a computer and a learner in which the computer provides the majority of the stimulus and the learner responds, resulting in progress toward increased skills or knowledge. Has a more complicated branching program of mediation and answering than CAI. Now an all-encompassing term used to describe any computer-delivered training including CD-ROM and the World Wide Web. Some people still use the term CBT to refer only to old-time text-only training.

Computer Managed Instruction (CMI)- The use of computers and software to manage the instructional process. Functions of CMI can include a management administration system designed to track student performance over a period of time, provide information concerning performance trends, record individual and group performance data, schedule training, and provide support for other training management functions.

Constraint- Any element or factor that prevents a person from reaching a higher lever of performance with respect to her goal.

Cost-sensitive classification- One of the mainstream research topics in data mining and machine learning that induces models from data with unbalanced class distributions and impacts by quantifying and tackling the unbalance.

Curriculum- The aggregate of courses of study given in a learning environment. The courses are arranged in a sequence to make learning a subject easier. In schools, a curriculum spans several grades, for example, the math curriculum. In business, it can run for days, weeks, months, or years. Learners enter it at various points depending on their job experience and the needs of the business.

Distributed System- A distributed system consists of a collection of autonomous computers, connected through a network and distribution middleware, which enables computers to coordinate their activities and to share the resources of the system, so that users perceive the system as a single, integrated computing facility.

Early childhood- Is a stage in human development. It generally includes toddlerhood and some time afterwards. Play age is an unspecific designation approximately within the scope of early childhood. Some age-related development periods and examples of defined intervals are: newborn (ages 0–4 weeks); infant (ages 4 weeks – 1 year); toddler (ages 1–3 years); preschooler (ages 4–6 years); school-aged child (ages 6–13 years); adolescent (ages 13–19).

Education- The development of knowledge, skills, and attitude not necessarily related to one's job.

Educational Technology- A complex, integrated process involving people, procedures, ideas, devices, and organization, for analyzing problems, and devising, implementing, evaluating and managing solutions to those problems, involved in all aspects of human learning.

E-Learning- Covers a wide set of applications and processes such as web-based learning, computer-based learning, virtual classrooms, and digital collaboration. It includes the delivery of content via Internet, intranet/extranet, audio and videotape, satellite, and CD-ROM. However, many organizations only consider it as a network-enabled transfer of skills and knowledge.

Entry Level Skills- Specific competencies or skills a learner must have mastered before entering a given instructional activity.

Evaluation- The process of gathering information in order to make good decisions. It is broader than testing, and includes both subjective (opinion) input and objective (fact) input. Evaluation can take many forms including memorization tests, portfolio assessment, and self-reflection. There are at least six major reasons for evaluating training, each requiring a different type of evaluation:

- Improve the instruction (formative evaluation)
- Promote individual growth and self-evaluation (evaluation by both trainer and learner)
- Assess the degree of demonstrated achievement (summative evaluation attained by the teacher)
- Diagnose future learning needs (of both trainer and learner)

- Enhance one's sense of merit or worth (learner)
- Identify or clarify desired behaviours (trainer).

Evaluation Instrument- A test or other measuring device used to determine achievement (go and no-go) or the relative standing of an individual or group or a test objective (i.e., attitude, behaviour, performance objective, and other attributes). Evaluation instruments include tests, rating forms, inventories, and standard interviews.

Evaluation Phase- The instructional system design phase that determines the value or worth of the instructional program. This phase is actually conducted during and between all the other phases.

Factor Model- In psychology, the Big Five personality traits are five broad domains or dimensions of personality that are used to describe human personality. The theory based on the Big Five factors is called the Five Factor Model (FFM). The Big Five factors are openness, conscientiousness, extraversion, agreeableness, and neuroticism. To Blanchard and Thacker are: declarative, procedural, and strategic).

Intelligent tutoring system (ITS)- A computer system that aims to provide immediate and customized instruction or feedback to learners: http://en.wikipedia.org/wiki/Intelligent_tutoring_system.

Item Response Theory (IRT)- The ability to match an assessment item to a child based on an estimate of the child's ability, and continually re-calibrate its estimate based on child performance.

Knowledge- The information we acquire, how it is organized into what we already know, and an understanding of how and why it is used.

Knowledge Management- Capturing, organizing, and storing knowledge and experiences of individual workers and groups within an organization and making it available to others in the organization. The information is stored in a special database called a knowledge base and is used to enhance organizational performance. Two of the most common ways are:

- Documenting individual's knowledge and disseminating through manuals or a database.
- Using such tools as groupware, email, and the internet that facilitates communication.

Learning Curve- A curve reflecting the rate of improvement in performing a new task as a learner practices and uses her newly acquired skills.

Lickert Scale- A way of generating a quantitative value (numerical) to a qualitative questionnaire (e.g. poor, fair, good, very good, excellent). Sometimes used on end of course evaluation. (Smile sheets) For an ascending five point scale incremental values are assigned to each category and a mean figure for all the responses is calculated. (via the sum of the products of the categories' assigned value times the number of respondents for that category, divided by the total number of respondents) Example: Total number of respondents=25, assigned values are; poor=1, fair=2, good=3, very good=4, excellent=5; respondents selecting following categories are; good=9, very good=10, excellent=6. The quantitative mean = ((9*3) + (10*4) + (6*5))/25=3.9

Model- (1) A person that serves as a target subject for a learner to emulate. (2) A representation of a process or system that show the most important variables in the system in such a way that analysis of the model leads to insights into the system.

Module- A stand-alone instructional unit that is designed to satisfy one or more learning objectives. A separate component complete within itself that can be taught, measured, and evaluated for a change or bypassed as a whole; one that is interchangeable with others, used for assembly into units of differing size, complexity, or function. A module consists of one or more lessons. Also called annex or sub course.

The No Child Left Behind Act of 2001 (NCLB)- A United States Act of Congress that is a reauthorization of the Elementary and Secondary Education Act, which included Title I, the government's flagship aid program for disadvantaged students. NCLB supports standards-based education reform based on the premise that setting high standards and establishing measurable goals can improve individual outcomes in education.

Pedagogy- Literally means the art and science of educating children; pedagogy is often used as a synonym for teaching. Pedagogy embodies teacher-focused education.

Performance- The accomplishment of a task in accordance with a set standard of completeness and accuracy.

Performance Analysis- It is the process by which professionals' partner with clients to identify and respond to opportunities and problems, and through study of individuals and the organization, to determine an appropriate cross-functional solution system. Performance analysis is a systematic and systemic approach to engaging with the client. It is the process by which we determine when and how to use education and information resources.

Performance Evaluation- A process of data collection and analysis to determine the success of learners on a specific task as a result of a training program.

Performance Evaluation Tools- Competency tests that allow the trainer to profile the student's proficiency and identify weak areas so that training can be efficiently planned for the areas of most critical need.

Performance Objective- A statement of the conditions, learner's behaviour (action), and standard. A criterion for prescribing the desired learner performance. This is a generic term and may be either a criterion objective or an enabling objective.

Purchasing Power Parity per capita- This entry gives the gross domestic product (GDP) or value of all final goods and services produced within a nation in a given year. A nation's GDP at purchasing power parity (PPP) exchange rates is the sum value of all goods and services produced in the country valued at prices prevailing in the United States. This is the measure most economists prefer when looking at per-capita welfare and when comparing living conditions or use of resources across countries.

Predictive Validity- The extent to which the test or expert opinion predicts how well students will actually perform on the job.

Process- A planned series of actions that advances a procedure from one stage of completion to another. A process always has an input and an output.

Proficiency- Ability to perform a specific behaviour (e.g., task, learning objective) to the established performance standard in order to demonstrate mastery of the behaviour.

Psychomotor Domain- Involves physical movement and coordination. The Taxonomies major categories in order of ascending difficulty are:

- Imitation: Observes skill and tries to repeat it.
- Manipulation: Performs skill according to instruction rather than observation.
- Precision: Reproduces a skill with accuracy, proportion and exactness. Usually performed independent of original source.
- Articulation: Combines one or more skills in sequence with harmony and consistency.
- Naturalization: Completes one or more skills with ease and becomes automatic.

Reliability- Yielding comparable results each time. In examinations, reliability is consistency; the same result is achieved on successive trials.

Response- Any behaviour that results from a stimulus or stimuli. In instruction, it designates a wide variety of behaviour which may involve a single word, selection among alternatives (multiple choice), the solution of a complex problem, the manipulation of buttons or keys, etc.

Rule induction- An area of machine learning in which formal rules are extracted from a set of observations. The rules extracted may represent a full scientific model of the data, or merely represent local patterns in the data.

Servlet- A Java programming language class used to extend the capabilities of a server.

Skills- General capacities to perform a set of tasks developed through the acquisition of experience and/or training which require more than just knowing about the subject.

Soft Skills- Skills needed to perform jobs where job requirements are defined in terms of expected outcomes, but the process (es) to achieve the outcomes may vary widely. Usually, an area of performance that does not have a definite beginning and end (i.e., counselling, supervising, and managing).

Test- A device or technique used to measure the performance, skill level, or knowledge of a learner on a specific subject matter. It usually involves quantification of results-- a number that represents an ability or characteristic of the person being tested.

Test Reliability- The degree to which a test/test item gives consistent results each time it is used.

Training- The systematic process of developing knowledge, skills, and attitudes for current or future jobs.

Validation- A process of testing the effectiveness of instruction by administering the criterion test immediately after the instruction. Also, a process through which a course is administered and revised until learners effectively attains the base line objectives.

Validity- The degree to which a test measures what it is intended to measure. Although there are several types of validity and different classification schemes for describing validity there are two major types of validity that test developers must be concerned with, they are content-related and criterion-related validity.

WebGL- A tool that enables web content to use an API based on OpenGL ES 2.0 to perform 3D rendering in an HTML canvas in browsers that support it without the use of plug-ins.

Wechsler Adult Intelligence Scale (WAIS)- A test designed to measure intelligence in adults and older adolescents.

White box- A model contains as much detail as the simulation model can provide and no approximations are made using any bulk parameters. Such detail in a model is only used in situations where the simulation results must closely match those produced in reality and often consume large amounts of computing power. A pure white box model cannot exist as it is essentially a copy of reality!

CHAPTER 1: INTRODUCTION

1.1 Problem Definition

The transition from kindergarten to school is considered one of the critical periods in the life of a child, during which he/she acquires fundamental skills and ways of learning and thinking. For the child, this is a profound change and a transition from a small, intimate setting to a larger setting with more expectations and various demands made upon him/her, Fogel, (2000); Hair et al (2006) . The transition also requires the child to adjust to and develop emotional and social relationships in a new environment, Duncan et al. (2007). Generally, the coordination is done by the kindergarten teacher, usually in cooperation with the parents, and is a critical component in the children's development.

An external advisory system takes part in addressing developmental delays through communications clinicians and educational psychologist as needed. They conduct observations of kindergarten children, receive reports from the kindergarten teacher and give psychological tests to children who appear to have developmental delays. These tests may be accompanied by questionnaires and testing instruments.

The most common "diagnosis" by psychologists regarding children with learning deficits, in cases when the intellectual measures are satisfactory, is "childish for his age" or "emotionally immature", Condron (2008). This is the fundamental diagnosis which is the basis for the decision of whether to have the child spend an additional year in compulsory kindergarten or advance to first grade. When the intelligence test scores seem low, there is generally a referral to special education.

Today, it is possible to diagnose various forms of dyslexia, language and attention deficits, motor deficits and cognitive mathematical deficits. It is possible to begin an early intervention at a young age, as needed and acceptable, David, (1999); Donald and Stenner (2005). Thus, school readiness is more than just about children. School readiness, in the broader sense, involves children, families, early environments, schools, and communities. Children are not innately ready or not ready for school. Their skills and development are strongly influenced by their families and through their interactions with other people and environments before coming to school. Assessing school readiness is important to the education of young children. Assessment helps in measuring the current state of children's development and

knowledge and can be used to guide classroom and individual education programming, Chambers (2000); David (1999); Feinstein (2003); Hair et al. (2006). Most of the employed systems and computerized tools concentrate on the child individually and in isolation from his/her community and this leads to incomplete or misleading outcome which may reflect negatively on the personality and behaviour of the child. Some social factors have a great impact on the readiness of a child for school and must be taken into account. These social factors are mostly inspired from the environment where the child belongs; these include friends of a child, siblings and relatives of a child, parents' education level, and parents' employment status.
The evaluation of a child's readiness to transit from kindergarten to school is a major challenge to schools and families and a critical life event of the child him/herself due to the need of new skills and ways of learning and thinking, Suleiman et al. (2010); Condron (2008). This transition requires the child to adapt to the new environment and to start developing new social relationships with school mates, these factors could be friends of the child, siblings and relatives of the child, parents' education level, and parents' employment status. In addition, this stage is also critical to parents and teachers to help the child to be ready for the new transition, Miller and Emihovich (1986).
Many research communities in Europe, North America, Australia, and New Zealand have been attracted by the school readiness research, Berger et al. (2008). For instance, a large number of schools currently use computerized tools to assess if a child is ready to start school. The assessment results are then evaluated with teachers reports about the child and a decision is made whether the child is ready to make the transition from kindergarten to school or still needs to spend more time in the kindergarten before he/she becomes ready to join the school.

1.2. Proposed Solution

In the effort to develop an effective automated assessment process it was necessary to integrate a modified on-line Genetic Algorithm (GA) into a web-based stealth assessment tool for school readiness. The goal is to create a cross-platform stealth assessment tool that can learn the user's skill and adjust the assessment tests accordingly. The user plays various sessions from various games, while the on-line GA selects the upcoming session or group of sessions to be chosen for the user according to his/her skill and status. In this work there is a need to describe the modified on-line GA and the learning procedure. A penalizing system was integrated into the on-line GA and a fitness heuristic for best choice selection. Two methods for learning were presented, a memory system and a no-memory system. Furthermore, several methods for the improvement of the speed of learning were presented. In addition, A prediction model was proposed to predict if a child is ready for school or not, the model is based on several data mining techniques features that were extracted from the children's social information which is expected to be maintained by schools. Data mining techniques were applied to school data to examine the readiness of children for school. The proposed model was evaluated and the results are encouraging by demonstrating the applicability and effectiveness of the approach.

1.3 Outline of the thesis

Chapter two reviews the early childhood Curriculum and Pedagogy in 10 different countries from various continents listed in alphabetical order: Brazil, Finland, France, Germany, Israel, Japan, Lebanon, South Africa, United Kingdom (UK) and the United States of America (USA).
The aim of this chapter is to review these curricula, the effects of Early Childhood Education (ECE) attendance on cognitive development and discuss quality aspects. A further aim is to raise awareness of curriculum questions in connection with children's learning and development.

Chapter three discusses a number of goals regarding the preschool system in all matters relating to young children, these goals emphasize improving language skills, thinking and enrichment, the acquisition of life skills and social skills, developing personal independence and tolerance for the other, literacy and problem-solving and creating the foundation for learning, Chapter three details a list of possible instruments according to specific criteria, and the instruments were rated based on a categorical matrix system. The assessment tools were either accepted or eliminated for inclusion in the final list of possible candidates of tools to be reviewed.

Chapter four discusses the term "readiness for school", the way in which it is evaluated and the nature of the recommendations made in the aftermath are dependent to a great extent on the theoretical basis on which they are made. Chapter four details three primary areas of development responsible for a child's readiness or lack of readiness for school: 1. the cognitive sphere; 2. motor perception and 3. The emotional-behaviour sphere. Chapter four also criticizes the current diagnostic and screening processes and the need for an objective diagnosis tools.

Chapter five asserts that a computerized platform for assessing school readiness may offer substantial added value for research and practice. Such a platform will offer: a) an intelligent management of the assessment outcomes; b) much more information processed from the assessment data than if they will be used disparately.

Chapter five describes in detail the method of the framework reviewing the kindergarten teacher's evaluation questionnaire, the computerized assessment of readiness for school, the technological infrastructure of the games, the achievement exams upon completion of the first grade, the data processing and the reliability of the computerized school readiness tool and also the relationships between the three measures. The main purpose of Chapter five is to define a new model for computerized assessment by adding new features like adaptivity, serious games and algorithm-based engine.

In Chapter six, an investigation is carried out to determine a suitable cross-platform adaptive hypermedia system for assessing readiness in pre-school. This chapter also asserts that the adaptation cannot be easily achieved without an automated system (rule-based and algorithm-based) that strongly captures expertise in the domain. Further, to provide for wider availability of the system, it is important to develop a cross-platform interface.

Chapter seven is involved with the use of a modified on-line genetic algorithm (GA) into an adaptive web-based stealth assessment that analyzes the subject's skill and dynamically adapts the assessment tests accordingly. A web-based stealth assessment is used for evaluating school readiness of a child by having the child play a series of games comparing the child's performance with a database of performance results for a population. The stealth assessment includes an engine for processing the child's performance data, for comparing the performance data with the performance results of the population, and for applying an online-GA to determine the most appropriate next test for the child. Additionally taking a closer look at the employed GA-process and discussing the modification of the GA to include set of conditions comprising the proposed method. The conditions are divided into two groups, according to the level of the seriousness of the condition. The logical difference between the two kinds of conditions dictate different methods of implementation, hence they are divided into two sets of constraints: soft constraints (SC) that may be broken and hard constraints (HC) that must be satisfied. Then it discusses the current computational trends in social network, which can be categorized to unsupervised learning in consideration of noisy environment in assessment processes, then describes two possible ways: learning by copying and analyzing group behaviour.

Finally, in Chapter eight, survey data was analyzed at 4 different schools for three consecutive academic years, It showed how Social Network Analysis (SNA) helps to uncover behaviour patterns and build models that predict the performance and dropouts of children's accurately. In Chapter eight, a prediction model was proposed to evaluate the readiness of a child to start school based on the socio-economic factors: father's education, father's job, mother's education, mother's job, family size, child position as well as siblings and friends in addition to the computerized assessment results. In this chapter, Data mining techniques were used, including association rules mining, clustering and classification. The final objective of this chapter is to detect as early as possible the children who are not ready for school in order to provide some type of assistance for trying to avoid and/or reduce school failure.

1.4 Contribution to the research field

- Evaluating school-readiness by using a web-based, adaptive, play-based assessment can be seen as an important aspect for accommodating the child's learning styles in web-based educational systems.
- Integrating a modified on-line genetic algorithm with adaptive parameters and soft and hard constraints into a cross-platform stealth assessment.
- Using social network data with data mining to predict if the child is ready for school.

CHAPTER 2: INTERNATIONAL PERSPECTIVES ON EARLY CHILDHOOD CURRICULA

2.1 Introduction

Early childhood education has received considerable attention worldwide. Exposing a child to a well-developed curriculum for preschool education will help in building his/her skills required to smoothly and effectively adapt to the actual school curriculum once he/she is ready to join grade one. However there is no unified curriculum which could be utilized globally; each country may have some specific aspects of the culture, the economy, etc. reflected in the curriculum.

This chapter is a review on the early childhood curriculum and pedagogy in 10 different countries from various continents listed in alphabetical order: Brazil, Finland, France, Germany, Israel, Japan, Lebanon, South Africa, United Kingdom (UK) and the United States of America (USA).

The aim of this chapter is to review these curricula, the effects of Early Childhood Education (ECE) attendance on Cognitive Development and discussing quality aspects. A further aim is to raise awareness of curriculum questions in connection with children's learning and development.

2.2 Brazil

2.2.1 Country Profile

Brazil is geographically the largest country in South America and the eighth largest country in the world. With many other South American Spanish speaking countries; Brazil is the only Portuguese speaking nation in the Americas. As of July 2012, approximately 205,716,890 peoples live in Brazil, CIA-Brazil (2012).

Table 1- Education profile **-** Brazil (2012)

Total population (000)	205,716
Annual population growth rate (%)	1.1
Population 0-14 years (%)	(2005) 28
Rural population (%)	15
Total fertility rate (births per woman)	1.8
Infant mortality rate (0/00)	14
Life expectancy at birth (years)	73
GDP per capita (PPP) US$	11,640
GDP growth rate (%)	2.7
Children of primary school-age who are out of school (%)	(1970) 30
Pre-primary school enrolment	73%

Source: UNESCO Institute for Statistics (2012)
Legend: 000= Thousands; 0/00= 1/100; PPP= Purchasing Power Parity per capita

2.2.2 Education system:

The education system is divided into basic education and higher education. Basic education consists of six years of non-compulsory early childhood education (0 to 6+ years), eight years of compulsory elementary education (7+ to 14+ years) and three years of no compulsory secondary education (15+ to 17+ years). Elementary and secondary education is free in public schools and fee-paying in private schools. Elementary education lasts nine years in some states, which have chosen, under the 1996 National Education Guidelines and Framework Law, to permit 6+-years-old to enrol in primary school. UNESCO/OECD (2007)

Table 2- Profile of key early childhood services

	Day care centres	**Pre-schools**
Age group	0-3	4-6
Purpose	Care and education	Education
Opening hours	Mostly full-time, five days per week	Mostly half-time, five days per week
Required qualification level of teachers	(Minimum) secondary education teaching certificate	(Minimum) secondary education teaching certificate
Responsible government sector	Education	Education
Funding	Municipalities (and states)	Municipalities (and states)

Source: UNESCO/OECD (2007)

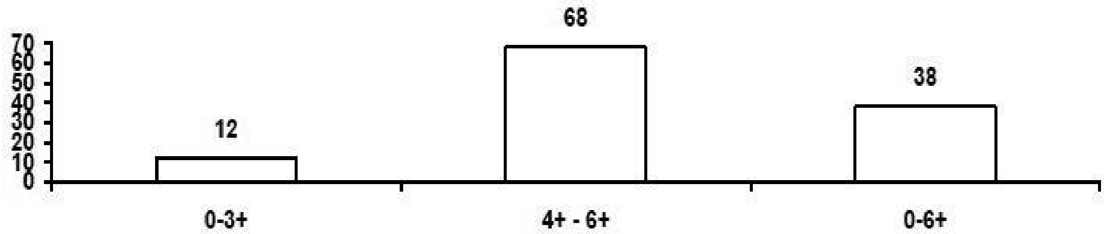
2.2.3 Early childhood profile

Legislative status: Early childhood education for children under age 6+ is a constitutional right in Brazil. The Constitution gives municipalities responsibility for providing education for young children.

Service structure: Early childhood education, as the law specifies, is divided into day care centres for ages 0 to 3+ and pre-schools for ages 4+ to 6+. UNESCO/OECD (2007).

In 2003 the schooling rate of 0- to 6+-years-old overall was 38% (Figure 1). However, while the schooling rate was 68% for 4+- to 6+-years-old, it was 12% for 0- to 3+-years-old – a substantial gap between the two age groups. For the most part, early childhood education in Brazil actually starts at age 4+, not at birth.

Figure 1- Schooling rate of young children in Brazil, by age, 2003



Source: IBGE (2004: Tables 2.6 and Table 11.4).

Table 3- Years of compulsory schooling in Latin America

Country	Pre-primary	Primary	Lower secondary	Upper secondary	Total	Age of entry into primary
Argentina	1	6	3		10	6
Brazil		**4**	**4**		**8**	**7**
Colombia	1	5	4		10	6
Costa Rica	1	6	3	1	11	6
Dominican Rep.	1	6	2		9	6
Ecuador	1	6	3		10	6
El Salvador	3	6	3		12	7
Mexico	3	6	3		12	6
Panama	2	6	3		11	6
Peru	1	6	3	2	12	6
Uruguay	1	6	3		10	6
Venezuela	1	6	3	1	11	6

Source: UNESCO (2003).

Two key aspects of Brazil's early childhood education system distinguish it from those of other countries in the region. First, early childhood education is not compulsory in Brazil, unlike in some other countries in the region as shown in Table 3. Second, Brazil has eight years of compulsory schooling, whereas in most other countries in the region, mandatory schooling lasts for ten to twelve years. Children in Brazil start primary education at age 7+, while 6+ years is more or less standard elsewhere.

2.2.4 Pre-School education (Educação Infantil)

Pre-School education is entirely optional, and exists to aid in the development of children under age 6. It aims to assist in all areas of child development, including motor skills, cognitive skills, and social skills while providing fertile ground for the later acquisition of knowledge and learning. There are day nurseries for children under 2, kindergartens for 2-3 years old, and preschools for children 4 and up.

2.2.5 Child development measurements

Testing children's cognitive and socio-emotional development can play an important role in gauging the overall health of the Early Child Education - ECE system as well as identifying children with special needs. Of course, test results at any age must be safeguarded to prevent abuse.

As the consequences of an assessment increase in importance, so does the importance of using high-quality instruments implemented by well-trained examiners. For example, a simple child monitoring test can have implications for how a child's family views the potential of that child. Other tests, used to screen for whether a child requires special services, can directly affect a long-term education trajectory. It is therefore essential to ensure that tests are implemented appropriately and that the results are used with care, Snow and Van Hemel (2008). This is in line with the National Education Council's 2009 judgment proposing that ECE evaluations not be used to hold back individual students, Evans and Kosec (2012). If the goal is to gauge the quality of the system, then testing a sample of students in the system can be sufficient and cost-effective. The test results can be delinked from child-specific identifiers to protect children's well-being. At the same time, many Quality Rating Systems (QRSs) in the United States require child care centres to provide screenings to ensure that children are developing appropriately and to see if they need any additional services. In no case are these assessments linked to the centre's incentives: They are purely intended to raise the quality of services for the child. Most programs that require assessments, however, must provide evidence that information from the assessment is used for individual planning for the children, and must share the information with parents, as in the New Mexico (United States) program.

Quality rating systems (QRS) for Early Child Education (ECE) in the United States generally evaluate the standards outlined in Table 4.

Table 4- Each QRS employs only a subset of these standards at Tout et al (2010)

Licensing Compliance	Family Partnerships
Ratio and Group Size	Administration and Management
Health and Safety	Cultural and Linguistic Diversity
Curriculum	Accreditation
Environment	Provisions for Special Needs
Child Assessment	Community Involvement
Staff Qualifications	

2.3 Finland

2.3.1 Country Profile

Finland was a relative latecomer to industrialization, remaining a largely agrarian country until the 1950s. Thereafter, economic development was rapid, such that today, Finland has a nominal per-capita income of over $46,000 in 2012, Agarwal, Arnold, Dowling, and Mircheva (2014). According to some measures OECD (2013) , Finland has the best educational system in Europe and has recently been ranked as one of the world's most peaceful and economically competitive countries, OECD (2009). It has also been ranked as one of the world's countries with the highest quality of life. In 2010, Newsweek magazine ranked Finland as the overall "best country in the world" after summing various factors. Newsweek (2010)

The country spends heavily on education, training and research - investment which pays dividends by delivering one of the best-qualified workforces in the world. This has been a key factor in the development of a modern, competitive economy in which an advanced telecommunications sector has been added to the traditional timber and metals industries. BBC News (2012).

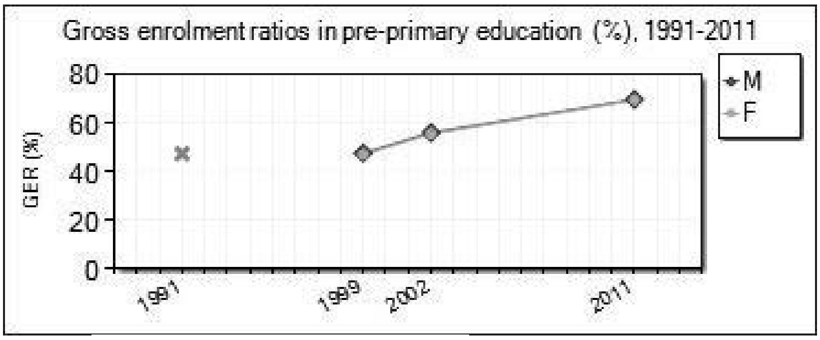
Table 5- Education profile - Finland (2012)

Total population (000)	5,385
Annual population growth rate (%)	0.5
Population 0-14 years (%)	16
Rural population (%)	16
Total fertility rate (births per woman)	1.8
Infant mortality rate (0/00)	2
Life expectancy at birth (years)	80
GDP per capita (PPP) US$	46,000

GDP growth rate (%)	2.7
Children of primary school-age who are out of school (%)	2

Source: UNESCO Institute for Statistics (2012)

Figure 2- Finland - Pre-primary enrolment - 70% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

<u>*2.3.2 Basic Data*</u>

Kindergarten teachers hold undergraduate degrees in early childhood education or social sciences and many continue on to postgraduate degrees. For children above the age of 3, the proportion is 1 teacher to 7 children (children with special needs have additional assistants). At preschool, the proportion is 1:13 and at afternoon care facilities it is 1:4. For children until age of 6, responsibility lies with the Ministry for Welfare and the Ministry of Health. For children from the age of 6, responsibility lies with the Ministry of Education. From the age of 6, pupils can participate in preschool. The state must make such studies available and finance them, as well as afternoon care. Preschool studies are for four hours a day, in which the students participate in games, physical activities, and problem solving. (For the core program, see below).

During the first two years (ages 7-9), there are 19 weekly hours. The local authorities provide the two lower classes with extracurricular afternoon activities, primarily in music and art. The number of school students ranges from 10-900, with an average of 300 - 400. Fifteen percent of students receive personal assistance or assistance in small groups.

<u>*2.3.3 Principles of the Core Program*</u>

It is customary in core programs to specify various study topics. The Finns emphasize less pedagogic aspects. Educators have a key role in involving parents on a daily basis in taking care of the child. Parental involvement is essential for the

child. The transition from cooperation to full participation requires ongoing mutual commitment in all matters relating to the child.
The principles are intended to create educational equality throughout the country, to improve quality and to increase professional awareness, the guidelines are: non-discrimination, the welfare of the child, the child's right to maximum development, giving weight to the child's opinion.
The child's right to receive warm, personal attention, secure development and study, a healthy, understanding environment, attention to special needs, and the acceptance of the child's language, culture and arts and an appropriate combination of concern, education and tuition will advance the child's positive self-image.
The teacher needs to listen to the child to give him the opportunity to initiate and make decisions, to examine and reach conclusions and to express thoughts.
Language has an essential role in creating the child's model of the world.
Word games direct the student's attention to language formulation.
Exposure to the arts: dancing, drawing, music, building, drama and literature. The intensity attracts the child's attention, and creates an imaginary world in which anything is possible. The arts also allow self-expression and cooperation.

Table 6- Curriculum content

Subject	**Fields**
Mathematics	Equations, conclusions and calculations
Science	Flora and fauna according to the seasons
History	Building a picture of time and events experienced by older people
Aesthetics	Rhythm, harmony, style
Ethics	The difference between good and bad, truth and falsehood, anxiety and blame
Religious	As agreed to with the parents

Source: Valimakiand Lindberg (2004).

A program for personal progress, prepared for each student in coordination with the parents and the teacher, is supposed to monitor the child's progress.
The core principles are general only. They are available at http://www.thl.fi/fi_FI/web/kasvunkumppanit-fi as part of the Internet program for young children called Edini (Educare-Internet-Interaction). The site was established and is maintained by the development branch of the Ministry of Welfare and Health (STAKES). To consolidate the guidelines, the director-general of the Finnish Ministry of Education established a steering group aided by a work committee that is staffed by experts, heads and teams of experts on specific matters.

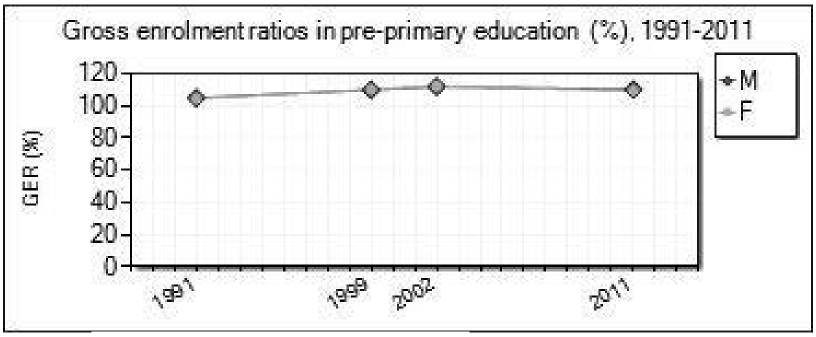
2.4. France
2.4.1 Country Profile

Table 7- Education profile - France (2011)

Total population (000)	63,126
Annual population growth rate (%)	0.5
Population 0-14 years (%)	18
Rural population (%)	14
Total fertility rate (births per woman)	2
Infant mortality rate (0/00)	3
Life expectancy at birth (years)	82
GDP per capita (PPP) US$	35,247
GDP growth rate (%)	1.7
Children of primary school-age who are out of school (%)	1

Source: UNESCO Institute for Statistics (2012)

Figure 3- France - Pre-primary enrolment (*) - 110% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)
(*) The GER may be greater than 100% when students younger or older than the official age for a given level of education are enrolled in that level.

2.4.2 Background, Curriculum and Evaluation

In 1980, the French Ministry of Education called for policies to be introduced based on evaluation, research and performance. "Evaluation policies" said the ministry "will raise both student achievements and the system through evaluation and management".

As such, the supervisor conducts research about the administration, budgeting and organizational aspects. Moreover, one visit is made every three years to each school.

Learning is divided into three cycles: the first is called first learning, and includes the two years before school. The second, basic learning - includes the last year before school and the first two years of school, Ministère de l'Éducation Nationale (2012), and are marked CP (*cours preparatoire*) and CE1 (*cours elementair*). The third cycle is consolidation - this includes the last three years of primary school. These years are marked CM2. CM1 (*cours moyen* 1), CE2.

Table 8- Structure of the School

Maternelle (Kindergarten)		
Age	Grade	Abbreviation
3	Petite section	PS
4	Moyenne section	MS
5	Grande section	GS
École élémentaire (Primary school)		
Age	Grade	Abbreviation
6	Cours préparatoire	CP
7	Cours élémentaire première année	CE1
8	Cours élémentaire deuxième année	CE2
9	Cours moyen première année	CM1
10	Cours moyen deuxième année	CM2

Source: Ministère de l'Éducation Nationale (2012).

Organizing schooling into cycles provides the necessary flexibility to accommodate children's diversity, abilities and rate of development. All students do not progress at the same rate in all subject areas. Creating cycles allow children to be stimulated and challenged. Teachers can better evaluate their knowledge and their work habits. As is common in France, some classes at La Petite Ecole might be organized by cycle rather than grade, resulting in split or combined classes. The class structure is adapted to enrolment patterns and to what works best for the students involved.
Each cycle of learning has an evaluation report; students work on the same concepts within the entire cycle and have that entire cycle of time to master the concepts before moving on. This evaluation report is shared with the parents twice a year in preschool and 3 times per year for all other grades. At the same time, student progress is discussed during parent–teacher conferences.
In preschool, children are fully immersed in the French language with a teacher/student ratio of 1 to 6. In Kindergarten, the teacher/student ratio is 1 to 12 and students have 45 minutes of English every day taught by a certified English teacher. At the Elementary level, the teacher/student ratio is 1 to 15 and students have one hour of English per day. Spanish is also introduced in 3rd grade.

Table 9- CYCLE 1, CYCLE 2 and CYCLE 3

CYCLE 1: First learning

PRESCHOOL (Toute Petite and Petite Section de Maternelle):	**JUNIOR KINDERGARDEN** (Moyenne Section de Maternelle)
This is a full French immersion program for 2 and 3 yrs. old.	The 4 yr. old students follow a French immersion program with the addition of 45 minutes of English language arts each day.
The program focuses on: • Socialization: school life • Behaviour towards learning • French oral language • Early literacy • Handwriting and fine motor skills • Mathematics • Time and space concepts • Gross motor skills	The program focuses on: • Behaviour towards learning • Fine motor skills • Physical abilities • World discovery • Early literacy • French oral language Mathematics • Time and space concepts • English language art

Source: Brougère at el. (2008)

CYCLE 2: Basic learning

KINDERGARTEN (Grande Section de Maternelle)	**1st and 2nd GRADES** (CP and CE1)
The 5 yr. old students follow a French Immersion program with the addition of 45 minutes of English language arts each day.	The 6 and 7 yr. old students follow a French immersion program with 60 minutes of English language arts each day.
The program focuses on: • Behaviour towards learning • Handwriting and drawing • Physical activities and music • Nature and science • Early literacy • French language arts • Mathematics • Time and space concepts • English language art	• French • Mathematics. • Discovering the World • Civics • The Arts • Physical Education • English Language

Source: Brougère at el. (2008)

CYCLE 3: In-depth learning

3rd, 4th and 5th GRADES (CE2, CM1 and CM2)
Students follow a French immersion program with 60 minutes of English language arts each day and 120 minutes of Spanish per week.
• French: Practicing oral skills • Mathematics • History and Geography • The Arts - Music • Physical Education • English Language Arts

Source: Brougère at el. (2008)

Following extensive revisions, and the development of the *socle commun* (the common basis of knowledge and skills), a new primary program of study was introduced from the beginning of the 2008 school year. Similar new programs of study were introduced to lower secondary education at the start of the 2009 school year. Phased introduction of the new upper secondary curriculum started in August 2010. Sargent, Houghton and O'Donnell (2012)

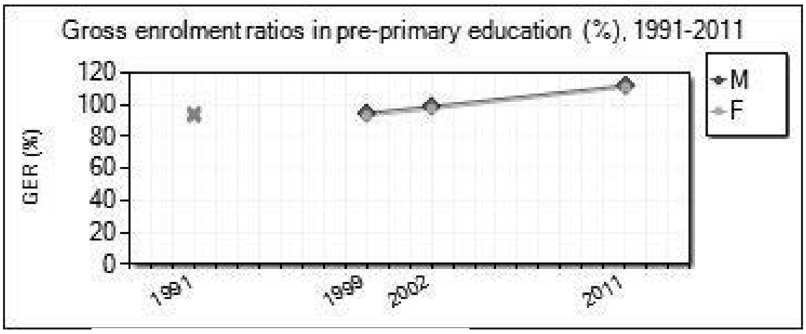
2.5 Germany
2.5.1 Country Profile

Table 10- Education profile - Germany (2011)

Total population (000)	82,163
Annual population growth rate (%)	0.0
Population 0-14 years (%)	13
Rural population (%)	26
Total fertility rate (births per woman)	1.4
Infant mortality rate (0/00)	3
Life expectancy at birth (years)	81
GDP per capita (PPP) US$	39,456
GDP growth rate (%)	3.0
Children of primary school-age who are out of school (%)	(2005) 1

Source: UNESCO Institute for Statistics (2012)

Figure 4- Germany- Pre-primary enrolment (*) - 112% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)
(*) The GER may be greater than 100% when students younger or older than the official age for a given level of education are enrolled in that level.

Germany has made a unique contribution to the field of early childhood education and care through its concept of social pedagogy, a holistic approach to child rearing, education and development that has become the foundation of the European Consortium Emergency Contraception (ECEC) profession in many European countries. However, Germany's system of ECEC service delivery is complex, as it is a federal state that relies on the principle of subsidiary. Driven by the need to improve economic performance and educational outcomes, Germany is moving towards universal access for children under the age of 3. However, the OECD noted that Germany still had a long way to go in terms of improving access for children of migrant or low income backgrounds. OECD (2004).

2.5.2 Curriculum

The German provinces have begun to develop education plans for ECEC services within a national framework that was developed through provincial ministerial conferences. Though the education plans vary from province to province, they all focus on the following areas: linguistic education and promotion, mathematics, natural science and technical education, musical education and child raising, aesthetic, visual and cultural education and child-raising, promotion of movement and sport, health and child-raising. Schmidt (2004) .

Germany is unique in the fact that it developed its own approach to early childhood education and care that has become the foundation of child pedagogy in many European countries, OECD (2004) . Developed in the 19th century, the concept of *Sozialpaedagogik* or social pedagogy is both a theory and practice for working with children. It is a holistic approach that focuses on the body, mind, emotions, creativity, history and social identity of the child, rather than scholastic outcomes. The approach sees learning, care and upbringing as intrinsically linked. As such, the OECD notes that despite the formal separation between education and child care in Germany, Germany's pedagogical approach brings them back together.

In Germany there is no fixed, nationally-defined early years curriculum, but within the various *Lander* kindergarten curricula do exist. Generally, these aim to *achieve a readiness for school by channelling the child's natural urge to play* but do not attempt to anticipate the subject matter taught in school.

Kindergartens individually develop their curriculum on the basis of a set of elementary aims for kindergartens in Germany and the ideological, denominational, religious or educational approach of the institution. Most early years settings have programs which stimulate children's general development, with an emphasis on the following areas:

- Development of a child's physical, mental, emotional and social abilities
- Development of a sense of responsibility
- Awareness of daily routines and basic hygiene

- Awareness of environmental responsibility.

National tests to assess performance against common standards in primary and lower secondary education are being introduced. The results of the first standardized tests were published in 2010. The process began in the 2004/05 school year, based on an agreement of the Standing Conference of the Ministers of Education and Culture of the 16 German *Länder* first signed in 2002. A common catalogue of objectives and measures was agreed in the Dresden Declaration of 2008. Sargent, Houghton, and O'Donnell (2012).

2.6. Israel

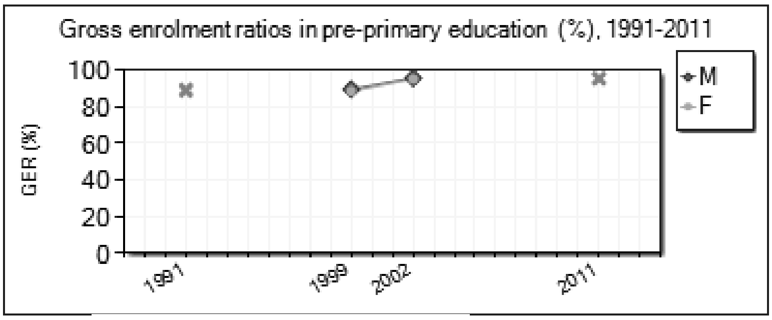
2.6.1 Country Profile

Table 11- Education profile - Israel (2011)

Total population (000)	7,562
Annual population growth rate (%)	1.8
Population 0-14 years (%)	27
Rural population (%)	8
Total fertility rate (births per woman)	3
Infant mortality rate (0/00)	4
Life expectancy at birth (years)	82
GDP per capita (PPP) US$	28,809
GDP growth rate (%)	4.7
Children of primary school-age who are out of school (%)	(2010) 3

Source: UNESCO Institute for Statistics (2012)

Figure 5- Israel- Pre-primary enrolment - 95% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

2.6.2 The kindergarten curriculum

The preschool division of the Israeli Ministry of Education poses a number of goals in all matters relating to young children. These goals emphasize improving language skills, thinking and enrichment, the acquisition of life skills and social skills, developing personal independence and tolerance for the other, literacy and problem-solving and creating the foundation for learning.

The division's policy promotes focus areas and goals within early childhood education, which kindergarten teachers follow in keeping with designed work plans. They evaluate learning and educational achievements in kindergarten and the level of the children's functioning. The kindergarten teachers' evaluation of the children must be ongoing and in keeping with their development, using current and appropriate tools which are currently being developed. Klein at el (2008).

The division advances a well-organized foundation for learning in kindergartens based on detailed curricula. In essence, the foundation is a core curriculum for kindergarten, which is still being consolidated. The plan comprises four central themes, Nachum (2010):

- **Literacy:** Children completing compulsory kindergarten are expected to have a command of literacy skills as they are defined in the "foundation for reading and writing" program. The program includes teaching the components of pre-literacy, alphabet skills, and the onset of writing and reading (including awareness of phonology, learning letters, and other skills), verbal skills and ability to tell a story. As part of inculcating the program in kindergarten, the teacher sets up reviews in various situations to evaluate the extent to which each child has grasped the components.
- **Mathematical thinking:** the preschool division emphasizes developing a positive stance toward math among kindergarten children, which includes development of skills in concentrating, thinking to develop counting, measuring and making comparisons. The program doesn't include evaluation by the kindergarten teacher.
- **Arts:** experimenting, independent creative expression, concentrating and relating to the aesthetics of the child's surroundings and creating art. All of this is achieved experientially in a methodical and focused manner, including giving children ongoing exposure to creating varied works of art.
- **Life skills:** Education in matters of health and safety and the acquisition of appropriate habits, with an emphasis on prevention.

In Summary:

The Ministry of Education's preschool curriculum is not fully inculcated in kindergartens under its auspices. In addition, the process by which the kindergarten teachers may evaluate the learning and the acquisition of the curriculum's proficiencies and skills is, in principle, based on observation. This allows for impressionistic documentation, but does not provide standardized measurements that permit comparisons of abilities, capacities and/or functioning. The evaluation of what is achieved in the kindergarten classroom is done by outside organizations, and does not take into account the group as a whole.

2.7 Japan

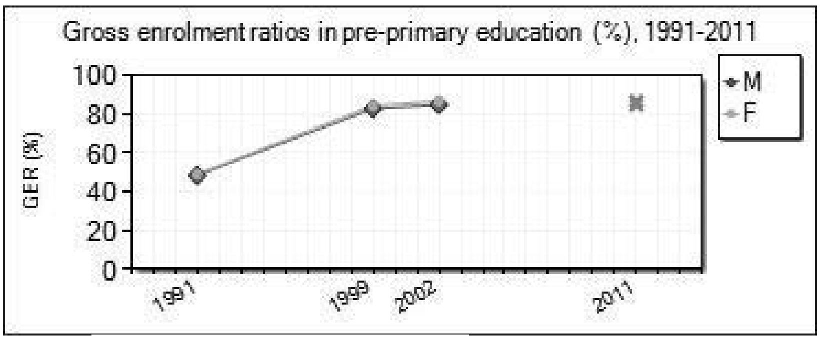
2.7.1 Country Profile

Table 12- Education profile - Japan (2011)

Total population (000)	126,497
Annual population growth rate (%)	0.3
Population 0-14 years (%)	13
Rural population (%)	9
Total fertility rate (births per woman)	1.4
Infant mortality rate (0/00)	2
Life expectancy at birth (years)	83
GDP per capita (PPP) US$	33,668
GDP growth rate (%)	-0.7
Children of primary school-age who are out of school (%)	(1983) 3

Source: UNESCO Institute for Statistics (2012)

Figure 6- Japan- Pre-primary enrolment - 87% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

2.7.2 Early Childhood Development Programming

Today, many Japanese children under the age of 3 are looked after by their mothers during the daytime. The enrolment rate of children under 3 years old in day-care centres is 21 percent (1999). Nine percent of 3-year-old children attend kindergartens and 30 percent of them attend day-care centres. At age 5, 83-percent of children participate in collective education (48% at kindergarten and 35% at day-care centres). Almost all 5- to 6-years-old children receive preschool education (60% at kindergartens and 39 % at day-care centres) before entering elementary schools. Elementary school is obligatory for children from 6 to 12 years old.

Early childhood education in Japan has two systems, kindergarten and day care. Kindergartens are operated under the School Education Law, and accept children from 3 to 6 years of age for four hours a day more than 39 weeks a year. The kindergarten education guidelines (National Curriculum Standards for Kindergartens) issued by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) regulate the objectives and contents of kindergarten education, although private kindergartens are not required to follow them completely Ochanomizu University (2004).

2.7.3 The Five Content Domains of Early Education

Japanese preschool education focuses on five areas of study: health, language, expression, human relationships, and environment. The objectives of preschool education are not to attain goals but to encourage motivation or inclination. In the Guidelines, for example, emphasis will be on objectives such as "a child *enjoys,*", "A child is *interested* in," "a child *tries* to . . .", "a child *feels*", etc. (Ochanomizu University (2006).

In Japan since 1990 there has been a national early years curriculum, a Ministry-defined *Course of study*. Each school is expected to organize its own curriculum in accordance with the course of study, taking into account local circumstances and children's needs. The course of study is regularly reviewed and revised, with the most recent version being introduced in 2000. The course of study instructs teachers on what and how to teach. In the course of study there is a focus on constructive play and learning social behaviour and how to cooperate in a group.

However, Japanese kindergartens provide an academic curriculum which includes the first stages of reading and arithmetic. Children are expected to be able to read and do simple sums involving addition and subtraction by the time they leave at six years of age. However, the Japanese school system does not require children to have academic abilities such as reading, writing and arithmetic before they enter compulsory schooling. In fact, the first year of primary education is designed for children who have no academic experience. In addition to the first stages of reading, writing and arithmetic, many kindergartens also attempt to develop the more general intellectual skills of thinking, observation, learning and general intelligence. To this end the new kindergarten curriculum framework has five inter-related aspects:

- Health
- Human relationships
- The environment
- Language
- Expression.

The overall aim is, through play, to promote intellectual development and qualities of self-reliance and awareness of others.

In 2006, the Fundamental Law of Education was revised for the first time in 60 years. Following a review in 1998, revised courses of study were introduced at primary and lower secondary level in 2002. In 2009, these were reviewed again and, as a result, new curriculum guidelines were introduced in elementary schools (six- to 12-years-old) in the 2011 school year, in junior high schools (12- to 15-years-old) in 2012, and in the high schools (15- to 18-years-old) in 2013, Sargent, Houghton, and O'Donnell (2012). In March 2010, the Japanese Government also passed legislation to abolish tuition fees for public high schools (students aged 15 to 18+). New national standardized tests in Japanese and mathematics took place for all pupils in Year 6 (ages 11 to 12) and Year 9 (ages 14 to 15) in April 2007, Sargent, Houghton, and O'Donnell (2012).

2.8 Lebanon

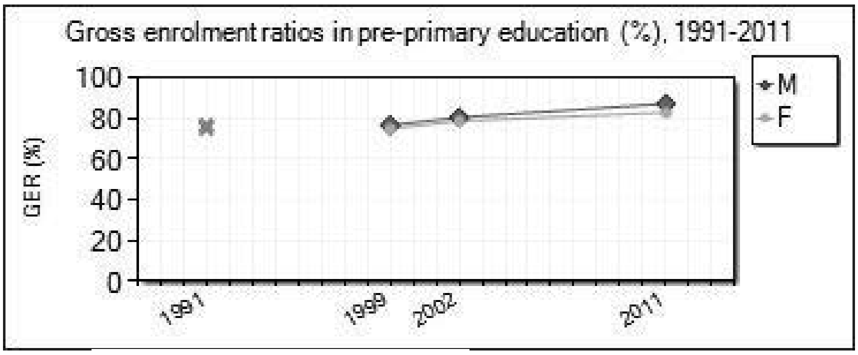
2.8.1 Country Profile

Table 13- Education profile - Lebanon (2011)

Total population (000)	4,259
Annual population growth rate (%)	0.7
Population 0-14 years (%)	24
Rural population (%)	13
Total fertility rate (births per woman)	1.8
Infant mortality rate (0/00)	8
Life expectancy at birth (years)	73
GDP per capita (PPP) US$	14,609
GDP growth rate (%)	3.0
Children of primary school-age who are out of school (%)	7

Source: UNESCO Institute for Statistics (2012)

Figure 7- Lebanon- Pre-primary enrolment - 85% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

Although the government in 1946 set the age for school entry at three for nursery and age five for beginning elementary, the government stopped here and did not include these classes in its own public school system until the 1970's, Bachour, Hoteit, Mukalid, and Sleem (2002). Efforts to expand early childhood services were hampered by the eruption of civil war (1975-1990). In the early 70s and 80s, some Early Childhood Care and Education (ECCE) programs were run by NGOs such as the Kanafani Foundation, Save the Children, and Maarouf Saad Foundation and others. These organizations worked with Palestinian refugees and children from low socio-economic backgrounds and in rural areas to provide kindergarten services.

2.8.2 Pre-School Education

The new ladder for general education in Lebanon led to two problems in pre-school education: 1) it built the curriculum of elementary education in such a way that a child could join the first grade without having gone through kindergarten; this has resulted in discontinuity between pre-school and elementary curricula; 2) it did not designate a class for the age group 3-4, despite the importance of starting education early. A Ministerial decree added this class without specifying a curriculum for it, which caused confusion in the schools.

The new curriculum for pre-school education has many positive characteristics, such as following activity-based learning and adopting a thematic approach with instructional units under each theme. On the other hand, the curriculum suffers from problems related to learning reading, writing, foreign language, mathematics, psycho-motor activities, and technology, Bachur (2002a). There is also confusion about the concept of “mother language” in a curriculum that is too general, Hatit

(1999). In fact, while all public pre-school educational institutions follow this curriculum, most free and non-free private institutions follow it only in part, Saleem (2002).

The official curriculum for preschool education in Lebanon seems harmonious with the approaches and objectives of global trends, which consider children themselves the axis of the learning process and by which children learn through the direct sensory activity in which they engage. However, this curriculum lacks fundamental elements where language is concerned: in the teaching of reading, writing, foreign languages, mathematics, psychomotricity, and technology. This curriculum also lacks important information about Lebanon. The preschool curriculum framework has five inter-related aspects: (1) Cognitive development, (2) Language development and communication, (3) Social and emotional development, (4) Physical and motor development, and (5) Creative expression. Saleem (2002)

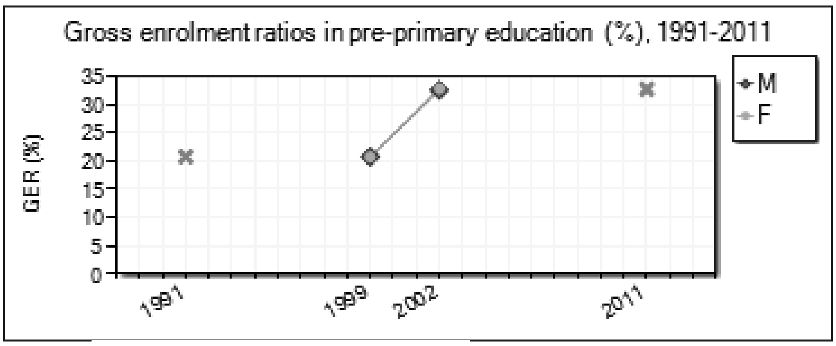
2.9 South Africa
2.9.1 Country Profile

Table 14- Education profile - South Africa (2011)

Total population (000)	50,460
Annual population growth rate (%)	1.2
Population 0-14 years (%)	30
Rural population (%)	38
Total fertility rate (births per woman)	2.4
Infant mortality rate (0/00)	35
Life expectancy at birth (years)	53
GDP per capita (PPP) US$	10,960
GDP growth rate (%)	3.1
Children of primary school-age who are out of school (%)	(2012) 10

Source: UNESCO Institute for Statistics (2012)

Figure 8- South Africa-Pre-primary enrolment - 18% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

2.9.2 Early Childhood Education in South Africa

Early Childhood Development (ECD) in South Africa has grown rapidly due to the rapid expansion of subsidies to this sector. The sector comprises pre-Grade R for children 0 to 4 years old and Grade R for children 5 to 6 years old. UNICEF, Basic Education and Social Development in South Africa (2011)

In South Africa, ECD is the term used for "the processes by which children from birth to nine years grow and thrive, physically, mentally, emotionally, morally and socially". According to the 2001 Census there are approximately 8.3 million children in this age group: 5,418,204 from 0–5 years, and 2, 872,254 from 6–9 years.

South Africa still faces formidable challenges in addressing the rights and needs of her children. Racist colonial and apartheid policies have left socioeconomic imbalances between black and white and rural and urban South Africans. There is high unemployment and many households live with the stresses of hunger, the lack of formal housing, and high levels of crime and violence including sexual abuse. Many children die of preventable diseases, with the under 5 mortality rate averaging 59.4 per 1000 in 1998. The revised projection for 2002 was 100 per 1000, attributed to the toll of the rising HIV/AIDS pandemic. The migrant labour system and rapid urbanization have eroded traditional family structures, and poverty-stricken female-headed households are common. At an overall prevalence of 29.5 percent, HIV/AIDS is a serious threat impacting on the livelihoods and family structure, with the burden of caring for children in badly affected regions falling upon the elderly and increasingly on older siblings. Many caregivers have low levels of literacy, making it difficult for them to fully support their children's early education. UNICEF (2006a)

2.9.3 Early Childhood Development Programming

Principles for programming include holistic development of the child, contextually and developmentally appropriate activities, a focus on human rights and values in the curriculum, and opportunities to play and learn informally through experience in a nurturing environment.

There is no prescribed curriculum for children under five years though the Department of Education plans to test and introduce curriculum guidelines for under fours. There are concerns in both the government and NGO sector that the requirements and delivery may be overly formal for such young children. ECD service guidelines reflect the need for stimulating activities as well as provision for health and nutrition. Asmal (2001)

Curriculum for 5-years-old forms part of the Revised National Curriculum Statement (RNCS) for the Foundation Phase (Grades R–3 or approximate ages 5–9 years). The focus is given to literacy, numeracy, and life skills programs. South Africa follows an Outcomes Based Education (OBE) system that clearly defines the outcomes to be achieved at the end of the learning process with grade-related assessment standards. Outcomes for each learning area are based on achieving a set of critical and developmental outcomes that focus on producing learners with knowledge, skills, and values for productive engagement in the workforce and a democratic and caring society.

2.9.4 Early Childhood Education Curriculum in South Africa

In post *apartheid* South Africa, "curriculum" carries with it connotations of liberation, social change, and transformation in education. *Curriculum 2005* is the new plan for school education. It specifies the "knowledge, skills and attitudes" that children are expected to attain, on a year-by-year basis, from age 5 to 15, in their journey through the formal schooling system. Importantly, as policy, it declines to prescribe either specific content or pedagogic process, deeming these to be the professional responsibility of educators. Instead, policy specifies a range of general ("cross-field") and subject specific outcomes that can, in principle, be attained along any number of different learning pathways. In this situation, consideration of curriculum is often highly politicized. Besides the usual features that one would consider—subjects, programs, pedagogy, assessment—any analysis of curriculum in South Africa must reflect on the following: its symbolic role in transforming the contents of the racist past, the implementation problems associated with pressures for rapid change, and the question of the right of access to a new curriculum.

2.9.5 Curriculum for the Under Fives

The "curriculum for the under-fives" in South Africa is concentrated in the hands of twenty or so different NGOs, and straddles a large range of "philosophies" and methodological approaches. This leads to many innovative approaches, but it also means that the overall provisioning for young children remains small in relation to the overall need. A national sense of curriculum in this area, which can go to scale, still seems some way off. There is wide expectation of government that it will, at some point, take the initiative in driving a national agenda in this regard. If it can tap into the wide pool of established curriculum knowledge in South African NGOs, it may well be able to do this. But it requires money, trained people, and political will.

2.9.6 Early Childhood Development Professional Development in South Africa

One of the most important indicators of quality early childhood development (ECD) programs is the quality of training received by the practitioners working with young children. A National ECD Audit conducted in May/June 2000 showed that the vast majority of ECD practitioners were under qualified (58%) or untrained (23%). The numbers of centres and children in provision were considerably greater than anticipated, but while provision for children has increased, training opportunities for practitioners have decreased considerably. The opportunities provided through the development of the National Qualifications Framework (NQF), accreditation procedures and some new initiatives for funding training need to be fully explored to generate creative solutions for meeting training needs as cost effectively as possible.

2.9.7 Early Childhood Development Qualifications

After 1994, the South African Qualifications Act was passed. The Act aimed to design a national learning system, and established the South African Qualifications Authority (SAQA) as a statutory body responsible for the development and implementation of the NQF. The Act embodied the government's integrated approach to education and training. The principle of lifelong learning also underlines the progressive education policies of South Africa. UNICEF (2005)

The NQF framework comprises eight levels, grouped in three bands. Level 1 (and below) comprises the General Education and Training band, levels 2 to 4 comprise the Further Education and Training band, and levels 5 to 8 the Higher Education and Training band (tertiary). The levels are defined by level descriptors that allow for equivalencies between different courses. For example, Level 1 on the NQF comes at the end of ordinary, compulsory schooling up to Grade 9, but can also be reached through ECD training for adults who had limited educational opportunities in the Apartheid era.

ECD standards and qualifications have been registered by SAQA at Level 1 (basic certificate equivalent to Grade 9), Level 4 (national certificate equivalent to a high school leaving certificate or Grade 12) and at Level 5, where there is a post-school higher certificate (one year) and a diploma (two years).

Each of these qualifications prepares teachers to work in infant and toddler care (0–3 years) or the preschool phase (2–6 years), with various specializations such as the reception year (Grade R). A 4-year bachelor of education degree is required in order to teach at the foundation phase (Grades R–3, or 5–9 years). This is recognized as a Level 6 qualification. Atmore (2007)

Some tertiary institutions offer a specialization in preschool education. Postgraduate opportunities include an honours degree and higher diplomas (Level 7), masters and doctoral programs (Level 8), but very few tertiary institutions offer higher degrees in ECD.

Following a review of the implementation of the National Curriculum Statements (NCS) in 2009, a revised curriculum for all learners began to be introduced in 2011. Annual National Assessments (ANAs) which are standardized national assessments for languages and mathematics taken by students in Grades 2 to 7 (aged 7/8 to 12/13). Grade 9 (students aged 14/15) literacy and numeracy ANA tests were first taken in 2012 academic year. The class of 2008 was the first to take the National Senior Certificate (NSC) in Grade 12 (aged 18). NSC is based on the National Curriculum Statement. Sargent, Houghton, and O'Donnell (2012)

2.10 UK

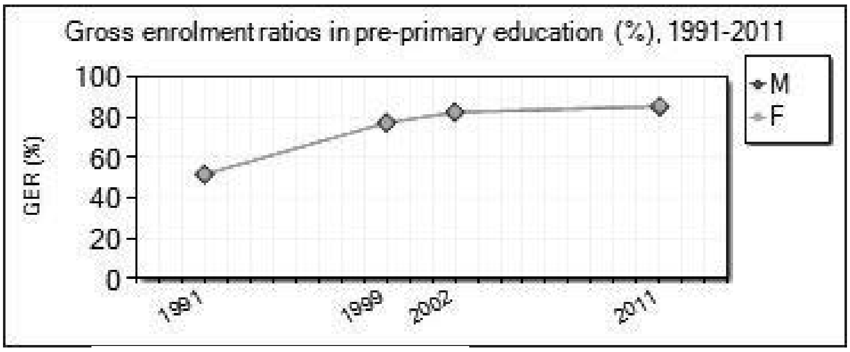
2.10.1 Country Profile

Table 15- Education profile - United Kingdom of Great Britain and Northern Ireland (2011)

Total population (000)	62,417
Annual population growth rate (%)	0.8
Population 0-14 years (%)	17
Rural population (%)	20
Total fertility rate (births per woman)	2.0
Infant mortality rate (0/00)	4
Life expectancy at birth (years)	81
GDP per capita (PPP) US$	35,598
GDP growth rate (%)	0.8
Children of primary school-age who are out of school (%)	(2007) 10

Source: UNESCO Institute for Statistics (2012)

Figure 9- UK- Pre-primary enrolment - 85% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

2.10.2 Basic Data

For children above the age of three, the proportion is one staff member for every 13 pupils (half of the staff have high school education, and half have an academic degree) from age 5 the proportion is 2:30 (a teacher holding an undergraduate degree and an assistant). From age 5, class duration is from 9-15:30.

Out of school time provision - OSP - is funded via the national lottery pursuant to a 10-year plan which commenced in 2004 and today is providing every student, with a solution from 08:00 a.m. to 06:00 p.m. The number of places rose from 137,000 in 1997 to 490,000 in 2004. School supervision was expanded from once every six years to once every three years, and is carried out by the supervision division of the Office for Standards in Education, Children's Services and Skills (Ofsted). Ofsted (2014).

Every Child Matters (ECM) is a UK government initiative for England and Wales, that was launched in 2003, at least partly in response to the death of Victoria Climbié. It is one of the most important policy initiative and development programs in relation to children and children's services of the last decade, and has been described as a "sea change" to the children and families agenda, The Guardian (2009). It has been the title of three government papers, Stelzner (2008), leading to the *Children Act 2004*. Every Child Matters covers children and young adults up to the age of 19, or 24 for those with disabilities.

Its main aims are for every child, whatever their background or circumstances, to have the support they need to: SHEEP

- **S**tay Safe
- **H**ealthy

- **E**njoy and achieve
- **E**conomic well-being
- **P**ositive contribution

Each of these themes has a detailed framework attached whose outcomes require multi-agency partnerships working together to achieve. The agencies in partnership may include children's centres, early years, schools, children's social work services, primary and secondary health services play work, and Child and Adolescent Mental Health Services (CAMHS). In the past it has been argued that children and families have received poorer services because of the failure of professionals to understand each other's roles or to work together effectively in a multi-disciplinary manner. ECM seeks to change this, stressing that it is important that all professionals working with children are aware of the contribution that could be made by their own and each other's service and to plan and deliver their work with children and young people accordingly. Barker (2009)

A helpful acronym to remember the 5 parts is SHEEP - Every child shall be: Safe, Healthy, Enjoy/Achieve, Economic, Positive contribution.

It is the central goal of Every Child Matters to ensure every pupil is given the chance to be able to work towards the goals referenced within it. Most of the legislation passed and guidance applies to England and Wales and all maintained schools have implemented the policy; it has also been influential in the rest of the UK and in some independent schools. The similar model Getting It Right For Every Child (GIRFEC) is the equivalent approach in Scotland.

2.10.3 The Curriculum

The curriculum is binding on all public schools in UK. For ages 5-11 it includes reading, English, arithmetic, natural sciences, scholarship and technology, history, geography, arts and drawing, music, technology design, physical education and Personal, Social and Health Education (PSHE). UK Department for Education (2014)

In September 2000, the government introduced the *foundation stage* to encompass publicly-funded educational provision for children from three to five plus years (end of reception year). The published *Curriculum guidance for the foundation stage* included a curriculum based upon six areas of learning:

- Personal, social and emotional development
- Communication, language and literacy
- Mathematical development
- Knowledge and understanding of the world
- Physical development
- Creative development.

It also included a set of *early learning goals* (previously called *desirable learning outcomes*) for each area which established expectations for most children to reach by the end of the foundation stage. Bertram and Pascal (2002)
In addition to the *Curriculum guidance for the foundation stage*, since 1999 school-based early years settings have also been subject to the *National literacy* and *numeracy strategies*, which form a major part of the government agenda for raising standards in schools. In both these programs there is an intensive and detailed literacy and numeracy curriculum provided for teachers, who are expected to deliver a daily hour of each program for all children. For pres-compulsory schooling age children, the National literacy and numeracy strategies may be delivered more flexibly.
For children under the age of three years, and pre-school children in non-publicly-funded education or care provision, there continues to be no nationally-prescribed curriculum framework. However, the government, through *Early Years Development and Childcare Partnerships*, is developing and disseminating good practice guidelines for all early education and care provision catering for children from birth. These focus primarily on children's social and emotional development and the development of language and literacy. There is also a government-funded project which is exploring the development of a national set of curriculum guidelines for under-threes. UK Department for Education (2014)

The Education and Skills Act 2008 introduced a requirement for all young people to participate in (at least part-time) education and training until their 18th birthday. The first cohort to be affected by the changes began secondary education (Year 7, age 11) in September 2008. The minimum age at which young people can leave learning will be raised in two stages – to 17 from 2013 and to 18 from 2015. In 2006, the weekly free entitlement of 12.5 hours of early education and childcare for three- and four-years-old was extended from 33 weeks per year to 38 weeks. Since 2010, all three-and four-years-old have been entitled to 15 hours of free early education and childcare provision. A review of the National Curriculum for primary and secondary education began in January 2011 and is ongoing. Sargent, Houghton, and O'Donnell (2012)

2.10.4 Future Curricula and Research

The Department for Education and Skills (DfEE) circulated a consultation paper in July 1999 which asserted the importance of developing a strong knowledge base to inform policy. The Department has emphasised the value placed on research and evaluation with plans to double its research budget (to £10.4 million) by 2002. Much of this work will be carried out by academics in the early years research community who have a strong national and international reputation for high quality work. Current DfEE research priorities for early childhood, which are expected to frame government-sponsored research and evaluation in the foreseeable future, include Bertram and Pascal (1999):

1) Evaluating the influence and efficiency of the new curricula on young children.
2) Examining the efficiency of intervention curricula on young children.
3) Discrepancies in the use of indexes for infants due to social background, gender, family background, special abilities or needs.
4) Research to collect international testimony regarding the efficiency of strategies for young children.
5) Research on qualification training, and recruiting experts to work with young children.
6) The relevancy of ICT - Information and Communication Technologies - for teaching preschool and learning methods.

Many preschools run programs that include the use of fax machines, digital palm cameras, cell phones and other accessories, in order to bring the child closer to the world of technology and to endear him to it.

In 2006, the Qualifications and Curriculum Authority (QCA) recommended that teaching be combined with listening to sounds, writing and reading. Research examining the effect of the Sure Start curriculum on parental involvement has not found a significant improvement resulting from the curriculum. NESS Impact Study (2005)

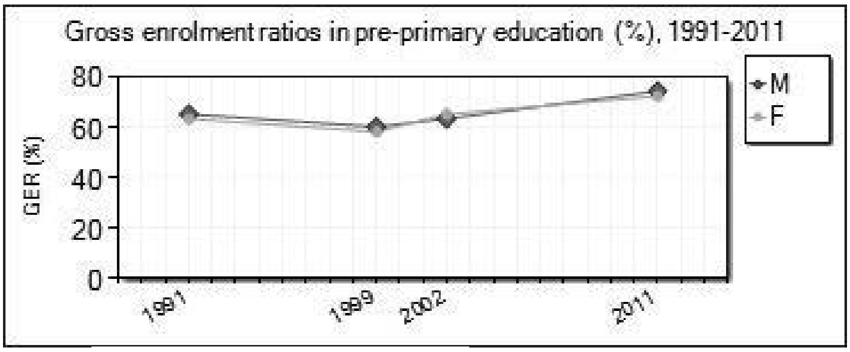
2.11 USA
2.11.1 Country Profile

Table 16- Education profile - United States of America (2011)

Total population (000)	313,085
Annual population growth rate (%)	0.7
Population 0-14 years (%)	20
Rural population (%)	18
Total fertility rate (births per woman)	1.9
Infant mortality rate (0/00)	6
Life expectancy at birth (years)	79
GDP per capita (PPP) US$	48,112
GDP growth rate (%)	1.7
Children of primary school-age who are out of school (%)	7

Source: UNESCO Institute for Statistics (2012)

Figure 10- USA- Pre-primary enrolment - 73% of children are enrolled in pre-primary school



Source: UNESCO Institute for Statistics (2013)

There is no national curriculum in the USA. Some federal interventionist programs, for example, Head start, existing for more than 35 years, have began under the Bush adminitration to put more emphasis in kindergarten on cognitive development directed especially towards children from low income families, specifically for reading skills. In most states, the curriculum for the kindergarten year (five- to six-years-old) is subsumed within the individual state's overall (five to 17 or 18) framework but there are some states which provide curriculum guidelines for the pre-kindergarten phase. Examples from Kentucky and Massachusetts are illustrative of curriculum guidelines for kindergarten.

Kentucky Curriculum decisions are made by the individual school council, and activities for pre-school children, aged three to five, should align with the curriculum for primary level students (kindergarten to grade 3, aged five to eight or nine). The curriculum is not specified but local districts are encouraged to design a curriculum from multiple sources of guidance. The pre-school program in Kentucky offered to disadvantaged children and children with learning difficulties aged three and over is expected to offer children developmentally appropriate experiences, and to assist young children in developing their interpersonal skills and in maximizing self-management and independence. The educational component is expected to promote development of skills in the following ways. Bertram and Pascal (2002)

Cognition and communication:

- Encouraging children to explore and learn by doing (concrete experiential learning)
- Encouraging language understanding and use among children as well as between children and adults (language experience approach)
- Integrating skills across content areas into activities targeted towards the interests of children (integrated curriculum)
- Providing a balance of activities (indoor/outdoor, child-/staff-initiated, structured/spontaneous, large/small group, group/individual, quiet/active).

Social and emotional development:

- Providing an environment of acceptance to help develop a positive self-concept
- Providing positive guidance for self-regulation of behaviour
- Providing positive adult and peer role models
- Having a curriculum which is relevant to and reflective of the population being served.

Physical development

- Providing developmentally-appropriate information on nutrition
- Involving children in snack and meal preparation where feasible
- Working with children during meals to develop language and problem solving
- Providing appropriate indoor and outdoor space with materials and equipment designed to increase physical skills
- Providing developmentally appropriate instruction in health and safety procedures.

In Massachusetts, since 1993, state-wide curriculum frameworks across seven subject areas have been developed for pre-kindergarten to grade 12 (around four years to 17 or 18 years of age). These are:

- Mathematics
- Science and technology
- Social sciences/social studies including USA and world history, geography, economics, civics and government
- English language, World languages, Arts, the arts including dance, music, theatre and the visual arts.
- Health including health education, physical education and family and consumer science education.

The Massachusetts curriculum frameworks for pre-kindergarten to grade 12 education establish three broad goals that are critical to life long learning and that frame the learning, teaching and assessment process. These are:

- Thinking and communicating: ways of making sense or meaning of the world and our experiences to ourselves and to others. Thinking includes being able to internalize new ideas and connect them to familiar ideas and prior knowledge. Communicating means putting into the language of speech or writing and requires reflection in such forms as examination, clarification, analysis and synthesis.
- Gaining and applying knowledge: involves pursuing ideas and experiences and applying new knowledge in real life contexts. This pursuit is interactive by nature. The more experiential it is, the more powerful the learning.
- Working and contributing: implies that student work is meaningful and purposeful and that the process and products of student work are valued contributions to the school and community. Embedded in powerful learning experiences are notions of persistence, self-discipline, hard work and effort and pride in producing quality work. (Bertram and Pascal, 2002).

2.12 Concluding Remarks

The literature review covered in this chapter revealed several interesting aspects. Few countries have national curriculum guidelines for the children under the age of three years. Many are considering it but others have a strong stance against doing so. Virtually all countries have defined curriculum guidelines for children over the age of three but they vary in detail and prescription. Most curriculum guidelines for those over three years of age included: social and emotional; cultural; aesthetic and creative; physical; environmental; language and literacy; and numeracy. Many countries emphasized cultural traditions and aimed to enhance social cohesiveness through the curriculum. (See appendix 1)

Decision makers are asking critical questions about young children's education. What should children be taught in the years from birth through age eight? How it is possible to know if they are developing well and learning? What they have to learn? And how to decide whether programs for children from infancy through the primary grades are doing a good job?

Answers to these questions—questions about *early childhood curriculum, child assessment,* and *program evaluation*—are the foundation of promoting the following aspects of child development in early childhood: (1) social and emotional adjustment; (2) language, linguistic literacy, and mathematical skills; (3) openness to learning and creativity.

Monitoring the development of children in these areas, partly in order to understand the contribution of the education system to children's development. Such understanding requires evaluation of their achievements, as well as of the quality of the interaction between teachers and children, a variable that many studies have found to be the best predictor of children's future achievements.

In the next chapter, the focus will be on diagnosis, assessment, and evaluation in early childhood of social and emotional development and of the acquisition of language, linguistic literacy, and mathematical skills, then important information will be needed to be accessed to select instruments to measure children's readiness for school.

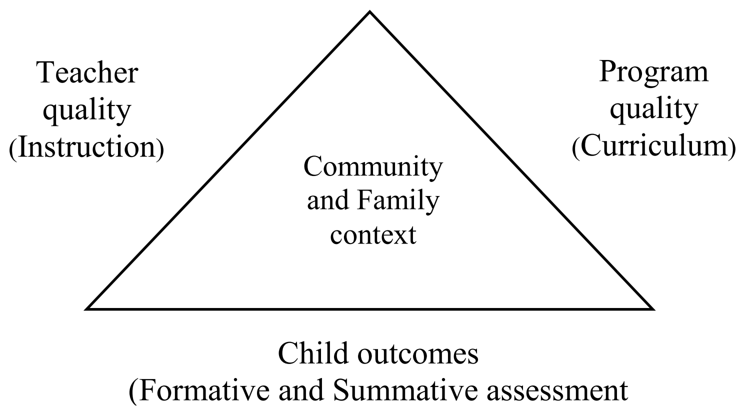
CHAPTER 3: DIAGNOSIS, ASSESSMENT AND EVALUATION IN EARLY CHILDHOOD EDUCATION: A COMPENDIUM OF ASSESSMENT INSTRUMENTS

3.1 Curriculum, Instruction, and Assessment

In general, three items are central and operative in the educational enterprise - *curriculum*, *instruction*, and *assessment*. The three elements of this triad are linked, although the nature of their linkage and reciprocal influence is often far less explicit than it should be. Furthermore, the separate pairs of connections are often inconsistent which leads to overall incoherence in the educational enterprise.

Curriculum consists of the knowledge and skills in subject matter areas that teachers teach and students are supposed to learn. The curriculum generally consists of a scope of breath of content in a given subject area and a sequence for learning. Standards in mathematics and science typically outline the goals of learning, whereas curriculum sets forth the more specific means to be used to achieve those ends. *Instruction* refers to methods of teaching as well as the learning activities used to help students master the content and objectives specified by a curriculum. Instruction encompasses the activities of both teachers and students. It can be carried out by a variety of methods, sequences of activities, and topic orders. *Assessment* is the mean used to measure the outcomes of education and the achievement of students with regard to important competencies. Assessment may include formal methods, such as large-scale state or national assessments, or less formal classroom-based procedures, such quizzes, class projects, assessment tools, and teacher questioning. Pellegrino (2006)

Figure 11-The triad- *curriculum*, *instruction*, and *assessment*



Source: Pellegrino (2006)

Given an assessment is the process of gathering data for the purpose of making decisions, it is important to assess young children when they are entering school. The major purpose of this process is to obtain information about the child in order to understand his or her areas of strength and need. In this way, teachers are provided with important information for adapting their learning environments and activities to the specific needs of the children in their classroom. When this information is used by the classroom teacher to design the child's learning environment, his or her success in school is enhanced, and a more stimulating, exciting learning environment is facilitated. Roberta et al. (2007)

Determining the best assessment instrument(s) for preschool is often a difficult challenge for school administrators and teachers. While a wide range of instruments exists, many of them emphasize different aspects of development or of the learning process. In identifying the appropriate assessment for specific school system needs, the challenge for school personnel is to become familiar with the instruments in a short period of time and without the expense of purchasing each tool, Roberta et al. (2007). Another challenge is to prioritize the components or aspects of the assessment instrument that are most important for the needs of their respective school system. The final challenge is using a strengths-based perspective to identify an appropriate instrument that accurately measures a young child's skills.

Because of the substantive difference between the range of measures utilized for preschool and elementary school age children, it will be important to distinguish between the two age groups: 3-6 years old (the kindergarten group) and 6-9 years old (elementary school children). The guiding principle is that measures of kindergarten age children are not conducted uniformly or nationally on the basis of ability, function, activities and/or achievements. The measures for achievement (in reading and writing only) are conducted on a limited basis in the first years of elementary school. Black and Powell (2004)

3.2 Diagnosis and evaluation of kindergarten-age children (ages 3-6)

3.2.1 The kindergarten curriculum

The division of preschool system in the most of the countries poses a number of goals in all matters relating to young children. These goals emphasize improving language skills, thinking and enrichment, the acquisition of life skills and social skills, developing personal independence and tolerance for the other, literacy and problem-solving and creating the foundation for learning.

The division's policy promotes focus areas and goals within early childhood education, which kindergarten teachers follow in keeping with designed work plans. They evaluate learning and educational achievements in kindergarten and the level of the children's functioning. Black and Powell (2004).

The division advances a well-organized foundation for learning in kindergartens based on detailed curricula, Roberta et al. (2007). In essence, the foundation is a core curriculum for kindergarten, which is still being consolidated. The plan comprises four central themes:

- **Literacy:** Children completing compulsory kindergarten are expected to have a command of literacy skills. It includes teaching the components of pre-literacy, alphabet skills, and the onset of writing and reading (including awareness of phonology, learning letters, and other skills), verbal skills and ability to tell a story. As part of inculcating the literacy knowledge in kindergarten, the teacher sets up reviews in various situations to evaluate the extent to which each child has grasped the components.
- **Mathematical thinking:** Developing a positive stance toward maths among kindergarten children, which includes development of skills in concentrating, thinking to develop counting, measuring and making comparisons.
- **Arts:** Experimenting, independent creative expression, concentrating and relating to the aesthetics of the child's surroundings and creating art. All of this is achieved experientially in a methodical and focused manner, including giving children ongoing exposure to creating varied works of art.
- **Life skills:** Education in matters of health and safety and the acquisition of appropriate habits, with an emphasis on prevention.

3.2.2 Evaluating proficiencies and skills in kindergarten:

- **Literacy:** The language and vocabulary development forms the foundation for reading and writing. Children's vocabulary is growing rapidly during these early years. Possibly the most important contributor to children's vocabulary is being read to. A considerable body of research confirms the link between being read to and learning to read and write successfully, Blair (2002). The kindergarten teacher with a number of venues to observe, document and evaluate the child's functioning and level in each of the program's fields. The kindergarten teacher is required to describe the child's behaviour in a specific situation and relate to the specific field (for example, awareness of phonology) and the child's level of relating to the field in that situation. (Each field is divided into three levels: At the *basic level*, for example, the child identifies rhymes and creates rhymes with invented words. At the *intermediate level*, the child creates words and divides them into syllables. At the *advanced level*, the child acquires skills, for example: divides words into their sounds and combines the sounds into rhyming words.) The evaluation process serves not only to document the functioning of the specific child, but also to plan instruction for the child (in accordance with the child's functional profile in the field of literacy measured).

- **Mathematical thinking:** There is no means for the formal education system to provide the kindergarten teacher with the process to examine the children's acquisition of skills.

- **Evaluation in kindergarten:** The preschool division has a policy of general evaluation in the kindergartens by which kindergarten teachers conduct a methodical observation of the children's development and learn to detect which children are having difficulties. The division provides general guidelines for but these are not evaluation standards and there is no national inculcation (it is more of a "recommendation" to conduct methodical observations). There is no structured supervision to utilize the observation, document it or assure the recommendations are applied.

In addition, the process by which the kindergarten teachers may evaluate the learning and the acquisition of the curriculum's proficiencies and skills is, in principle, based on observation. This allows for impressionistic documentation, but does not provide standardized measurements that permit comparisons of abilities, capacities and/or functioning. The evaluation of what is achieved in the kindergarten classroom is done by outside organizations, and does not take into account the group as a whole.

3.3 Goals of the diagnostic systems:

There are several key goals in the diagnosis of young children before they enter the school system. The key goal is to measure their cognitive functioning, day-to-day functioning and emotional-social functioning on an individual basis when difficulties, delays or deficits in one of the areas is suspected. Group diagnosis examines readiness for first grade and is conducted by certain psychological services in specific regions but they do not have a clear set standard (even as to when such testing is needed) or specific diagnostic tools. An individual examination to determine readiness for first grade is done in cases when a younger child with advanced functioning is considered for enrolment in first grade, or when lower functioning may indicate that a child should remain in kindergarten for an additional year. In such cases, the aim of the diagnosis is to determine possible gaps between cognitive and emotional functioning and to utilize the profile to make the recommendation about placement in kindergarten or first grade.

3.4 Tools

The standard tools utilized to diagnose kindergarten age children may be divided into a number of groups:

- Tests examining cognitive/mental functioning
- Tests designed to examine language proficiencies
- Tests to examine visual-motor proficiencies
- Projective tests
- Examination of adaptive functioning
- Early identification of learning deficits

3.5 A Compendium of Assessment Instruments

Below are brief descriptions of all the tools (with additional details in appendix 3): The list of possible instruments to be reviewed in this chapter was chosen according to specific criteria, and the instruments were rated based on a categorical matrix system. The assessment tools were either accepted or eliminated for inclusion in the final list of possible candidates of tools to be reviewed.

The below instruments met the criteria from the matrix. Each criterion was used for these purposes as follows:

Language: Having a multi-language version became the first criteria when rating the instruments. Language is of utmost importance in selecting instruments to appropriately serve the population where many children are second-language learners, like Hispanics in the USA and Arabs inside Israel.

Psychometrics: Norm-referenced instruments with good psychometric properties were preferred. Criterion referenced instruments were expected to have lower psychometric properties, but preferential treatment was given to those that approached the .70 cut-off point. However, it is important to remember that with authentic-based assessments such as portfolios and teacher-rating scales, the cut-off scores in the field can be as low as .45 and still prove to be effective tools.

Translated/Adaptations: This criterion pertained to whether the Spanish, Arabic or Hebrew versions of the instrument was a literal translation from the English language (i.e., not desirable) or a true adaptation (i.e., desirable) where ideas and basic concepts are expressed in native patterns and colloquialisms. Unfortunately, few of the instruments either (a) were adaptations from English into Spanish, Hebrew or Arabic or (b) had information on whether they were translated or adapted into Spanish, Hebrew or Arabic from English.

Second Language-Speaking Norms: This category has to do with whether, or not, the normative data was gathered from a second language-speaking population. For the purposes of making a determination on the selection of instruments, preferential treatment (or weigh) was given to the second language version of instruments which were standardized on this type of sample of children. Unfortunately, only three instruments met these criteria.

Reporting System (Friendly Recommendations): The fifth category of the matrix was tools with parent/teacher-friendly reporting systems. This category was critical because sometimes instruments which are child-friendly fail to provide usefulness to the parent or teacher. Given (a) the young age of our preschool population and (b) the current trend to work with the child before any referral can be made, the instruments with useful reporting systems were preferred over others.

Date Published: The cut-off date of publication was 2000. Instruments that were developed before this time, though perhaps reviewed, were not even considered for the original list. The more recent instruments were preferred because since their norming samples were more current, they were generally more representative of the populations being tested today.

Examiner Characteristics: This criterion was based on the examiner minimum qualifications as prescribed by the test publishers. The final list of instruments had examiner qualifications which ranged from that of a broad continuum (e.g., professional to paraprofessional) to being very narrow and specific in focus (e.g., licensed school psychologists only). There was no predetermined preference; the decision depended on the instrument.

Administration: This category had a specific cut-off point; specifically, +/-60 (sixty) minutes. Assessments with administration times less than sixty minutes - most of which were screeners - were given favourable ratings in the matrix; those with times over the sixty minutes were not given favourable ratings, unless the other criteria could justify doing so. Keeping this in mind, few tools with administration times over sixty minutes were able to meet criteria.

Purpose: This criteria was the most complicated to score. Principles and recommendations of the National Educational Goals Panel (NEGP), Legal Information Institute (2012), were used to operationalize the purposes of assessments - according to NEGP there are four: (a) to support learning – P1, (b) to screen for and/or identify special needs – P2, (c) to meet program evaluation/monitoring objectives – P3, (d) for high stakes accountability – P4. The original list was reviewed and scored in the matrix and the respective sub-grouping was chosen in the case of each instrument – P1, P2, P3, or P4. There was no predetermined preference; the decision depended on the instrument. However, the NEGP is clear about the risks of combining assessment purposes.

Software: This last criteria pertained to whether, or not, the tool had some type of computer program available, and if so, the extent to which the program would assist users (e.g., 1- just to enter data; 2- enter data and simple reporting system; 3- enter data, palm pilot program, plus all types of reports, including program evaluation, etc.). The instruments which had useful, better software were preferred, however, no tool was disqualified for poor or lack of software (e.g., this is a variable that can always be added or improved).

3.5.1 Age and Stages Questionnaires: Social Emotional (ASQ-SE)

The Age and Stages Questionnaires: Social Emotional (ASQ:SE) were developed as a companion tool to the widely used Ages and Stages Questionnaires (ASQ), a well researched system that uses parent report to screen the development of infants and young children. The ASQ: SE was developed and continues to be studied in an effort to address the need for age-appropriate tools to monitor very young children's behaviour and address parental concerns. In addition, the ASQ: SE provides an inexpensive, culturally versatile tool for states to participate in child-find activities for children at-risk for social-emotional and behavioural delays. Squires, Bricker, and Twombly (2002).

The original ASQ system consists of a series of 19 parent completed questionnaires that screen a child from 3 months to 5 years of age and cover 5 domains of development: communication, fine motor, gross motor, problem solving and personal social.

The Ages and Stages Questionnaires-Social Emotional (ASQ: SE) were developed to monitor a child's development in the behavioural areas of self-regulation, compliance, communication, adaptive, autonomy, affect and interaction with people. ASQ: SE questionnaire intervals correspond with the ASQ system, screening children from 3 months to 5 and 1/2 years of age. Questionnaire intervals are as follows: 6, 12, 18, 24, 30, 36, 48 and 60 months (Squires, Bricker, and Twombly, 2002).

3.5.2 Bateria III Woodcock-Muñoz™

The Batería III Woodcock-Muñoz is a comprehensive set of tests that assesses both cognitive abilities and achievement levels of Spanish speaking individuals between the ages of 2 years and 90+ years.

This assessment tool offers: Woodcock et al. (2005):

- Professionals the ability to interpret an individual's cognitive and/or academic performance in Spanish based on the *CHC Theory*.
- Multiple options for brief, as well as comprehensive assessment.
- A computer scoring program that saves valuable professional time.
- A brief summary report that is available in both English and Spanish.
- Access to all the tests and interpretative options of the *WJ III*® for Spanish dominant individuals.
- A comprehensive set of tests, the *Batería III* accesses and evaluates both cognitive and achievement levels of Spanish speaking individuals between the ages of 2 and 90+ years of age.
- Cluster scores to interpret information, which aid in determining strengths and weaknesses that can be used to determine educational processes

3.5.3 Battelle Developmental Inventory 2nd Edition (BDI-2)

The new Battelle Developmental Inventory, Second Edition (*BDI-2*) may be used by a team of professionals or by an individual. The *BDI-2* can be administered to children with various handicapping conditions by using stated modifications. Appropriate for age's birth to 8, the *BDI-2* is ideal for several uses (Newborg, 2004):

- Identification of Children with Disabilities.
- Evaluation of Groups of Children with disabilities in Early Education Programs.
- Assessment of the typically developing Child.
- Assessment (Screening) for school readiness.
- Program evaluation for accountability.

Administration of the *BDI-2* can begin in any of the 5 Domains (see list below). The start points for each sub domain are clearly marked and are determined by the age or the estimated ability level of the child. Examiners proceed through each of the sub domains to determine the child level of development.

The BDI-2 Data Manager is designed as a web-based scoring software program (Mac or PC) or as a standalone computer software program (PC only). The *Data Manager* program provides consistency in determining all the raw scores totals and the subsequent norm-referenced scores for the *BDI-2*. A wide selection of reports is available to choose from including narrative reports for parents or professionals, score reports for student folders and aggregate reports for program evaluation support. All reports can be printed and many reports can be exported and then imported to a word processing file for editing as necessary (Newborg, 2004).

BDI Domains:

1. Personal-Social Domain: Adult Interaction, Self-Concept and Social Growth, Peer Interaction
2. Adaptive Domain: Personal Responsibility, Self-Care
3. Motor Domain: Fine Motor, Perceptual Motor, Gross Motor
4. Communication Domain: Receptive Communication, Expressive Communication
5. Cognitive Domain: Perceptual Discrimination/Conceptual Development, Reasoning and Academic Skills, Attention and Memory

3.5.4 Behaviour Assessment System for Children - Second Edition (BASC-2)

The Behaviour Assessment System for Children (BASC), the second edition offers an powerful family of tools to help assess the behaviours and emotions of preschool through college-age individuals. The Behaviour Assessment System for Children—Second Edition (BASC–2) enables assessment from three vantage points—teacher, self, and parent/caregiver—to help ensure a balanced evaluation.

The BASC–2 provides the most comprehensive rating scales available. Here are some advantages: Assing (1998)

- Unlike many other assessments of behaviour and emotions, the BASC–2 was constructed using both an empirical and theoretical approach.
- This outstanding system is respected for its developmental sensitivity, differentiating between behaviours of children and adolescents.
- The BASC–2 stands apart in providing both combined-sex and separate-sex norms.

School psychologists, clinicians, and other professionals can use the BASC–2 system to help: Assing (1998)

- Evaluate and address behavioural and emotional issues that may impede an individual's ability to thrive in home and school environments
- Meet guidelines for identifying strengths and weaknesses and diagnostic testing a differentiated instruction and progress monitoring

- Differentiate between hyperactivity and attention problems with one efficient instrument
- Monitor treatment interventions and outcomes

3.5.5 Bilingual Verbal Ability Tests- Normative Update (BVAT-NU)

The *Bilingual Verbal Ability Tests* (*BVAT*) Normative Update measures bilingual verbal ability in English and another language, Bilingual verbal ability is the unique combination of cognitive-academic language abilities possessed by bilingual individuals. The need for this test is based in the reality that bilingual persons know some things in one language, some things in the other language, and some things in both languages. Traditional procedures only allow the person's ability to be measured in one language, usually the one considered to be dominant, even though anecdotal evidence suggests that these individuals know "more" than they can demonstrate with these monolingual approaches Muñoz-Sandoval et al., (2006). The BVAT includes updated norms and Provides assessment in 17 languages plus English, Creates a more equitable prediction of ability for gifted and special education evaluations and Assesses the total knowledge of a bilingual individual using a combination of two languages and also includes a scoring and reporting software program.

3.5.6 Bracken Basic Concept Scale: Expressive (BBCS:E) and (BBCS–3:R)

The Bracken Basic Concept Scale – Third Edition: Receptive (BBCS-3:R) and Bracken Basic Concept Scale: Expressive (BBCS:E) are developmentally sensitive measures of children's basic concept knowledge.

Acquisition of basic concepts is strongly related to cognitive and language development as well as early childhood academic achievement. Building on the strength of the Bracken Basic Concept Scale – Revised, the BBCS-3:R includes updated norms and improved items. Bracken and Thomas (2000).

The main features:

- Gain a more complete understanding with the new Expressive Measure
- Includes the ability to evaluate a child's understanding of basic concepts expressively
- Offers a Scoring Assistant
- Contains a school readiness composite

- Provides clinical studies on specific populations including Developmental Delayed and Mental Retardation

The BBC-3:R and BBCS:E can be used to:

- Assist you in developing appropriate Individualized Education Plan-Program (IEP) goals that relate to the educational curriculum.
- Follow the early childhood education curriculum outlined through Every Child Matters.
- Easily administer, score and interpret
- Assess important educational concepts – Colour, letter/sounds, numbers/counting, size, shapes, direction/position, self-/social-awareness, texture/material, quality, time/sequence.

3.5.7 Brigance K & 1 Screen II

The BRIGANCE Early Childhood Screen II is a collection of quick and highly accurate assessments and data-gathering tools to use with children in kindergarten and first grade. Brigance (2005).

All assessments in the Early Childhood Screen II have been nationally standardized producing results that are highly reliable, valid, and accurate. The Early Childhood Screen II includes the following age-specific screens:

- Basic Assessments for the Kindergarten Child
- Basic Assessments for the First-Grade Child

Screening can be done quickly, usually within 10-15 minutes, allowing teachers to identify readily children who may be developmentally delayed or advanced. Assessment items are both criterion-referenced and norm-referenced and cover a broad sampling of a child's skills and behaviours. Key developmental skills include:

- Fine-motor and Gross-motor
- Language
- Academic/Cognitive
- Self-help and Social-emotional

Other data-gathering tools included with the Early Childhood Screen II: Bricker and Squires (1999)

- Data Sheets to record screening results providing a one-page review of the child's performance.

- Self-help and Social-Emotional Scales to gather data on the child's functional independence and play skills.
- Parent's Rating Forms to record input from parents/caregivers.
- Teacher's Rating Forms to record input from teachers.
- Screening Observations Forms to record examiner's observations while screening.

3.5.8 Child Observation Record Second Edition (COR-2)

The Preschool COR is an observational assessment tool for children aged 2½ to 6 years. It is designed to measure children's progress in all early childhood programs. . It looks at 32 dimensions of learning in six broad categories critical for school success: Initiative, Social Relations, Creative Representation, Movement and Music, Language and Literacy, and Mathematics and Science. Cost, Quality, and Child Outcomes Study Team (1995).

Teaching staff gather information to complete the COR in the course of everyday program activities, so COR assessment is seamlessly integrated with early childhood teaching and planning. The results provide detailed information on each child's development, as well as a variety of group reports analyzing progress for various audiences.

The Preschool COR Kit, Second Edition, includes all the materials needed for COR-based classroom planning, assessment, and reporting to parents, for one class of 25 children. Components are also sold separately.

3.5.9 CELF® Preschool, Second Edition (CELF® Preschool-2)

The CELF Preschool-2 language assessment is specifically designed for preschool aged children who are bound for the classroom. CELF Preschool-2 provides a variety of subtests to comprehensively test the language skills of preschool aged children who will be in an academic-oriented setting. Semel, Wiig, and Secord (2004)

- Includes a variety of subtests that provide in-depth assessment of a child's language skills.
- Includes a pre-literacy scale and phonological awareness subtest.

- A pragmatics profile helps to describe the child's language use at school or at home.
- Contains interesting, age appropriate, full-colour pictures to hold the child's attention.
- Meets current IDEA guidelines.
- More than 1,500 children participated in standardization, reliability, and validity studies.
- Subtests: Total Language Score, Receptive Language Composite, Expressive Language Composite and additional index scores, Standard Scores, Percentile Ranks, Age Equivalents.

The administration is untimed, but takes approximately 30 to 45 minutes.

3.5.10 Denver Developmental Screening Test II (DDST-R)

The Denver Developmental Screening Test (DDST), commonly known as the Denver Scale, is a test for screening cognitive and behavioural problems in preschool children. The scale reflects what percentage of a certain age group is able to perform a certain task. In a test to be administered by a paediatrician or other health or social service professional, a subject's performance against the regular age distribution is noted. Tasks are grouped into four categories (social contact, fine motor skill, language, and gross motor skill) and include items such as *smiles spontaneously* (performed by 90% of three-months-old), *knocks two building blocks against each other* (90% of 13-months-old), *speaks three words other than "mom" and "dad"* (90% of 21-months-old), or *hops on one leg* (90% of 5-years-old). Frankenburg et al. (2005)

The DDST is the most widely used test for screening developmental problems in Canada (Canadian Task Force, 1994). While this study acknowledges the test's utility for detecting severe developmental problems, the test has been criticized to be unreliable in predicting less severe or specific problems. The same criticism has been upheld for the currently marketed revised version of the Denver Scale, the DENVER II. Glascoe et al. (1992).

This revised definition of the Denver's function remains commensurate with what screening tests are designed to do: sort those who probably have problems from those who probably don't. Thus standards for screening test construction still apply to the Denver. Although the instrument has proven reliability, it was not constructed on a large, current, nationally representative sample. It has not been studied for validity. As a consequence, the measure was not studied by its authors for the most critical attribute of any screen, its accuracy. Studies by other researchers showed it to detect only about 50% of children with disabilities, although its specificity in identifying normally developing children is high (when questionable are grouped with normal scores) and the converse when questionable scores are grouped with abnormal results.

3.5.11 FirstSTEp: Screening Test for Evaluating Preschoolers

The FirstSTEp is a brief screening tool designed to guide further assessment and referral of young children. Twelve subtests are divided into three domains: Cognition, Communication and Motor. The test also includes parent-completed Social-Emotional and Adaptive Behaviour checklists. Miller (1993)

Children's performance is scored according to age level: Level 1 (ages 2:9–3:8), Level 2 (ages 3:9–4:8) and Level 3 (ages 4:9–6:2). The activities are enjoyable and motivating for children while simultaneously providing valuable qualitative and quantitative information to help clinicians make decisions about the need for further assessment or referral to other agencies.

3.5.12 Kaufman Survey of Early Academic and Language Skills (K-SEALS)

The K-SEALS utilizes subtests for expressive and receptive language, number skills, letter and word skills, vocabulary, and articulation to provide a comprehensive survey of a child's speech and pre-academic development. The K-SEALS can be used to test for school readiness, identify gifted children, evaluate program effectiveness, and research a child's early development. Ellingsen, Burch-Lewis and Pham (2012)

K-SEALS is individually administered and although it is untimed, it can be completed in approximately 15 minutes. Subtest and composite performances are reported as standard scores and percentile ranks. Age equivalents and descriptive categories are also provided. Ellingsen, Burch-Lewis and Pham (2012)

The test comprises four scales, each of which is intended to produce standard scores with an average of 100 and a standard deviation of 15. The scales:

1) Serial comprehension scale—solving problems with an emphasis on the order of stimuli (for example: repeating a series of movements); average 10, standard deviation 3.
2) Simultaneous comprehension scale—holistic problem solving (for example: filling in parallel forms); average 10, standard deviation 3.
3) Complex mental comprehension—combination of the serial and simultaneous scales, providing a broader evaluation of intellectual functioning; average 100, standard deviation 15.
4) Achievement scale—working knowledge, knowledge of language concepts, academic skills (for example: reading and math); average 100, standard deviation 15.

3.5.13 Stanford-Binet Intelligence Scales for Early Childhood (Early SB5)

The intelligence test is based on measuring verbal and nonverbal intelligence via five factors. It is intended for ages 2-85. It is also possible to conduct a briefer version of the test (for screening). In addition, the test may be conducted with the nonverbal scale to test children or adults with communication deficits, speech deficits or deafness, autism, specific learning deficits (in language) and those with a limited command of the English language. The test is also based on the hierarchal model of the fourth edition. In the United States, norms were gathered on the basis of a sampling of 4,800 participants ages 2-85. The test is organized according to levels. On the non-verbal dimension, the test-taker's level is determined by a series of objects and matrixes. On the verbal level, the test-taker's level is determined by a vocabulary test. The test-taker begins at his or her level in each dimension and advances to higher levels until reaching the cap. Roid, (2005)

The standard grade for the subtests is on average 10 with a standard deviation of 3. The verbal, functional and general IQ all have an average of 100 and a standard deviation of 15. There is a standard score for each factor (the verbal and nonverbal test are linked to the same factor)—with an average of 100 and a standard deviation of 15. Below are the dimensions, factors and scales. Roid, (2005)

Table 17- Stanford-Binet Intelligence Scales – 5th Edition

Factor	Dimension	Subtest
Fluid deductions	Nonverbal	Series of objects/matrixes
	verbal	Initial deductions, absurdities, analogues
Knowledge	nonverbal	Procedural knowledge, visual absurdities
	verbal	vocabulary
Quantitative deductions	nonverbal	Quantitative deductions
	verbal	Quantitative deductions
Working memory	Nonverbal	Delayed reaction, block span
	Verbal	Memory of sentences, last word

Source: Roid (2005)

The test is a bit complicated to give and does not offer a clear picture regarding specific cognitive functioning. That said, it is definitely an alternative to more dated tools.

3.5.14 Test of Mathematics Ability - Third Edition (TEMA-3)

The TEMA-3 measures the mathematics performance of children between the ages of 3-0 and 8-11 and is also useful with older children who have learning problems in mathematics. It can be used as a norm-referenced measure or as a diagnostic instrument to determine specific strengths and weaknesses. Thus, the test can be used to measure progress, evaluate programs, screen for readiness, discover the bases for poor school performance in mathematics, and identify gifted students, and guide instruction and remediation. The test measures informal and formal (school-taught) concepts and skills in the following domains: numbering skills, number-comparison facility, numeral literacy, mastery of number facts, calculation skills, and understanding of concepts. It has two parallel forms, each containing 72 items.

The all new standardization sample is composed of 1,219 children. The characteristics of the sample approximate those in the 2001 U.S. Census. Test results are reported as standard scores, percentile ranks, and age and grade equivalents. Internal consistency reliabilities are all above .92; immediate and delayed alternative form reliabilities are in the .80s and .90s. In addition, many validity studies are described. Ginsburg and Baroody (2003).

Also provided is a book of remedial techniques (Assessment Probes and Instructional Activities) for improving skills in the areas assessed by the test. Numerous teaching tasks for skills covered by each TEMA-3 item are included.

After giving the test, the examiner decides which items need additional assessment information and uses the book to help the student improve his or her mathematical skills.

3.5.15 Test of Early Reading Ability - Third Edition (TERA-3)

The *Test of Early Reading Ability-Third Edition (TERA-3)* is a unique, direct measure of the reading ability of young children ages 3-6 through 8-6. Rather than assessing children's "readiness" for reading, the TERA-3 assesses their mastery of early developing reading skills. This new edition has been redesigned to provide the examiner with three subtests: Alphabet (measuring knowledge of the alphabet and its uses), Conventions (measuring knowledge of the conventions of print), and Meaning (measuring the construction of meaning from print). Standard scores are provided for each subtest. An overall Reading Quotient is computed using all three subtest scores. The TERA-3 has been improved in the following ways: Kim Reid et al (2002)

1. All new normative data were collected during 1999 and 2000.
2. Characteristics of the normative sample (n = 875) relative to socioeconomic factors, gender, disability, and other critical demographics are the same as those projected by the U.S. Bureau of the Census for 2000 and are representative of the current U.S. population.
3. The normative information is stratified by age relative to geography, gender, race, residence, and ethnicity.
4. Studies showing the absence of gender, racial, disability, and ethnic bias have been added.
5. Reliability coefficients have been computed for subgroups of the normative sample (e.g., African Americans, Hispanic Americans, females) as well as for the entire normative sample. Reliability is consistently high across all three types of reliability studied. All but 2 of the 32 coefficients reported approach or exceed .90.
6. New validity studies have been conducted; special attention has been devoted to showing that the test is valid for a wide variety of subgroups as well as for a general population.
7. New items have been added to make the test more reliable and valid for the upper and lower ages covered by the test.

8. All pictures have been drawn in colour to present a more appealing look to children.
9. Examiners no longer have to prepare their own items that require the use of company logos and labels because these items are now standardized and provided as part of the test kit. Logos and labels from such national companies as McDonald's, and Kraft, Libby's, are used to make the TERA-3 colourful and meaningful.
10. Age and grade equivalents are provided.

3.5.16 Wechsler Preschool & Primary Scale of Intelligence - Third Edition (WPPSI™-III)

An intelligence test for ages 4-6 1/2. Published in the United States in 1967. The test comprises 10 subtests: five verbal and five functional tests. The average of the subtests is 10 with a standard deviation of 3. Wechsler (2002)

Verbal subtests	Functional subtests
1. General knowledge	1. animal house
2. Vocabulary	2. complete the picture
3. Math	3. mazes
4. Common factors	4. Geometric shapes
5. Comprehension	5. blocks

The test is given on an individual basis and there are three scores: verbal IQ, functional IQ, and a general IQ (all have an average of 100 and a standard deviation of 15). Only psychologists are allowed to give the test.

WPPSI is widely utilized in Israeli, and is perhaps the most widely used tool for the psychological diagnosis for kindergarten age children. This is the case despite the fact that it is a test that was standardized well over 35 years ago. In the field, it is felt that the scores for this test do not accurately reflect children's abilities.

The fourth edition of WPPSI was released in the United States in 2002 and in UK in 2004. It is an intelligence test given individually to children from ages 2:6 until 7:3. The test is divided into two sets according to age: ages 2:6 to 3:11 has a battery of tests designed for them and ages 4:0 to 7:3 has an additional battery. In each set, there are core tests and tests which are not compulsory and may be given as a supplement. There are 5 standard general scores (with an average of 100 and a standard deviation of 15): verbal IQ, functional IQ, general IQ, swiftness of comprehension and general language ability. Wechsler (2002)

The test underwent a standardization process in the United States based on a sampling of 1,700 children, and was also standardized in UK on the basis of a representative sampling. In Israel, extensive use is being made of the U.S. and British versions, mainly at Institutes for Childhood Development. This is the case even though the test has not been standardized in Israel and there are no Israeli norms or translation.

Table 18- Wechsler Preschool and Primary Scale of Intelligence-3rd edition (WPPSI-III)

	Verbal scale	**Functional scale**
Ages 2:6 to 3:11	Passive vocabulary General knowledge	Puzzles Blocks
Ages 4:00 to 7:3	General knowledge Vocabulary Verbal deductions (Comprehension) (Common factors) Passive vocabulary (Naming pictures)	Blocks Nonverbal deductions Conceptualizing from pictures Decoding Finding signs Filling in pictures Puzzles

Source: Wechsler (2002).

3.5.17 Woodcock-Johnson® III (WJ-III) Tests of Achievement and Tests of Cognitive Abilities

The Woodcock–Johnson Tests of Cognitive Abilities is a set of intelligence tests first developed in 1977 by Richard Woodcock and Mary E. Bonner Johnson. It was revised in 1989 and again in 2001; this last version is commonly referred to as the WJ III. They may be administered to children from age two right up to the oldest adults (with norms utilizing individuals in their 90s). The WJ III is praised for covering "a wide variety of cognitive skills”. Woodcock at el. (2005)

The Woodcock-Johnson III Tests of Cognitive Abilities include both the Standard Battery and the Extended Battery. The Standard Battery consists of tests 1 through 10 while the Extended Battery includes tests 11 through 20. There is also a Woodcock-Johnson III Diagnostic Supplement to the Tests of Cognitive Abilities with an additional 11 cognitive tests. All of which combined allows for a considerably detailed analysis of cognitive abilities. The Cattell–Horn–Carroll theory factors that this test examines are based on 9 broad stratum abilities which are: Comprehension-Knowledge, Long-Term Retrieval, Visual-Spatial Thinking, Auditory Processing, Fluid Reasoning, Processing Speed, Short-Term Memory, Quantitative Knowledge and Reading-Writing. A General Intellectual Ability (GIA) or Brief Intellectual Ability (BIA) may be obtained. The BIA score is derived from three cognitive tests which include Verbal Comprehension, Concept Formation, and Visual Matching. These three cognitive tests measure three abilities; Comprehension-Knowledge (Gc), Fluid Reasoning (Gf), and Processing Speed (Gs), which best represents an individual's verbal ability, thinking ability, and efficiency in performing cognitive tasks. The BIA takes about 10 to 15 minutes to administer and is especially useful for screenings, re-evaluations that don't require a comprehensive intellectual assessment, or research that needs a short but reliable measure of intelligence. On the other hand, the GIA obtained from the WJ III Tests of Cognitive Abilities provide a more comprehensive assessment of general ability (g) and the score is based on a weighted combination of tests that best represents a common ability underlying all intellectual performance.

3.5.18 Work Sampling System 4th Edition (WSS-4)

The Work Sampling System (WSS) ® to observe and document children’s work and classroom behaviour. Detailed and comprehensive, based on national standards and is curriculum embedded, that is, the assessment occurs within the context of normal classroom activity. WSS consists of three interrelated elements: developmental guidelines and developmental checklists; portfolios, and summary reports. The four of the WSS domains are: personal and social development; language and literacy; physical development and health, and mathematical thinking. Bergeson et al. (2008) WSS was designed as a systematic approach to assessing children’s skills, knowledge and behaviour in the classroom. It ensures that teachers provide opportunities for children to exhibit skills in the various items of the checklist. It guides teachers in creating situations in the physical environment of the classroom, and making additions to the curriculum so that children are given opportunities that cover all of the indicators in WSS. In addition, teachers may identify aspects of a child's learning that require special attention with the ultimate goal to achieve proficiency in the indicators of the checklist by the end of the year.

While the use of WSS can enhance children's school readiness approach to all aspects of the development of school readiness, the use of WSS data to predict school readiness is less developed. Using students' mean scores from the developmental checklists on WSS

The WSS checklists are compiled to show the progression of children's learning across the school year, and the degree to which children have mastered the Preschool WSS indicators. Domains in which children show less progress are identified.

3.6 Computer-based assessments

For most of the 20th century, part of the assessment world was dominated by the continuing promise of psychology and psychometrics. These developing sciences held out the possibility of precise and accurate measurement of mental attributes, in parallel to the precision and accuracy of physical science. There was an emphasis on objectivity, and a technology of test development grew up, heavily dependent upon statistical analyses. Alongside this with its own emphases, generally in Europe, an alternative approach, based on written examinations prospered, which has some of the same characteristics, but differed in the styles of questions and scoring processes. In the psychometric tradition, the test-taker was the object being measured and the test outcome took the form of a battery of numbers – raw scores, standardized scores, percentiles, confidence intervals, correlation coefficients – which related performance to established norms, or to other tests. Test items were frequently multiple-choice, and were selected mainly for their statistical properties. Most current paper-based tests are still located in this psychometric tradition. Their claim to rigor lies in large-scale representative sampling and statistical analyses following established methods. These principles are now frequently also applied to current computer-based tests. Some are simply paper tests adapted for the screen, with statistical equating exercises to relate the scores from the two methods. Others are adaptive, with statistical test development technology being extended to deal with the situation where each test taker takes a different set of items. The Gilbert Report (2006)

Towards the end of the 20th century, in some countries, a further strong imperative arose in the assessment world. Governments increasingly required a testing program for the purpose of evaluating the success of schools, teachers and the education system. For this, it was necessary to broaden the scope of the tests to match the depth and richness of the subjects as defined by the curriculum. At first, this led to tests which had high validity, but were less manageable than their psychometric predecessors, cumbersome to mark, with a resulting loss of 'objectivity'. However, as the requirements for accountability grew, the tests themselves moved back to a psychometric model, with a strong emphasis on reliability, security and the comparability of results.
Thinking on assessment is moving into a new phase. Added to its existing monitoring and accountability functions are new demands for tracking pupil progress and giving teachers the evidence they need to provide personalized learning. To meet the new requirements, assessment will have to deliver new types of data and become more sharply focused and this will expresses concern about the discrepancies in progress made by individual children in the course of their school careers. Based on this, the combination of high expectations and targeted interventions could be mobilized to address the problem. For assessment to play its part in this process, it should take on a new focus on progress, with progress targets supplementing the existing targets for absolute attainment. Alongside this, the integration of effective assessment into ongoing teaching and learning is seen as central. Teachers will be expected to make systematic use of data analysis, regular assessment of curriculum topics and techniques such as pupil peer and self assessment. This will lead to a clearer understanding in the minds of both teacher and pupil about the pupil's existing understanding and help to formulate sharper and more achievable targets for continuing progress.

However, this picture of a coherent, constructive assessment system makes enormous demands on the teacher. Schools will have to continue to manage national tests and stringent accountability targets, but there is now to be a new requirement that each child has a personalized curriculum planned in the light of comprehensive assessment evidence. There is a risk that these demands will become overwhelming, and indeed there are indications that many teachers are already finding them so. There are also reports that pupils find assessment stressful. It is essential to ensure that assessment is a coherent, manageable and useful process for teachers so that pupils benefit from it.

3.7 E-assessment

Introducing e-assessment for important, high stakes national tests has the potential for great improvements, but also brings with it significant problems. In England, The Qualifications and Curriculum Authority announced a policy in 2005 for the gradual introduction of more computerized testing, with GCSEs, AS and A2 examinations having an on-screen option within five years. In time, this could also apply to the proposed national curriculum progress tests. However, in moving towards this situation the confidentiality of high-stakes test materials must not be compromised, and the chances of candidates cannot be blighted by technical failures.

Less attention, however, has been paid to the potential of e-assessment in low-stakes contexts. It is clear that teachers are required to focus on the understanding and attainment of individual pupils in order to develop effective plans for personalized learning. This will involve the management of a great deal of assessment evidence for planning teaching, in the form of test data and information on progress through the ongoing curriculum. Making sense of this mass of evidence requires teachers to discern patterns, interpret their meaning and use the results to formulate targets and specific differentiated teaching plans. Traditionally, this has been done informally, based on the teacher's personal knowledge of each pupil. With a requirement for more systematic assessment of progress and recording of targets, however, e-assessment can occupy a central role, first in gathering detailed information about the nature of individual pupils' understanding and attainment, and then in collating and analyzing this data. Rather than supplanting the teacher's role in relation to the child, it could supplement it, reducing the marking and recording workload while increasing and easing the flow of genuinely useful information.

Using e-assessment for low-stakes, formative purposes would seem to offer some attractive opportunities:

- A bank of assessments could focus in depth on individual curriculum topics, rather than attempting to cover an entire subject, leading to richer data on individual pupil progress.
- Printed test questions can assess only limited aspects of the curriculum, whereas the dynamic and interactive capacity of the computer allows for a

wider range of question types and styles of assessment. E-assessment also helps pupils to demonstrate their visual and kinaesthetic understanding more effectively.

- More frequent assessments can give formative data before a subject has been taught and summative (as well as further formative) data afterwards. Tests can be used to inform individual teaching plans as well as to assess achievement. By contrast, many conventional tests are primarily summative, with only limited diagnostic or formative information.
- Instead of being taken at distinct points in the school year, formative e-assessments can be integrated into ongoing classroom teaching. In this way, assessment becomes an integral part of the normal teaching and learning cycle for teachers and pupils.
- E-assessment can build a profile of strengths, weaknesses, partial understandings and misconceptions. Going far beyond scores and standard outputs, these reports can be used to improve teaching as well as communicating effectively to various interest groups.
- Because it is low-stakes, e-assessment can be a positive part of the classroom experience. Administering tests on computer and using engaging tasks can make them more motivating. Boys, in particular, may engage more readily with computers.

There are corresponding challenges, however. Where pupils' responses are to be computer-marked, computer-based assessments are usually limited to the use of questions with closed answers, rather than allowing pupils to express their responses in their own ways. To be effective, these questions must be carefully devised to capture as much as possible of the full richness of the curriculum, and to be thought provoking rather than superficial. Computers have a potential for dynamic and interactive activities that are not available on paper, and this potential must be exploited to create effective, innovative digital question types. Computers can effortlessly capture a vast quantity of data about each pupil's responses, but much work has to be done before this becomes a useful, meaningful and manageable tool for the teacher.

Previously the main purpose of assessment was the provision of information in numerical form to be used *outside* the classroom to summarize and compare pupils' performance. What is now required is an unprecedented quality of information to be used *inside* the classroom, by teachers and, to some extent, by pupils too. This is reflected in some of the recent educational and assessment trends.

3.8 New technologies

In 2020, the children who started in Reception classes in September 2006 will be entering higher education or employment. Fourteen years is one entire school generation in general.

Most teachers who will become senior and potential school leaders in 2020 are currently junior teachers in their early years in the career or still studying to earn their degrees. Many of the parents of the children who will start primary education in 2020 are just coming to the end of their own school period.

During their school years, children should grow from relative dependence on their parents and teachers into mature learners, armed with the skills to adapt to changing demands. Society's aspirations for them are expressed in the outcomes of the Every Child Matters framework: be healthy, stay safe, enjoy and achieve, make a positive contribution and achieve economic well-being.

The vision of *2020 Vision- Report*, Gilbert (2006), is one in which these aspirations are realised for all children and young people. The education system will need to act now if it is to transform the experience of children starting school today. We do not underestimate the challenges involved. However, the author of *2020 Vision- Report* believe that the process of achieving their vision will be an exciting one in which many schools are already leading the way.

Together, schools, local and national government need to work towards a society in which: Gilbert (2006)

- A child's chances of success are not related to his or her socio-economic background, gender or ethnicity,
- Education services are designed around the needs of each child, with the expectation that all learners achieve high standards,

- All children and young people leave school with functional skills in English and mathematics, understanding how to learn, think creatively, take risks and handle change,
- Teachers use their skills and knowledge to engage children and young people as partners in learning, acting quickly to adjust their teaching in response to pupils' learning,
- Schools draw in parents as their child's co-educators, engaging them and increasing their capacity to support their child's learning.

Already, with significant western countries investments, over the past ten years the use of technology in schools has increased considerably. The new technologies have an impact on a school in three main areas:

- The administration of the school, including budgeting, planning and databases managing pupil details and progress.
- The creation and delivery of lesson materials, including teachers' and pupils' use of whiteboards, visualizes handheld voting devices and tablet PCs to enable reproduction of and access to resources.
- The use of domestic digital technology as a learning tool, including home access to the internet, digital cameras, video cameras, gaming devices, Personal Digital Assistants (PDAs) and mobile phones.

Table 19 shows some of the ways in which new technologies contribute to personalizing learning by influencing what, how and why children learn.
While all schools have systems for recording and reporting information about pupils and their achievement, this information is not always readily available to those who could draw on it to improve learning, namely classroom teachers, pupils, and parents. Using the new technologies to inform learning and teaching will be a priority.
This should take advantage of the potential of on-line learning opportunities linked to individual learning plans (or 'e-portfolios') and information held on pupils' progress. The Gilbert Report (2006, p.27)

Table 19- Ways in which technology might contribute to personalizing learning

Technology influences what, how and why children learn by	• Broadening the range of learning material children are able to access, either guided by a teacher or as part of self-directed learning. • Enabling quick interactive assessments, for example, using 'voting' technology. • Promoting development of a broad range of knowledge, skills and understanding, in new contexts and with virtual access to experts. • Facilitating collaboration with peers (in the same school and in other schools). • Increasing the variety of learning resources, software and communication tools, through new media • Helping schools to use a wider range of readily available resources and software to enhance learning, including making software available to children to use at home. • Blurring distinctions between informal and formal learning – giving children the ability to choose what they learn and when they learn it. • Increasing motivation, through pace and variety. • Increased relevance, through greater links between children's experience of school and of the technology-rich world outside.

Supported by

Engagement with parents and pupils	**Whole-school systems**
Expanding the potential for communication, sharing resources, creating shared spaces to record pupils' learning and progress.	Integrated learning and management systems that bring together all the information on pupils' progress and analysis of assessment data, and are capable of being shared with other schools and organizations

Source: Gilbert, C. (2006)

It will be important that decisions on the use of the new technologies be taken in the context of a clear vision for personalising learning and be informed by comprehensive, objective advice in order to present good value for money.

3.9 A new generation of assessments

Building upon all of this, the time is now right for assessments which offer an extra dimension not available in traditional tests. The pupils are no longer the 'objects being measured' but instead become active, engaged participants in the process. The experience of trailing the questions with groups of children provides evidence that pupils find demanding open-ended questions genuinely interesting. Extended discussions take place, with different pupils spontaneously providing evidence and reasoning to support their points of view. Children are animated in their opinions, but also show willingness to adapt their views in the light of reasoning to the contrary.

Such thought-provoking questions should support high-quality information that is available to teachers. They allow in-depth probing of pupils' knowledge and reasoning, uncovering misconceptions and pinpointing the limits of understanding. However, adding further value will be the provision feedback so that teachers can confidently go straight from the test results to detail and tightly focused teaching plans. These types of requirements can be addressed through computerized testing, but this will require a new type of test with different approaches to structure and, crucially, to the reporting mechanisms.

3.10 Evaluation through playing

The game is a very common situation for children and it is especially a characteristic of childhood, since the child spends a significant portion of his/her time at play. Many researchers such as Furstenberg and Hughes (1997) and others discussed the central characteristics of play:

1) The motivation to play stems from the inner and personal will of the child and is not forced upon him/her by any external factor.
2) Enjoyment is the drive that causes the child to play.
3) Play requires active involvement on the part of the child and causes him/her to have a positive feeling.

Play is not isolated; it is related to the advancement and development of skills in various fields. Regarding the connection between the development of play and cognitive development, or the connection between the development of play and social-emotional development and other areas Athey (1984); Fink (1976), play can be used as a tool to assess children (Play-based assessment). This has its origins in the beginning of the twentieth century, O'Connor (1992); watching children at play serves as an initial and main source of information regarding the cognitive, social, emotional, motor and other aspect of the development of the child. One of the leading researchers in this field was Linder (1990), who presented the model of inter-disciplinary play-based assessment. The model is intended for children from birth through six years of age, it is based on the observation of children during play. The

activity of the child during the observation serves as a source of information regarding the child's development in different fields. The information gained from the observations serves as the basis of the designation of the child's strong and weak points and is used to shape an intervention plan that will be especially built and tailored for him/her at more advanced stages. Hughes (1990)
Johnson, Christie, and Yawkey (1999); Fewell and Kaminski (1988); Hughes (1990); Linder (1993a) also claim that the child at play is more flexible and feels more comfortable. The flexibility leads to less stress and is less threatening- this facilitates greater participation on the part of the children, which can grant the professionals the required and most genuine information regarding the child. One of the advantages of play is flexibility, and thus the efficiency of play as a tool for assessment or therapy. An additional advantage that Linder (1993a) cites in order to strengthen the idea of play-based assessment is that play is a more natural situation for the child, and can thus reduce the stress experienced by the child in the artificial diagnostic situation. This neutralizes most of the irrelevant factors that can impair the child's functioning during the assessment. An additional advantage is that a bond with the child can be relatively easily forged with the child in a play situation. Linder (1993b)

3.11 Learning in Games

In general, learning is at its best when it is active, goal-oriented, contextualized, and interesting, Bransford, Brown, and Cocking (2000); Bruner, (1961); Quinn (2005); Vygotsky (1978). Instructional environments should thus be interactive, provide ongoing feedback, grab and sustain attention, and have appropriate and adaptive levels of challenge—in other words, have the features of good games. Gee (2003) has persuasively argued that the secret of an immersive game as an instructional system is not its 3D graphics and other bells and whistles, but its underlying architecture. Each level “dances around the outer limits of the player’s abilities,” seeking at every point to be hard enough to be just doable. Similarly, psychologists Falmagne, Cosyn, Doignon, and Thiery (2003); Vygotsky (1987) have long argued that the best instruction hovers at the boundary of a student’s competence.
Recent reports Thai, Lowenstein, Ching, and Rejeski (2009) have further contended that well-designed games can act as *transformative digital learning tools* to support the development of skills across a range of critical educational areas. The simple logic mentioned earlier is that compelling storylines represent an important feature

of well-designed games that tend to induce flow, Csikszentmihalyi (1990), which in turn is conducive to learning. One major problem is that immersive games lack an assessment infrastructure to maximize learning potential. Furthermore, typical assessments are likely to disrupt flow in good games. Thus, there is a need for embedded (i.e., stealth) assessments that would be less obtrusive and hence less disruptive to flow.

3.12 Computer-Based Games

In their seminal book on the topic, *Rules of Play*, Salen and Zimmerman (2004) define a game as "a system in which players engage in an artificial conflict, defined by rules that result in a quantifiable outcome". In addition to conflict, rules, and outcomes, Prensky (2001) adds goals, feedback, interaction, and representation (or story) into the mix of essential game elements. The combined list of essential game elements as used includes: (1) conflict or challenge (i.e., a problem to be solved), (2) rules of engagement, (3) particular goals or outcomes to achieve (which often include many sub-goals), (4) continuous feedback (mostly implicit, but may be explicitly cognitive and/or affective), (5) interaction within the environment, and (6) compelling story and representations. This inventory of important game elements is actually quite similar to those underlying good instructional design, but excludes design-free activities, where there are likely to be rules but unlikely to be quantifiable outcomes, such as points or rank accrued. Also note that this definition is parallel to the idea of assessment, with the purpose of describing knowledge, skills, and other attributes in a quantifiable manner.

Narrowing the definition a bit further, the focus will be on *interactive, digital games that support learning and/or skill acquisition*. This narrower definition is still pretty broad, and includes serious games as well as casual, educational, action, adventure, strategy, role-playing, puzzle, simulation, and massively multiplayer online games. One reason why games are so engaging is because kids (of all ages) like to be in control of what's on the screen, and games offer this control on a continuing basis. In addition, games can give kids a powerful sense of mastery. Success is addictive, and computer-based games provide constant doses of small successes as players defeat more enemies, earn higher scores, and graduate to more challenging levels. In addition to fostering feelings of control and mastery, other reasons that games are so engaging are because players are motivated by social interaction, competition, knowledge, and escapism. Hirumi, Appelman, Rieber, and Van Eck (in press); Novak (2005)

Similarly, Prensky (2001) cites a number of ways that games capture and sustain players' interest including sensation, fantasy, narrative, fellowship, discovery, and expression. Once engaged, learning takes place naturally within the storyline of a well-designed game. The key, then, is seamlessly aligning "story" and "lesson"—a non-trivial endeavour. Rieber (1996)

3.13 Serious games

Identifying games that can be used for education is complex. There are many definitions and ways of classifying educational games, serious games and their relationship to virtual worlds and simulations.

Some view them as a continuum, Aldrich (2009), while others see them all as different categories of the same thing, Sawyer and Smith (2008). Serious games are the accepted term for games with an educational intent. They need to be engaging, although not necessarily fun, while the learning can be implicit or explicit. There is no uniform pedagogy within serious or educational games; earlier games tended to be based on a behaviourist model. Later games try and incorporate experiential, situated and socio-cultural pedagogical models. The learning outcome is dependent upon an appropriate pedagogy and the underlying game mechanics and how the content is integrated into the game so the learning is intrinsic to play.

A comparison of the use of serious games (including simulations and virtual worlds) in multiple domains was made. The aim was to determine if the practice could be transferred to the formal educational domain.

Serious games, particularly training simulations, are integral to the military. They provide a safe cost effective mechanism for training tasks to be performed in hazardous circumstances or which would be time and labour intensive to set up in the real world. The high level of fidelity, that is, their close resemblance to actual events, enables transference, Stone (2008). Learning is predominantly mediated through instructors externally to the game experience, although players can "win" or "lose". The ability to modify the scenario to ensure fidelity is key. Serious games in the health sector are also a growing domain. Like the military, training simulations are becoming more common for medical practitioners. Realistic role-play is time and labour intensive and traditional methods of teaching, such as card sorting, lack the

psychological fidelity – that is, they do not mimic the responses that the real situation would cause. Such games are also likely to make use of alternative interfaces. Again like the military the games tend to have clear well-defined learning goals although there is no fixed answer the use of serious games in commerce is also increasing. They are used to train staff via simulations, and, as in the other domains, popularity is increasing due to the cost benefits. However, commerce is aware that games develop skills needed in everyday life, like confidence in taking risks and improving communication across the organization. They also take advantage of the fact many new employees understand the concept of games and appreciate the flexibility when carrying out learning exercises.
Games also have a vocational potential. Simulations are used for continuing professional development and training. They may also be useful for young people not in education, employment or training systems (NEETS). They can act as a safe introduction to various vocational careers – failure is not an issue, in fact it is expected, when learning a game. Squire (2005)

Finally, in formal education the games used with sufficient support are shown to be motivational and an aid to learning high level or complex skills. Some researchers, notably, Gee and Shaffer (2010) argue that games, particularly epistemic games that model professional practice, are good for *teaching and assessing* because the best commercial games provide appropriate challenges, they build on previous information; they require problem solving and critical thinking. This practice has not yet transferred to the classroom. This, they argue, is because games *teach and assess* 21st century skills, such as problem solving, collaboration, negotiation etc that are not the foundation of the current education system. Currently games are more likely to be used if they can be seen to inspire, or there is a direct link to the curriculum. The latter is more likely if the game can provide *appropriate assessment* and fits into existing lesson structures. The criterion for using a game is often whether it will make the teacher's life easier.

3.14 Assessment in Games

In games, as players interact with the environment, the values of different game-specific variables change. For instance, getting injured in a battle reduces health, finding a treasure or other object increases your inventory of goods, and so on. In addition, solving major problems in games permits players to gain rank. One could argue that these are all "*assessments*" in games of health, personal goods, and rank. But now consider including additional variables in games. Suddenly, in addition to checking health status, players could monitor their systems-thinking skills, creativity, and teamwork skills, and if values of those variables got too low, the player would likely take action to help boost them.

Playing well-designed games certainly has the potential to enhance learning, and more researchers every year are claiming that a lot of important learning and development is going on within such games, e.g., Green and Bavelier (2003); Tobias and Fletcher (2007). But what exactly is being learned? Are students/players learning what's intended via the game design? Are these skills educationally valuable (especially with an eye toward future workforce needs)? And how to substantiate these claims?

The main challenge for educators who want to employ or design games to support learning is making valid inferences about what the student knows, believes, and can do without disrupting the flow of the game (and hence student engagement and learning). One solution entails the use of an assessment design approach called evidence-cantered design, Mislevy, Steinberg and Almond (2003), which enables the estimation of students' competency levels and further provides evidence supporting claims about competencies. Consequently, Evidence-cantered assessment design (ECD), has built-in diagnostic capabilities that allow any stakeholder (i.e., the teacher, student, parent, and others) to examine the evidence and view the current estimated competency levels. This in turn can inform instructional support.

The framework of evidence-centered design (ECD) was chosen because of its increasing conceptual and practical traction in various assessment communities since the first foundational papers appeared about 10 years ago [e.g. Almond et al. (2001); Mislevy et al. (2003)]. ECD has now been successfully applied to state large-scale science assessments [e.g. Zallas et al. (2010); see http://ecd.sri.com/], computer networking environments [e.g. Frezzo et al. (2009)], and other assessment contexts. The contribution of ECD to the story of measuring what students are getting from their interactions with games relates to its ability to equally and accurately assess lower- as well as higher-order thinking skills as distinguished in Anderson and Krathwohl's (2001) categorization (i.e., lower-level skills include knowledge, comprehension and application, while higher level skills include analysis, synthesis, evaluation, and creation). Historically, higher-level skills, requiring students to think critically and creatively, are very difficult to assess.

3.15 Integration of the computer into the kindergarten's teaching culture

3.15.1 Computers in the kindergarten

Today, the environment in which people live exposes the individual to a wide range of uses for the technology encountered in daily life and in educational frameworks. Computer technology has developed over the past years in a manner that finds it integrated in all areas of life. Today, the computer is a part of the kindergarten and almost every kindergarten has a computer, and children have access to it and use it. The entry of the computer to the kindergarten sparked a heated debate between researchers and educators- some accepted the entry of the computer and saw it as an advantage and a benefit, as opposed to the second group that saw its entry as a source of concern.

3.15.2 The possible benefits and concerns regarding the integration of computers in work with young children

The use of the computer is a means to bring about significant pedagogic change, Attwell and Hughes (2010). The use of the computer among preschoolers, utilizing appropriate educational tools and stressing focus, excitement, expansion, promotion and modulation of behaviour in relation to the development of thought in the computerized environment enables an enlightened use of computer technology as a means to achieve goals such as: development of children's thought; forming new models in the role of the teacher as an broker of thought; moving the emphasis from acquiring pieces of information to promoting advanced thinking skills and suiting the instruction and the learning to the diverse needs of the student. In other words, the combination of computers and brokering presents the possibility to advance the quality of education and learning at the preschool age in technology-rich environments, National Association for the Education of Young Children (2012). Thus, the computer can be turned into a window of opportunity for play, learning of content and diagnosis.

3.15.3 The advantages

1) At this age, the natural curiosity of the child is at a high level, making the child curious and open to novelties- thus, the child's early exposure to the computer is likely to build a positive, simple and natural relationship with the computer. An early start in computer education can turn learning from gruelling work to an enjoyable process, to a part of play. Health Nexus Sante (2011).
2) The computer enables interactive learning through which the children do not simply respond to stimuli, but also influence and supervise the outcome, and thus such learning contributes to the child's involvement and to the feeling of control over the subject.
3) Providing instant feedback immediately after the child's response helps the child to assess his/her work. Rooke and Lawrence (2012)
4) A child's self-image is constructed mainly by the environment, by people and by activities that encourage and assure the success of the child. Thus, a computer can serve as a powerful tool in building self image. Some programs offer a positive response to each success, and do not respond to mistakes. Other programs are able to adjust the level of difficulty to the children's level, thus preventing frustration. Children can enjoy a feeling of control over their activities, and by virtue of independent learning. A success turns into another success as the children amass confidence, which can develop and build the self-image. Brooker and Woodhead (2008); Health Nexus Sante (2011).
5) Children who are bashful and lack confidence can benefit from positive feedback provided by the computer, and at the same time, anonymity is preserved. Children also benefit from a supportive environment that attempts to ensure progress and success. Malinen, B. (2010); Shekhar (2012); Health Nexus Sante (2011).
6) There is a variety of educational frameworks and styles, and many children learn with great efficiency when they can chose the style of learning, instead of using the style forced upon them. French (2007); Health Nexus Sante (2011).
7) The study by Lillard (2013) demonstrates a high level of verbal communication and participation between the kindergartener and his/her

peers when working with the computer, as opposed to other conventional activities. According to the study, the computer can strengthen early mathematic concepts, promote the issue of pre-reading and strengthen problem solving skills.

8) The study by Kernan (2007); Ryokai, Farzin, Kaltman, and Niemeyer (2013) examined the influence of the computer on the children's choice of game corners and on the social interaction of the children in the game corners. The results of the study show that during the first period, the computer influenced the children's access to the children to the other game corners. However, after a period of time, the children returned to play in the other game corners- but the computer corner became one of the children's preferred corners. Thus, it can be claimed that there was not a change in the social interaction in the other game corners as a result of the introduction of the computer to the kindergarten.

<u>3.15.4 concerns related to introducing the computer in the kindergarten</u>

1) In order for the preschooler to acquire significant experience with the computer, he/she must be provided with individualized and intensive instruction by the kindergarten teacher. Similarly, the kindergarten teacher must have a general understanding of computers and an understanding of the specific software being used (including its educational goals), this in addition to her general educational training and experience. The study shows that the computer cannot fill the role of the teacher; the kindergarten age child requires someone next to him, at least at the initial stage, someone who will be attentive to his needs and problems during the entire process of initiation with the computer. Orey (2010); Chinn, C. A. (2011).
2) Beyond the technical problem, the central question is whether young children possess the required cognitive abilities such that their computer experience will be significant and constructive. Studies by Health Nexus Sante (2011) demonstrated that it is possible to give four-years-old basic instructions in the internet so that they could work independently to draw or copy models or sketches shown to them, or even copy their own drawing. However, the learning process is long and demands great effort. The same level of ability can be

achieved in a more efficient manner and at a greater level of understanding if the same children are taught several years later.

3) OECD (2012 report claims that the use of the computer is a threat to children's social development. He maintains that this is liable to bring about the loss of the direct connection between the child and the teacher.
4) The kindergarten is organized as a microcosm of the world in which the child lives, and there is no doubt that the computer enjoys a prominent role in that world. However, the program for preschoolers is built in a manner such that the child will be involved in the investigation of the world around him using his five senses. This leads to a full, rich and direct experience with materials and activities in comparison to the type of these experiences with the help of a computer, which are very limited and artificial. Brooker and Woodhead (2008); Health Nexus Sante (2011); Buckingham (2008).
5) Dyer-Withefordand de Peuter (2009) claim that the computer can create an automaton and make the child's entire actions automatic, quashing the child's humour and emotions.
6) Fear that the computer will uproot or replace the basic learning activities in the classroom- this will lead to social isolation, which will be expressed in language.
7) Some of the negative results of the use of a computer: Competitiveness as opposed to cooperation; a halt in cognitive development; acquiring a negative influence and difficulties in social-emotional development; delaying of play behaviours and the ability to develop an imagination. Erfan and Hakeem (2014); Edgar and Edgar (2008).
8) Children at this age lack the full range of skills needed in order to benefit from the computer's advantages since they lack the ability to read; they must develop problem solving skills and hand-eye coordination; it is necessary to improve basic computational skills and strengthen memory. Erfan and Hakeem (2014); Edgar and Edgar (2008) claim that children must around seven years of age in order to begin benefiting from the use of the computer.
9) The use of the computer as a means to bring about a significant pedagogic change, Attwell and Hughes (2010); Johnson and D'Souza (2013). As it was stated, the *brokerage model theory* did not crystallize in the context of computing or in response to it, but it provides a rationale for the opportunities that computing unlocks in the preschool age. The brokerage concept, with an

emphasis on focus, excitement, expansion, encouragement and behavioural regulation in the context of developing thought in a computerized environment allows for an enlightened use of computer technology as a means to achieve a range of goals. These include: Developing children's thought; forming new roles in the teacher's function as a broker of thought; shifting the emphasis from imbuing pieces of information toward promoting advanced thinking skills, and making instruction and learning compatible with the varied needs of the student. In other words, the combination of computing and brokerage unlocks opportunities to advance the quality of instruction and learning for preschool age children in technologically rich environments.

3.16 Innovations in research

The existing trends in research as of today point to an integration between the following two fields: **The first**- Assessment through play, and **the second**- The use of the computer in the realm of education—in which it is proposed as a new tool to assess the readiness of the child to learn in school. The evaluation of the child's readiness is a process, whereas the tool allows us to neutralize subjective influences. And the tester's dynamic reference to the child's activity allow for an objective prediction that will lead to efficient treatment and advancement. The goal is to create a predictive tool with added value in anticipating the future functioning of a child in first grade. Today, there is a wide variety of games that cover a number of areas of cognitive ability, knowledge and the ability to use advanced areas in multimedia. The battery of tests allows for an assessment of the child's level of functioning in several developmental fields, in a number of areas: Comprehending quantity and computational understanding, memory, visual perception, auditory perception, visual-motor functioning and speech.

3.17 Concluding Remarks

Assessment is used to measure a child's ability whether ready for school. This chapter reviewed information on assessment instruments, such as the purpose, gives a snapshot of the important features that should be compared when selecting an instrument. It is important to note that when choosing an instrument, it should match the purpose for which the assessment information is going to be used and that one instrument may not meet all the intended needs.

The importance of early intervention and prevention has garnered international recognition and support. In this regard, early intervention is aimed to take care of individuals who need services before these issues escalate into severe problems. Critical to this process is an appropriate and efficient assessment approach. In the past, practitioners found it difficult to obtain ecological valid and reliable data when using traditional assessment tools. To address these concerns, play-based assessment has gained popularity due to its sound theories and age-appropriate methodology.

Data from 122 Head Start children were analyzed to examine the impact of computer use on school readiness and psychomotor skills. Children in the experimental group were given the opportunity to work on a computer for 15–20 minutes per day with their choice of developmentally appropriate educational software, while the control group received a standard Head Start curriculum, Xiaoming Melissa and Bonita (2006). Four standardized tests were administered at baseline and 6 months later to assess their school readiness, visual motor skills, gross motor skills, and cognitive development. The experimental group performed significantly better than the control group on the school readiness test. The effect of computer use at school was strongly enhanced by the children's home computer experience. The data were inconclusive regarding the potential effect of computer use on motor skills. These findings underscore the importance of early childhood computer use in the development of minds and bodies of children from socioeconomically disadvantaged families. Xiaoming at el. (2006)

The next chapter will focus on the concept of 'school readiness' as concerned early childhood educators at both preschool and primary school levels for several years. Children who have commenced school without developing vital readiness skills, have been identified as 'at risk' for their future academic, social and occupational success. With the increasing complexity of our world today, and the corresponding increases in the skills needed by young people entering adult society, school readiness has never been more important.

CHAPTER 4: READINESS FOR FIRST GRADE

4.1 Introduction

Entering first grade and starting school is one of the turning points and central events in the life and education of a child. The transition from kindergarten to school is considered one of the critical periods in the life of a child, during which he acquires fundamental skills and ways of learning and thinking. For the child, this is a profound change and a transition from a small, intimate setting to a larger setting with more expectations and various demands made upon him/her. The transition also requires the child to made adjustments and develop technical skills as well as emotional and social relationships in a new environment. Generally, the coordination is done by the kindergarten teacher, usually in cooperation with the parents, and is a critical component in the children's development. An external advisory system takes part in addressing developmental delays through communications clinicians and educational psychologist as needed. They conduct observations of kindergarten children, receive reports from the kindergarten teacher and give psychological tests to children who appear to have developmental delays. These tests may be accompanied by questionnaires and testing instruments. The most common "diagnosis" by psychologists regarding children with learning deficits, in cases when the intellectual measures are satisfactory is “childish for his age"; "emotionally immature". This is the fundamental diagnosis which is the basis for the decision of whether to have the child spend an additional year in compulsory kindergarten or advance to first grade. When the intelligence test scores seem low, there is generally a referral to special education. However, intelligence is a weighted score which is not a reliable indicator for learning deficits. Generally, there are no diagnostic kits for learning deficits, most of the wording cites varied difficulties attributed to "lack of maturity" or "need for help". At this age, it is possible to predict developmental delays, including the late acquisition of motor skills, lapses in language and speaking skills, and attention and concentration deficits. These are learning difficulties in which early care is essential to allow for early integration into "regular" frameworks which provided the needed care, or special frameworks, which provide treatment. Treatments given in the aftermath of a thoughtful diagnosis will allow children to utilize methods appropriate to their needs. Today, it is possible to diagnose various forms of dyslexia, language and attention deficits, motor deficits and cognitive mathematical deficits. It is possible to begin an early intervention at a young age, as needed and acceptable. Klein (2002)

Even a child "ready for school learning" may undergo a difficult adjustment period. Before beginning school, the child's capacities were oriented toward casual learning alongside purposeful learning, with many free-play hours. In school, the child is required to concentrate his efforts on focused and planned learning conveyed by an adult, and he/she is expected to demonstrate a high level of appropriate concentration on both the cognitive and emotional-social levels. The educational research conducted by Gullo and Burton (1992) examined the issue of children's transition from kindergarten to first grade. The findings reveal that children's preparedness for school may be perceived from the perspective of long-term influences on their development in cognitive, emotional and social aspects. Today, the accepted term is self adjustment, Kopp (1989); Zelazo, Muller, Frye, and Markovich (2003). This process is developed gradually and is rooted only once he/she is about to enter kindergarten and has a command of speech and the technical capacity for control of actions and thought. Therefore, when a child is unprepared for school because of a lack of self-adjustment, it is expressed in his/her attention span, capacity to respond to requests, low motivation and limited understanding of the teacher-student relationship and its emotional aspects. Inadequate self-adjustment may increase tension (frustration and failure), which will have an impact on the child's self-image, his motivation to learn and his openness to acquire knowledge, Sanders (1997). Changes in the extent of the child's adjustment to school are linked to the teacher's perception of the student and degree of closeness to the child. The teacher is responsible for the ecological system and can alleviate risk factors. Cicchetti and Valentino (2006)

The recommendations are based on a diagnosis of lack of maturity or readiness for school. The children remain in kindergarten and receive occasional treatment (individual and/or group assistance) by various professionals (kindergarten teachers with special education qualifications); occupational therapists and psychologists. The recommendation to keep a child in compulsory kindergarten for an additional year is made with the consideration that the children are not mature enough and the additional time will allow them to build their own capacities to attain the emotional and cognitive maturity to meet the challenge of study and adjustment to school learning. The literature demonstrates that in a substantive number of cases, an additional year of kindergarten without monitoring, inspection, evaluation and proper intervention is likely to lead to emotional and motivational damage. Thus, the process of ongoing monitoring is very important to allow for greater predictive ability with much greater precision than is the current practice.

4.2 School Readiness

School readiness was considered a crucial issue in the United States in the past decades, Kamerman and Kahn (1995). Kindergarten teachers released a report that about a third of the children in the country are not sufficiently prepared to achieve success in school, Boyer (1991). In fact, experts warned that there were many children that enter the school without fundamental skills that were needed in order to achieve academic success. Most reports reveal that children from minority groups have not developed appropriate skills for language, literacy and other areas that were needed to ensure they will do well at school. Early et al. (2007)

Despite the fact that public schools are focusing much needed attention in preschool and elementary school education to serve younger children, the schools are not perceived to be adequately equipped to handle the children's early learning and development, Winter and Kelley (2008). Programs for early intervention and school readiness emerged as early as the mid-1960s, as spurned by initiatives that included the passage of the *Economic Opportunity Act of 1964*, Grubbs. (1965), and initiatives such as *War on Poverty*, The Council of Economic Advisers (2014), Focusing on early childhood programs in this period enhanced the development of economically and socially disadvantaged children because of services in the areas of education, health and family support, Winter and Kelley (2008). *Head Start*, according to Barnett and Hustedt (2005), is considered as one of the most valuable products of the *War on Poverty Act*. It offers a model that provided services in the areas mentioned for young children and their families. Ever since, variations of this program emerged.

In 1989, the *National Education Goals 2002,* Legal Information Institute (2012), initiative gave emphasis to the importance of early intervention and school readiness efforts to help children achieve individual success and accomplish societal goals towards building a better workforce, Winter and Kelley (2008). The increase in the literature for school readiness strengthened federal commitment to early education.

The preschool level is then perceived to be just as important as all the other grade levels. There is still a critical need to learn more about early learning environments. The stress on the value of preschool education involves achieving the objectives at this age. It also highlights the negative consequences involved if children will enter grade school without earlier experience in preschool education, especially in literacy development, Kamerman and Kahn (1995). In response, there is a focus on the cognitive and socialization aspects of preschool programs in order to help children and parents experience successful preschool experiences.
According to the Elizabeth Love Inner East Community Health Service, Elizabeth Love program (2003), during the preschool years of the children, teachers and parents are faced with the significant concern of evaluating if the child is ready to for grade school the following year. The education process is perceived as a joint venture between the child, the family, the school and the teachers. This is involved in the discussion of school readiness, a complex issue in education research.
Cassidy, et al. (2003) mentioned that there is an increase in the focus on readiness in the context of early childhood education in the country because of the growing concern for failing students and schools, as determined by the *No Child Left behind* (NCLB) assessments. The National Education Goals Panel, Legal Information Institute (2012), promoted an approach for school readiness that covered five areas of child development and learning, such as physical health and motor development, socio-emotional development, approaches toward learning, literacy, cognition and general knowledge development, Cassidy, et al. (2003).

The National Association of State Boards of Education (NASBE) points out that developing school readiness was about building the ability for children to be ready to benefit from school and readiness to learn more than the alphabet and numbers. Although, there needs to be a recognition that it is not appropriate to expect that children will have a common set of skills when they enter school because they come from different backgrounds. Moreover, the focus on readiness does not necessarily involve the children alone. It is also about scrutinizing the environment by which the children are exposed to in order to guarantee student success.
Weigel and Martin (2006) noted that the development of intervention programs to help improve early literacy and school readiness skills for young children need to be developed to address the needs of children, with the help of parents, child care

programs and the community at large. Through this focus, educators and early childhood providers will be able to target local programs at an optimum level. The increase in the demand for accountability and for the improvement of the performance of students at a national level also increased the concern for school readiness and early literacy, Weigel and Martin (2006). School readiness remains to be a sensitive topic wherein early educators and policy makers have not agreed upon definition. Furthermore, it is about recognizing predictors based on the preschooler's literacy and language abilities as to their performance in the early levels of grade school, Weigel and Martin (2006).

The concept of early literacy and school readiness involves laying down the foundation for literacy and school success in the early years of the student's life. During this time, children develop skills and attitudes that will strengthen their potential for success. Daily experiences and opportunities to develop oral language skills and to gain knowledge through written language strengthened their emergent literacy skills. Children acquire skills and knowledge in different formal and informal settings, even at home, and at child care programs, Weigel and Martin (2006).

The development of young children does not happen in isolation. Instead, it occurs in wide array of direct and indirect influences. Research links children developmental outcomes and environments wherein they have supports for that recognized the critical nature children's experiences to their learning and growth, Weigel and Martin (2006).

According to Cassidy et al. (2003), the preschool teachers should plan their activities in such a way that they consider the interests of the children and how these interests can be used to increase their understanding and learning. These activities must be shaped in such a way that they accommodate the development of specific skills. This helps in building a curriculum that is developmentally appropriate and child-centered, as well as increases the school readiness levels of children, Cassidy et al. (2003).

Cassidy et al. (2003) recognized three essential factors that need to be present to address the needs of preschoolers. The first is the teachers' need to be knowledgeable and have the ability to facilitate each child's learning. They need to possess an understanding for the child's development and the process by which young children learning. They need to have the ability to identify the child's skills, individual personalities, family cultures and priorities, Cassidy et al. (2003). The teacher serves as a catalyst in the creation of an educationally stimulating environment. Additionally, it is also significant to have communication with the *parents* in order to help them build on the benefits of the curriculum, through establishing play-based strategies to enhance the child's development at home, Cassidy et al. (2003).

Missal et al. (2008) emphasized on the importance of e*arly literacy development and school readiness*. Children that fail to enter school with the adequate level of literacy and school readiness are more likely to fail than to catch up with peers that are equipped with these attributes. They are considered to be at a high risk of reading failure and also considered to have a higher potential for dropping out in high school and experiencing broader social failure, Missal et al. (2008). This highlights the need for educational practices in early education to allow children to maximize on their skill development, but at the same time proceed at their own rate. There is a need to balance skill acquisition with the individual development rate of the students. Conversely, early education classroom environments and curriculum must be designed to offer the most opportunities to enhance the individual potential of the child for school readiness and early literacy development.

4.3 Theoretical Approaches to "Readiness for School"

Defining the term "readiness for school", the way in which it is evaluated and the nature of the recommendations made in the aftermath are dependent to a great extent on the theoretical basis on which they are made, Cohen and Gumpel (2000). That said, there is widespread consensus among researchers that the concept of readiness for school is a broad and complex term which does not relate to function, specific development (such as walking), or acquired skills (such as reading). It relates to a number of varied functions, both naturally gained and acquired, which are linked to the future capacity of the child to function in school. The academic knowledge about the relative importance of each of those functions is relatively limited and therefore the concept is defined and measured by various investigators with different methods, and each gives emphasis to different areas of functioning. One of the more broadly accepted definitions is offered by Anastasi, Anne, and Urbina, (1997), according to which *school readiness relates mainly to the acquisitions of skills, knowledge, and* *motivation that are the needed* basis to enable learning that yields its greatest value from school study. The researchers Hunt and Kirk (2005) have called these prerequisite "entry skills"—skills needed to enable the child to cope effectively with the study conditions that they will confront in first grade. There are two key approaches with regard to the concept of readiness, the approach of *natural maturity* and the *environmental approach*:

<u>4.3.1 Readiness as a process of natural maturity:</u>

The maturity approach held reign in scientific theory in the 1950s and 1960s. Among its prominent proponents were Geles and Illg (1966) coined the phrase "developmental readiness," according to which a child can only succeed once he achieves the developmental phase for that level of learning. The approach states that readiness is a product of internal developmental maturation of biological and intellectual components. According to this approach, readiness is exactly like motor maturity, and the maturity is dependent on genetic factors, set by a predetermined timetable. Therefore, this approach claims that readiness for school is also a predetermined process, through a maturation of the capacities required of the child for school. Therefore, the term "readiness for school" reflects the belief that the child's development process leads him even before entering school, to acquire a set group of cognitive, linguistic, social and motor capacities, Kagan (1995). Therefore, readiness is a matter of time, and one should wait until the child himself achieves the appropriate developmental maturity to learn, and thus the child will acquire the skills needed for reading and writing.

According to Shapiro (1977), maturation is a significant component of readiness for first grade. Cohen and Gumpel (2000) claims that a child with suitable potential and a slow maturation process is different from a child with a developmental impediment. In accordance with this approach the purpose of the diagnosis of readiness for school is to identify children in need of more time to reach maturity before beginning school and being required to meet the demands of formal education. The maturation approach suggests that the main solution is that the child who is not ready for school remains an additional year in compulsory kindergarten. From this perspective, there is no need for rehabilitative or ameliorative intervention during the addition year, in keeping with the claim of "letting nature do its work".

Over many years, the maturation approach has been criticized. For example, Buntaine and Costenbader (1997) present a research survey that no positive educational influence has been demonstrated by having children stay in kindergarten for an additional year. Dennebaum and Kulberg (1994) examined third graders and the link to learning achievements. The student population examined was third graders, and the group included children who spent a second year in compulsory kindergarten on the basis of professional opinions of "lack of maturity": The second group was children who entered first grade either against or without the approval of professionals. The findings reveal that there were no differences between the children in the two groups. May and Kundert (1997) claim that an additional year in compulsory kindergarten is neither helpful nor damaging, if the child enters first grade after an additional year with the same gaps and difficulties. The main criticism of the maturity approach is that it focuses on the question of when the child is ready to learn and neglects such questions as what should be taught to him and how he can be advanced—the key questions that are the core subjects of developmental and cognitive psychology, Gergely and Watson (1996).

4.3.2 The environmental approach:

This approach made great waves in the 1960s and 1970s. Its main proponents were Blum (1969) and Hunt (1965). This approach put forth that cognitive and emotional development are an interactive process in which the environment plays a central role. The approach recognizes the contribution of heredity and organic elements, but distinguishes between them on the interpersonal level. Thus, the approach claims that learning is an outcome of the environment in which the child grows up Greenspan (1985); Vygotsky (1978). Supporters of this approach contend that the child's behaviour is shaped by the environment and thus is a product of the environment. Therefore, learning may be advanced through interaction with the environment adapted to the individual needs of the child. And it is even possible to influence the brain functions through experiences and enrichment, Nash (1997); Peterson (1994). The development of complex mental functioning is connected to the process of learning and is the product of the social interaction of the individual with others in his environment, Vygotsky (1978).

The environmental approach focuses mainly on the desire to reduce the damage which may be caused by environmental limitations or environmental tendencies unsuited to development. One of the guiding principles is that early education of children provides an opportunity for development suited for learning and thus boosts cognitive development. According to this approach, there should be intervention in the development process to promote readiness. Supporters of the approach rely on research which demonstrates children's capacity to successfully complete various tasks (eye-hand coordination, reading and other tasks) after they benefited from appropriate training. On the basis of this approach, many preventive programs were implemented for babies, children and youth, Bergan, Sladeczek and Schwartz (1991). The goal of diagnosing children's readiness before entering school is to identify those in need of special attention and support in specific areas because they are members of risk-groups in the area of learning success. Supporters of the environmental approach contend that these children should be identified as early as possible to advance their development before they enter school. But there are cases when the assistance is given in the school if needed, Kagan (1995).

4.4 Evaluating readiness for school

The research literature presents three primary areas of development responsible for a child's readiness or lack of readiness for school: **1.** the cognitive sphere; **2.** motor perception and **3.** the emotional-behaviour sphere.

4.4.1 The cognitive sphere

Many researchers are convinced that, among all the field of development, early cognitive abilities are the best predictors for learning achievements in school. There is solid research which indicates clear, though not necessarily strong, links between cognitive-readiness scores for kindergarteners and reading and math achievements in first grade, Campbell, Schellinger and Beer (1991); Chew and Morris (1989).
Eshel and Bensky (1995) examined the contribution of evaluating readiness in various spheres of development and the findings demonstrate that in the *cognitive*, *perceptual-motor* and *emotional-behavioural* spheres are the best predictors for children's success in first grade. In addition, they found that cognitive measures offer the main contribution to predicting learning achievements in first grade. They claim that measures in other spheres add only slightly to the predictive value of the cognitive measures. A study conducted by Stevenson and Newman (1986) revealed that among the capacities measured by the *Wechsler scale test* for kindergarten

children, the conceptual ability and verbal abstraction (the common factor subtest), the cognitive variable proved the best predictor of later achievements in reading. Although other capacities are measured by the Wechsler test, they contribute only a little to predicting reading achievements. The studies show that language development and the verbal factor, which are cognitive skills, have a central place in evaluating readiness for school. Evaluating linguistic functioning is cited in more than half the studies that were surveyed by Tramontana, Hooper and Selzer (1988) who claim that assessment of cognitive capacities offers the best predictors for student achievements (especially in reading tests). In contrast, Badian (1984) demonstrates that linguistic skills given expression in the Wechsler tests (taken by five-years-old) are not necessarily good predictors for reading ability in school. The reason may be the fact that the scale tests do not include assessments of the cognitive skills essential to the acquisition of reading, such as phonological skills, phonological awareness defined as sensitivity, or conscious awareness of the phonological structure of the spoken word, mainly the phonemes represented by alphabetical orthography. These include the ability to manipulate and utilize judgment with regard to the components of speech phonemes and access to the phoneme structure of the words in language. It is customary to examine phonological awareness through various task segmentation of syllables and phonemes, combining separate phonemes in one word, removing and switching phonemes, manipulating phonemes, sorting sounds, counting phonemes in a word and identifying or creating words that rhyme with a given word.

Research on predictors of achievement, on the acquisition of reading on the basis of tasks based on phonological awareness, examined pre-reading acquisition. The findings demonstrate that completing tasks of phonological awareness done in pre-kindergarten or over the course of compulsory kindergarten were a strong predictive factor for success in the acquisition of reading in first grade. In addition, research on phonological training demonstrated that direct training in phonological awareness before the acquisition of reading (or during the first phases of learning to read) has a meaningful and positive influence on the ability of those students to attain the early skills to read words. Educational research has found this to be a central factor in predicting reading acquisition in elementary school, Adams, Forman, Londberg, and Bieler (2001). Research indicates that in the case of pre-schoolers, language and phonological awareness are among the best predictors for reading acquisition in children in the lower grades. Research findings demonstrate that it is worthwhile to teach the components of language to young children before they begin school and to develop the capacity to interpret writing before beginning school. Coding skills are directly linked to the written word and knowledge of letters and the connection between sounds and writing, Pullen and Jusice (2003). Mastery of phonological awareness at age five is a predictor of spelling ability at age nine, Muter and Snowling (1997) and the quality of reading comprehension in the upper grades.

4.4.2 The motor perception sphere

Researchers claim that readiness for school is also linked to the development of motor perception skills. These skills enable students to acquire life skills and basic skills essential to academic learning: motor perception skills relate to the ability to organize retain, and classify, reading ability and expression, the development of memory, reaching conclusions and problem solving. These abilities are advanced in tandem with brain development, and promote reading ability, aural comprehension and selection, coding skills, a child's ability to identify shapes, likenesses and to distinguish between them and to develop the hand-eye coordination to copy them, Eshel and Bensiky (1995). These skills are the foundation for reading and writing letters as well as literature. Motor perception has gained considerable attention from researchers in the field. The skills are regularly included in readiness tests for visual and hearing perception, sensory integration, visual-motor coordination, broad-range perception and basic conceptualization, Anastasi, Anne, and Urbina (1997).

One of the most commonly used tests is the *Bender-Gestalt*, which examines visual-motor coordination and is found in correlation up to 0.40 with measures for reading and math in elementary school. Another test which examines only motor perception stills is the Biri VMI (Development test of Visual-Motor Integration). This test, like the Bender test, is based on copying geometric forms. Success in first grade is a predictor primarily for cognitive readiness measures. Scores for perception and motor skills do not contribute much to the predictive measures. There is little knowledge of whether such tests can predict achievement at varied ages and grades, and thus there are no clear conclusions which may be reached, Butler et al (1991). It may be said that the relative weight of various predictor is to a great extent dependent upon the tests included in the regression analysis, and therefore it is possible that the outcomes will be different in various test batteries, Halász and Cunnington (2012). This claim is also correct with relation to the criteria for success in school. It is possible that there is a lower predictive value for perceptual and motor tests, reflecting the fact writing skills are barely represented among those criteria. There is a tendency to examine neuroscience generally, and specifically cognitive neuroscience, in the development of dyslexia, which is an impairment of numerical knowledge linked to a developmental failure. In this field numerical cognition is examined, Halász and Cunnington (2012), the children demonstrate weakness in conducting tasks that require quantitative knowledge, counting items, comparing quantities, presenting numbers even before enrolment in formal education. The importance of the attention capacity must be considered, because of its significance in achieving behaviour adaptation. Attentiveness includes three subsystems: alertness, orientation and selective executive management. Studies demonstrate that it is possible to train visual attentiveness through computer games and videos. This kind of training has improved varied aspects of visual perception, such as selectiveness, ability to discern and perceive several targets at once. In an additional experiment in this field, the examinee was successful in perceiving three targets at once without training, and four targets after training. Green and Bevelier (2003).

4.4.3 The Emotional – Behavioural Sphere

The emotional-behavioural sphere is one of the fields which contributes to a child's readiness, or lack of readiness, for school. According to Casey, Gail, and Evans (2011) there are a number of emotional-behavioural characteristics which offer starting points for success in learning. Among these characteristics, it is possible to identify attentiveness and concentration, awareness of surroundings, the ability for delayed gratification and coping with frustration. It is anticipated that the child will be able to create and maintain social ties and consider the needs of his friends and control impulses such as aggression and anger. Shapiro (1977) cites three central expressions of emotional and social maturity:

1) The child's ability to accept tasks and to work and not just play;
2) The ability to delay gratification and overcome frustration, and
3) The ability to cooperate with others and accept rules of social behaviour.

There is a great deal of empirical evidence to support that early difficulties in emotional and social functioning lead to adjustment problems and functioning in school. The field of attentiveness-concentration is one of the elements considered a good predictor for achievements in first grade, especially in the fields of math and reading, Birrell, Heather, Phillips, and Stott (1985). In most of the studies relating to the child's emotional-behavioural functioning, the kindergarten teacher's kit was utilized to attain data on the children, Bensky (1992). The kindergarten teacher's kit related to variable of adjustment, social development and educational potential as the more efficient predictors for learning achievements than tests, which include academic measures, Evans (1977). The above indicates that there is tremendous importance to the teacher-student relationship developed during early education, and that this relationship makes a significant contribution to the child's social and emotional development. In his research, Pianta (2003) cites the way in which the teacher-student relationship creates a supportive foundation for the best possible development in formal education. Reaction patterns between the two create a source of security for the child; encourage investigative behaviour and healthy interactions with one's surroundings over the long term.

4.5 Criticism of current diagnostic and screening processes

Today, readiness evaluations for children are done with paper and pencil tests, and the participants in the diagnosis are the tester (the kindergarten teacher) and the child. This diagnostic situation may be criticized on the basis of several points: consideration of the qualification of the kindergarten teacher to provide an objective diagnosis requires thorough examination because of her subjective relationship with the child. Her capacity must include topics related to exposure to the shared source of development of the parent and child. She must also have skilled knowledge of topics related to normative and delayed development, neuropsychology, attention and concentration disorders, sensory motor development, perceptual and functional delays, reading and writing, and awareness of tools to diagnoses mathematical capacities, in order to detect deficits in mathematical perception. To conduct a balanced evaluation of young children, the kindergarten teacher must provide the children with opportunities for active learning, and must evaluate not only the outcomes of learning but also the quality of the learning process until they attain the finished product. Vogler, Crivello, and Woodhead (2008).

4.6 Circumstances of the Diagnostician Professional

1) The screening process demands a great deal of time from the diagnostician since it is done individually, Panter and Bracken (2009); Anastazi (1990). The process appropriates attention away from the kindergarten group, and demands individual learning, requiring long work hours, when the process is done during hours intended for other activities in the kindergarten.
2) The diagnostic process requires tools which are not necessarily familiar to children and thus demands preparation, such as paper, work pages and other items which take the kindergarten teacher's time and draw her away from other planned activities.
3) The setting for the diagnosis is very important. The diagnosis requires a quiet space that isolates the child from the others, which may interfere with the diagnostic process. In addition, unfamiliar surroundings may also interfere with the diagnostic process and hinder the child's functioning. Panter at el (2009)
4) The diagnostician may be limited in the way he can vary the tasks assigned to the child and the child may become bored, which will hinder his functioning.
5) The diagnostician is prevented from offering positive or negative feedback regarding the child's functioning during the diagnosis and this may lead to a child's uncertainty regarding his functioning.
6) The conditions of the diagnosis limit the diagnostician in the capacity to present instructions and activities in an interesting and enjoyable manner, which may lead the child to become bored and reduce his motivation to continue the work.
7) The level of the diagnostician's documentation is influenced by many variables, some subjective, and under these circumstances, are likely to lead to imprecision that will prevent a complete and accurate picture of the child's functioning. The diagnostician may also be influenced by his own perceptions and opinions.
8) The way in which the activities and tasks are presented to the children is significant. Today, it is accepted that it is difficult to conduct a large number of sequential activities due to the child's ability to concentrate and retain interest over a long period. Clearly the emphasis must be on screening, methodology and monitoring.
9) The situation of a formal diagnosis with an unfamiliar diagnostician, and not with the kindergarten teacher, is unnatural for the child. Meeting people he

doesn't know, in an unfamiliar room, and being confronted with unknown materials will reduce the level of the diagnosis due to the potential stress experienced by the child. Even a creative child may find it hard to instantly adapt to the testing environment and hence the outcome will not reflect the real capabilities of the child.

10) The diagnosis requires face-to-face interaction and a direct interpersonal connection. The diagnosis will be impeded in the case of children who find such circumstances difficult, and this may harm the functioning of the child and his individual diagnosis.

The basis for using these tests is the view that intelligence is a set and relatively stable entity, not given to substantive change. The test outcomes predict short and long term academic achievements, among other outcomes.

The great weight given to intelligence tests in choosing the future path of the individual raises a number of criticisms. The first is the perception of human intelligence as a static entity, Feurstein, Rand, Hoffman, and Miller (1980). They claim that the nature of the accepted intelligence tests is not structured to measure dynamic processes and factors**.**

Those who criticize standard diagnosis take the view that the individual is an open system subject to substantive structural change, and therefore they propose an alternate theoretical approach. Prominent among them is Vygotsky (1978) who proposed the concept "close-range development". Fuerstein suggested "theoretical capacity for change in cognitive structure, Feurstein et al (2003), which describes individual functioning in an open system dependent upon unique experiences which the individual encounters during the course of his development. (Feurstein, 2003)

This can be seen in contrast with the classical parameters, according to which intelligence is defined by the capacity of the individual to utilize experience in order to adjust to new situations.

There are two components to this definition:

1) Diagnosis of the ability of the individual to change through a process of learning
2) Diagnosis of the individual to efficiently utilize the change in new experiences.

These abilities help in understanding mathematics in a clear, consequential and vital manner. The emphasis in learning must be on "how": How to teach so that the child will understand the meaning of the terms, definitions, actions and symbols and how to teach children equally and as individuals with differences. Diagnostic tools must also be developed accordingly. Today, computers are tools which assist in all aspects of learning and thought, and especially mathematical thought. Until the culture of computer assisted learning is inculcated among all populations and in all kindergartens, the learning tool (1) may be an alternative to the computer in enhancing mathematical thinking and (2) will test the theory of the capacity for cognitive change and principles of learning.

4.7 Concluding Remarks

The argument that all children "start school ready to learn" combines in a single goal statement two historically different concepts: readiness for learning and readiness for school. Readiness to learn, generally, has been thought of as the "level of development at which an individual (of any age) is ready to undertake the learning of specific materials", Kagan (2000). When applied to a population or group, it refers to the age at which the average individual has the specified capacity. This concept of readiness, although perhaps useful in some situations, is not very helpful in assessing progress toward the national goal. As the National Association for the Education of Young Children has pointed out, "Every child, except in extreme instances of abuse, neglect, or disability, enters school ready to learn". National Association for the Education of Young Children (1990). Merely being "ready to learn" something may not, however, guarantee success in school, The concept of school readiness tethers the notion of readiness for learning to a standard of physical, intellectual, and social development that enables children to fulfill school requirements and to assimilate a school's curriculum, Kagan (2000).

Unfortunately, while some idea of a standard is nearly universal in readiness discussions, there is little agreement as to exactly what that standard should include. Crnic and Lamberty (1994). Some studies have examined characteristics of children which are associated with higher achievement test scores, but there is little agreement regarding the totality of the necessary and sufficient ingredients for readiness. Nord et al. (1994).

The demands placed on grade one children are high. A child who enters grade one classroom without the necessary skills is likely either to work hard and spend tremendous effort to catch up or he/she may develop problems emotionally, behaviourally or academically, though the latter group is more frequent. Knowledge of the child's strengths and weaknesses when they enter grade one may be beneficial for understanding the academic performance of the child throughout their academic career. This knowledge may also be utilized to develop strategies to facilitate effective learning in the child.

The next chapter will approach assessment for School Readiness that encompasses three major frameworks that promote an understanding of school readiness for parents and families, and preschoolers. The three frameworks and their accompanying results provide a solution for implementing systemic and integrated comprehensive child development that lead to school readiness for young children and families.

CHAPTER 5: FRAMEWORK FOR ASSESSING SCHOOL READINESS

In the first half of the twentieth century, a person who acquired basic reading, writing, and math skills was considered to be sufficiently literate to enter the work force, Kliebard (1987). The goal back then was to prepare young people as service workers, because 90 percent of the students were not expected to seek or hold professional careers, Shute (2007). The second half of the twentieth century witnessed a rapid shift into more educated societies with more people holding high school and university degrees. Even the last decade of the twentieth century marked the start of a major shift affected by the increased popularity of the Internet. With the emergence of the Internet, however, the world has become more interconnected, effectively smaller, and more complex than before, Friedman (2005). Developed countries now rely on their knowledge workers to deal with an array of complex problems, many with global ramifications (e.g., climate change or renewable energy sources). When confronted by such problems, tomorrow's workers need to be able to think systemically, creatively, and critically. Shute and Torres (2012); Walberg and Stariha (1992).

These skills are a few of what many educators are calling twenty first-century (or complex) competencies (see Partnership for the 21st Century 2012; Trilling and Fadel (2009).

Preparing K–16 students to succeed in the twenty-first century requires fresh thinking about what knowledge and skills (i.e., competencies) should be taught in the schools. In addition, there's a need to design and develop valid assessments to measure and support these competencies. Except in rare instances, the current education system neither teaches nor assesses these new competencies despite a growing body of research showing that competencies, such as persistence, creativity, self-efficacy, openness, and teamwork, can substantially impact student academic achievement, Noftle and Robins (2007); O'Connor and Paunonen (2007); Poropat (2009); Sternberg (2006); Trapmann et al. (2007). Furthermore, the methods of assessment are often too simplified, abstract, and decontextualized to suit current education needs. Our current assessments in many cases fail to assess what students actually can do with the knowledge and skills learned in school, Shute (2009). What is needed are new performance-based assessments that assess how students use knowledge and skills that are directly relevant for use in the real world.

One challenge with developing a performance-based measure is crafting appropriate situations or problems to elicit a competency of interest. A way to approach this problem is to use digital learning environments to simulate problems for performance-based assessment, Dede (2005); DiCerbo and Behrens (2012); Quellmalz et al. (2012). Digital learning environments can provide meaningful assessment environments by supplying students with scenarios that require the application of various competencies.

This chapter describes in detail the method of the framework reviewing the kindergarten teacher's evaluation questionnaire, the computerized assessment of readiness for school, the technological infrastructure of the games, the achievement exams upon completion of the first grade, the data processing and the reliability of the computerized school readiness tool and also the relationships between the three measures.

5.1 Why use well-designed games as vehicle to assess and support learning?

There are several reasons. First, schools have remained virtually unchanged for many decades while the world is changing rapidly, there are a growing number of disengaged students. This disengagement increases the chances of students dropping out of school. For instance, high dropout rates, especially among Hispanic, black, and Native American students, were described as “the silent epidemic” in a recent research report for the Bill and Melinda Gates Foundation, Shute (2011). According to this report, nearly one-third of all public high school students drop out and the rates are higher for minority students. In the report, when 467 high school dropouts were asked why they left school, 47 percent of them simply responded, "The classes were not interesting". It is necessary to find ways (e.g., well-designed digital games and other immersive environments) to get kids engaged, support their learning, and allow them to contribute fruitfully to society.

A second reason for using games as assessments is a pressing need for dynamic, ongoing measures of learning processes and outcomes. An interest in alternative forms of assessment is driven by dissatisfaction with and the limitations of multiple-choice items. In the 1990s, an interest in alternative forms of assessment increased with the popularization of what became known as authentic assessment. A number of researchers found that multiple-choice and other fixed-response formats substantially narrowed school curricula by emphasizing basic content knowledge and skills within subjects, and not assessing higher order thinking skills, Kellaghan and Madaus (1991); Shepard (1991); Shute (2011). As Madaus and O'Dwyer (1999); Shute and Torres (2011) argued, though, incorporating performance assessments into testing programs is hard because they are less efficient, more difficult and disruptive to administer, and more time consuming than multiple-choice testing programs. Consequently, multiple choices have remained the dominant format in most K–12 assessments in many country. New performance assessments are needed that are valid, reliable, and automated in terms of scoring.

A third reason for using games as assessment vehicles is that many of them typically require a player to apply various competencies (e.g., creativity, problem solving, persistence, and collaboration) to succeed in the game. The competencies required to succeed in many games also happen to be the same ones that companies are looking for in today's highly competitive economy, Shute and Kim (2011). Moreover, games are a significant and ubiquitous part of young people's lives. The Pew Internet and American Life Project, for instance, surveyed 1,102 youths between the ages of twelve and seventeen. They reported that 97 percent of youths, both boys (99 percent) and girls (94 percent), play some type of digital game, Lenhart et al. (2008).

Additionally, Ito et al. (2010) found that playing digital games with friends and family is a large as well as normal part of the daily lives of youths. They further observed that playing digital games is not solely for entertainment purposes.

In fact, many youth participate in online discussion forums to share their knowledge and skills about a game with other players, or seek help on challenges when needed. In addition to the arguments for using games as assessment devices, there is growing evidence of games supporting learning, Tobias and Fletcher (2011); Wilson et al. (2009). Yet it is required to understand more precisely how as well as what kinds of knowledge and skills are being acquired. Understanding the relationships between games and learning is complicated by the fact that it is necessary to not disrupt players' engagement levels during game play. As a result, learning in games has historically been assessed indirectly and/or in a post hoc manner, Shute and Ke (2012); Tobias et al. (2011). What's needed instead is real-time assessment and support of learning based on the dynamic needs of players. There is a need to be able to experimentally ascertain the degree to which games can support learning, and how and why they achieve this objective.

5.2 Assessment of school readiness

There are at least three arguments that could be invoked to understand the importance and the impact of evaluating school readiness.

First and the strongest argument by far, is the predominant *formative* character of competence assessment at this age. A correct identification of the most salient aspects of each competence opens the door for efficient interventions, to be remedial or enriching. Relying on a valid assessment, one may precisely circumscribe the target of the intervention and its operational goals. Any individualized instruction requires careful assessment of the existing competences.

Second, a correct assessment of the salient competences may offer critical information for the decision to enter schooling or to delay the integration into the school system, both for parents and children. It is necessary to underline that this information is just one part of the equation but by relying on research data and adequate measurements it is hard to ignore, Raver and Knize (2002). It may also predict later academic achievements and adaptation to primary school-life relying on early education of the relevant competences, Wayne, Fantuzzo, and McDermott, (2004).

Last but not least, the measurement of the efficacy and effectiveness of any program (or curriculum) implemented in early education requires reliable assessment of children competences, able to offer precise information about the baseline and the outcomes of the program (curriculum). Without longitudinal assessment of relevant competences, the superiority of a particular early education program over any other has no empirical support.

To summarize, the assessment of school readiness has a critical practical and theoretical importance. Some of these assessments may be implemented by computer testing, but most of them are not, due to the age of the children and their low computer skills, so they will be administered in a classical format. However, it is extremely important to create a computerized platform capable to offer the management of all the assessment data for each child, collected by using different methods and various informants.

5.3 Critical competences for School Readiness

Several extensive and authoritative searches of the literature, Denham (2006); Ionescu and Benga (2007); Blair (2002) allow us to consider that the most relevant competences for school readiness refer to cognitive development, socio affective development and characteristics related to temperament/personality.

5.3.1 Cognitive competences

Cognitive competences are the abilities to process information, and may differentiate between general cognitive abilities and curriculum-based (specific) cognitive skills. General cognitive abilities are those involved in almost any kind of problem solving and refer to the processes of attention, memory, language, reasoning and executive functions. Curriculum-based cognitive skills are those knowledge and problem-solving abilities that are the outcomes of a specific curriculum or intervention program in early childhood as for example early literacy skills. They refer, for example, to the ability to recognize several capital letters, perform simple arithmetical operations, and understand the connection between sound and letter. They are relying on general cognitive abilities but they are not direct emergencies from these abilities, requiring domain-specific learning.

5.3.2 Socio-emotional competences

Socio-emotional competence is a complex construct that has two components: one rather *social*, focused on social information processing and performance in social contexts (e.g., interpersonal interactions, social problem-solving), and another rather *emotional*, concerned with understanding, sending/receiving emotional messages and emotion regulation, Lemerise and Arsenio (2000); Crick and Dodge (1994). Although some of the tasks a preschool age child is facing are primarily social (e.g., working cooperatively), whereas others are more emotional (e.g., self-regulation of fear), much of the time they are strongly intermingled, Dodge et al. (2002). Consequently, any assessment of social skills should include the assessment of emotional competences. The evaluation of socio-affective abilities at preschool children predicts: (a) Academic success in the first and then later elementary years, even controlling former academic success or cognitive skills, Carlton (1999); Izard et al. (2001); (b) Participation in the classroom and acceptance of peers and teachers, Carlton and Winsler (1999); (c) Task persistence and drop-out rate in primary school, Robins and Ruther (1990); Raver and Knitze (2002); (d) Delinquency and antisocial behaviour later in life. Kachendefer and Ladd (2006).

5.3.3 Temperament/personality characteristics

The temperament is referring to those individual differences in reactivity and self-regulation and is assumed to have an important constitutional basis. However, during the early years it strongly interacts with the environment and the regulatory dimensions become more important due to anterior cortical brain development. Beginning with the age of three the temperament begins to be differentiated into personality and later on personality characteristics themselves become more differentiated, approaching *the big five model of personality* (extraversion, agreeableness, conscientiousness, neuroticism and openness to experience). The assessment of temperament and emerging personality characteristics in early childhood may offer salient data for adaptation to school environment and constitute a prerequisite for many remedial interventions. Denham (2005).

5.4 A Computerized Platform for Assessment of School Readiness

A major critique of the existent literature on children's competences concerns the "isolationist" approach: competences are considered as separated entities with no interactions and mutual constraints satisfaction, Cichetti and Toth (1997). Moreover, when evaluated, they are presented separately, one by one, as they occur at the interaction with a specific method and from a specific perspective. It is claimed that irrespective of the used measurements there is a need for integrating the assessment outcomes from various methods and perspectives in a single format or platform.

Also a computerized platform for assessing school readiness may offer a substantial added value for research and practice. Such a platform will offer: (a) an intelligent management of the assessment outcomes; (b) much more information processed from the assessment data than if they will be used disparately. The famous adage of Corbusier, the father of the modern architecture – *form follows function* – is relevant in this context, Miclea and Mihalca (2007). Before creating the particular form of any computerized design it is required to set up the critical functions that must be accomplished. Any candidate to the status of computerized platform for assessing school readiness must mutually satisfy the constraints outlined below.

5.4.1 The platform must create a global assessment profile (GAP)

The assessment outcomes (either stored automatically – for those scales administered on computer version or manually introduced - when the assessment took place on a classical format) should be stored in a database. The user will have the possibility to navigate between these outcomes and to operate upon them so that one can:

1. *Visualize* the developmental profile of each competence or personality characteristic;
2. Perform any *combination and comparison of profiles*: by measured competence, by psychological relevance. In other words, the platform will offer the menu and the user will make the choices, according to his/her needs or interests;
3. Have, in a single format (a Report on School Readiness), *the developmental profile of all competences.* It can be a Word document where, besides the assessment outcomes, the qualified user may add further relevant information, interpretations or recommendations. Overall, this Report on School Readiness will be a valuable tool for deciding whether any child is school ready or what kind of remedial education (or special psychological interventions) should be enacted.

5.4.2 Effective document management

The documents of assessment outcomes (i.e. the Report on School Readiness or any other document resulting from a combination and comparison of various profiles or competences) could be saved in various formats, stored, printed and exported. Any other requirements of an efficient document management should be matched.

5.4.3 To offer a multi-method and multi-informant integration

There is a need to: (1) reduce the possibility of the artifact occurring when one uses only a type of measure for competence or/and from a single perspective, and (2) collect as much relevant information as possible from trustworthy informants.
Thus, the platform will contain several instruments for the same competence and three types of informants or assessors: the psychologist, the teacher and the parent, each using an appropriate assessment tool. The assessment outcomes will be presented under the label of each competence, so that one can see which information

is provided by all tools and informants and which one is covered only by one or another instrument/informant. Thus, it can circumscribe the most reliable information by mutual corroboration of the existent data and draw adequate conclusions.

5.4.4 To offer the possibility that some of the tests may be administered in computer version

Some of the evaluation scales could be filled online by parents or teachers and used later by a child psychologist to calibrate his/her own assessments. Due to the reduced level of computer skills by this age, most of the tests targeting young children will be in a classical format, but not excluding some subtests (or even a whole test) to be administered in a computer version.

5.4.5 Longitudinal assessment

The platform will store and integrate iterative evaluations of the same competence. For example, the assessment outcomes of a child at the age of 3, 4 or 5 will be collected in a database and processed so that one can have on the display not only the discrete results for each evaluation but also the longitudinal trend in a graphic format. As it is known, the same result has one meaning if it is considered as a punctual outcome and another meaning when it is imbedded in a longitudinal tendency. A low attention performance at 5 years of age could, however, be a good sign if compared with an even lower performance at 4 and much lower at 3 years. The platform allows us to extract much more information from the same data.

5.4.6 Advanced data processing

The platform should allow an advanced computational and/or statistical analysis of the assessment data. For example, it must offer the possibility to compare the assessment outcome of children belonging to families with various economic, social or cultural backgrounds, the impact of different curricula, the adequate or non-adequate character of specific learning standards, regression analyses, etc. The advanced data processing is an important requirement for any sound political measure or educational intervention. The same amount of data spread in insulated databases may produce rather a puzzling effect than a coherent approach and implementation plan.

5.4.7 Continuous upgrading

The platform should allow any upgrading of the assessment tools and documents; any time one can upgrade the norms of the tests or the documents format, add new assessing instruments or upgrading versions of those already existent. The up-gradation or new versions of the platform should be user-friendly.

5.4.8 Restricted access

Some of the information stored on the platform may be misused. To prevent such issues, the access to the assessment outcomes will be limited, according to the user's qualification level. For example, a teacher will not be allowed to use the data obtained by using standardized psychological tests.

To conclude, a computerized platform for assessment of school readiness, covering assessment outcomes about cognitive, socio-emotional competences and temperament/personality characteristics and satisfying the constraints mentioned above may offer a substantial added value. It will proceed to a multi-methods, multi-informants integration and will allow a much better exploitation of the assessment data than before. The time is ripe now to construct such a platform.

5.5 The Framework

5.5.1 Method of the framework

Examinees

The sample will include around 200 kindergarten children who, according to their chronological age, are supposed to enter the first grade in the coming school year. The tracking of these children will take place between the end of the school year (April) in the kindergarten until their first year in the first grade. Of the 200 children of the sample, 186 were promoted to the first grade, 9 children were promoted to the first grade and were allotted special support, and 5 were held back for an additional year in kindergarten.

5.5.2 Assessing readiness for school

Kindergarten teacher's evaluation questionnaire, based on the Ministry of Education's Questionnaire ("Questionnaire for the identification of special needs", Director General's Circular (March 2000)). In order to meet the needs of the study, the questionnaire underwent accommodation. The questionnaire includes two parts; the **first part** includes questions that examine the kindergarten teacher's evaluation regarding the kindergarten child's level of functioning in the cognitive, verbal, motor, behavioural-emotional and motivational fields. The questions are worded for the *Likert scale*, every question has 5 possible answers: 1- "No problem" to 5-"Very serious problem". The **second part** includes questions that examine the kindergarten teacher's assessment regarding the child's success in the first grade, in the following fields: Reading, writing, arithmetic and the behavioural-emotional field. In this section too, the questions are worded for the Likert scale, every question has 5 possible answers: 1-"Very high chance of success" to 5-"Low chance of success". Additionally, this part of the questionnaire asks for the kindergarten teacher's recommendation regarding the suitable educational framework for the following academic year (first grade in regular education, special education or being held back in compulsory kindergarten). The questionnaire gives a subjective picture of the kindergarten teacher's assessment of the child's readiness for school (see appendix 4).

5.5.3 Computerized assessment of readiness for school

The computerized assessment of readiness for school is designed to assess and develop the user's various learning skills in the course of the game. The wide variety of games covers different areas of cognitive skill, knowledge and skill. Using advanced multimedia tools. The diagnostic battery enables an evaluation of the child's level of functioning in a number of developmental areas: Comprehension of quantity and mathematical understanding, memory, visual comprehension, auditory comprehension, visual-motor functioning and language functions.

The evaluation can be run for a long period of time without the instructor's intervention. The evaluation engine collects data on the user, while the games are being run. The system allows for a report to be delivered to the instructor at the end of the activity period. The computerized system is comprised of seven activities: the magic circles, the shadow, analogies, triangles, ordering pictures, identifying faces, and arithmetic (for a detailed description of each of the activities, see appendix 5). The timeframe for going through the entire computerized system ranges between 45-

60 minutes. The first activity with which each child begins is "find the red square", the child is required to click on all of the squares appearing on the screen and to find the red square, the other squares on the screen being blue. The goal of this activity is to train the child to use the mouse. On the bottom and left sides of the screen, there is a toolbar that includes a number of buttons meant to help the child work independently. On each of the buttons, a picture is drawn that is meant to explain the reason for its appearance on the screen. The activities have things in common: 1- For every activity, a verbal instruction is played in the spoken Arabic language, where the option of hearing the instruction an additional time is given to the child by pressing a certain button on which a speaker is drawn. 2- In each activity, there are a number of items that the child goes through on a rising level of difficulty. 3- Before the child begins the activity, he is given a demonstration with the option of an additional demonstration in case the child needs one by pressing on a button. 4- The activity only begins after the child has heard the instruction, seen a demonstration and pressed a button on which a traffic light is drawn, the moment that the child presses the button, the traffic light turns green and the activity begins. 5- During the diagnostic activity (whose purpose is evaluation, as opposed to the demonstration at the beginning of the activity), an hourglass appears on the screen meant to illustrate to the child that he is in a situation in which time is important. 6- After the time allocated for the activity ends, the activity ends and the computer solves the last item that appeared to the child. 7- For every correct response, the child receives positive feedback, as opposed to an incorrect response for which the child receives no feedback, but rather the game simply continues. 8- On the main screen of the system, there are two pictures, of which one of them is a small girl playing on a computer, the child must click on the picture of the girl in order to enter the system, the second screen includes pictures of the kindergarten students, and he must click on his personal picture in order to begin playing or to continue from the point that he left off at the last time. 9- If the child needs help, the child must press a question mark in order to receive help.

5.5.4 The technological infrastructure of the games

The games are based on Microsoft Corporation's Windows operating system. The games are based on a framework of objects that were specially developed in order to make the modular use of the system's tools easier. The system supports graphic designs, vocal communication, touch-screen and more. The games are tailored for various levels of difficult and levels of instruction in order to examine and develop specific abilities of the user, according to a number of parameters. The infrastructure of the games supports several languages. Thus the interface's language can be adapted for the user.

5.5.5 Achievement exams upon completion of the first grade

The children who were found to be prepared and entered first grade underwent achievement tests in reading, reading comprehension, writing and arithmetic. These exams were structured according to the school's curriculum, after consultation with the first grade teachers regarding the content and the exam's structure; this is meant to achieve a uniform version for all of the sample's children from the various schools. This version serves as a grade-wide test that examines all of the skills and contents, despite the differences in teaching methods, the amount of material that the teachers managed to complete, etc. (See appendix 6 and appendix 7)

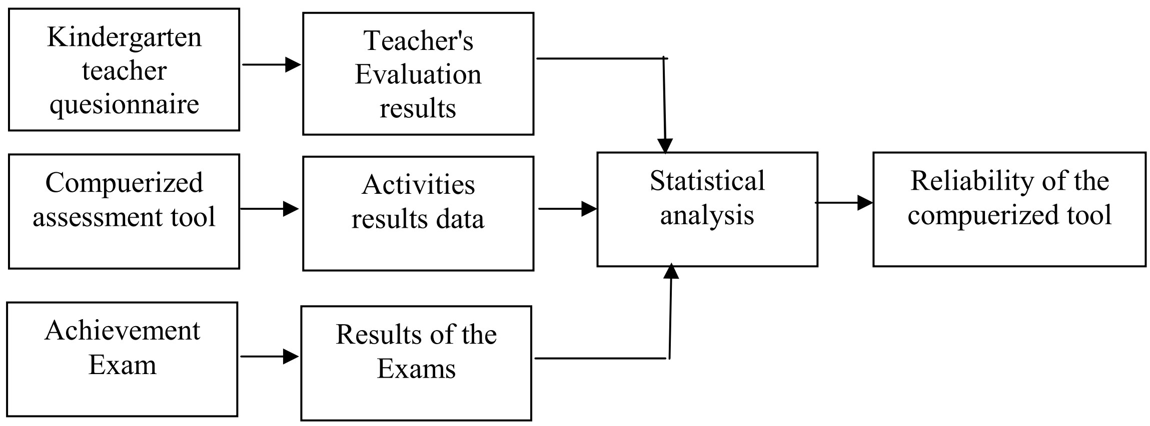
5.5.6 The guidelines

An application to receive approval for the study was submitted to the Education Ministry's offices in the Haifa and Northern districts. After receiving the approvals, At the same time, an explanation form was sent to the parents, including a form certifying approval for their child's participation in the study (See Appendix 8). For parents who approve their child's participation, the child undergoes a series of computerized neuro-cognitive examinations to evaluate the cognitive functioning. Following that, the first-grade readiness questionnaires prepared by the kindergarten teachers are collected. The results of the cognitive identification battery will be *confidential* and will not, in any way, influence the normal process splitting the kindergarten students into two groups. The students found ready and promoted to the first grade underwent achievements tests in reading, writing and arithmetic. These examinations were structured in accordance with the school's curriculum.

5.5.7 Processing the data

The selection was held separately for children delayed enrolment in the first grade, for children integrated in the special education system and for children integrated in the first grade in the public school system. The main goal of the testing of this diagnostic battery is to evaluate the achievements of the third group at the conclusion of third grade in keeping with the predictors of the computerized tests done the year before. Although the numerical size of this group is unknown, on the basis of past data, one can predict that this group will include 80%-85% of the overall kindergarten children in the initial sample. In order to evaluate the validity and the benefit of the proposed battery, the teachers' evaluations and the results of the achievement tests will be checked: In reading, writing and arithmetic- that will be adapted for this study. These data, to be received toward the end of the first grade, will serve as the criteria test of the predictive ability of the battery. Beyond examining the links between expectations and actual achievements, the computerized system's predictors of failure in school are compared to the evaluations of the kindergarten teachers, the psychological services and the tests utilized to predict the children's potential for success or failure given toward the end of the kindergarten year. In the event that there are children who are not promoted to first grade or who are referred to special education, they will be identified at the conclusion of the kindergarten year and the outcomes of the computerized tests for this group will be examined.

Figure 12– Checking the reliability of the Computerized Tool



5.6 The Reliability of the Computerized School Readiness Tool

5.6.1 Participants:

184 children were included in the study, 85 (46.2%) boys and 99 (53.8%) girls. All statistical procedures that were applied require at least 30 subjects in each cell/each measurement (n=30). Hence, n=184 is sufficient for all the statistical analysis.

5.6.2 Results (Means and Standards Deviations for the computerized tool)

Table 20- Means and Standards Deviations for computer assessment, preschool's teacher evaluation and first grade achievements

	Mean	Standard Deviation
Computer program (CP) Assessment (T1)		
Balloon Counting	46.9	49.25
Balloons numbers	46.9	49.25
Choose the Form	9.4	27.24
Click the…	40.2	48.04
Counting and numbers	1.3	5.90
Faces	22.8	31.91
Incomplete Shadow	38.4	39.17
Magic Circle	36.6	36.46
More or Less	44.7	48.00
Remember Location	45.0	47.57
Set order	18.4	30.22
Preschool's teacher (PT) evaluation (T1)		
Motivation	4.4	0.78
Behaviour	4.4	0.57
Language and cognitive skills	4.7	0.60
Participation in activities	4.7	0.55
Motor skills	4.8	0.45
Chances of success in school	4.2	0.80
First grade achievements (T2)		
Arithmetic	91.4	10.26
Reading	89.5	16.43
Dictation	88.4	20.36
Exercise	89.7	14.48
Understanding	89.5	17.73
Analogy	94.2	8.19

As can be seen from Table 20 above, PT evaluations are rather high with means ranging from 4.2 to 4.8 (on a scale of 1 to 5, with 5 indicating the highest evaluation).

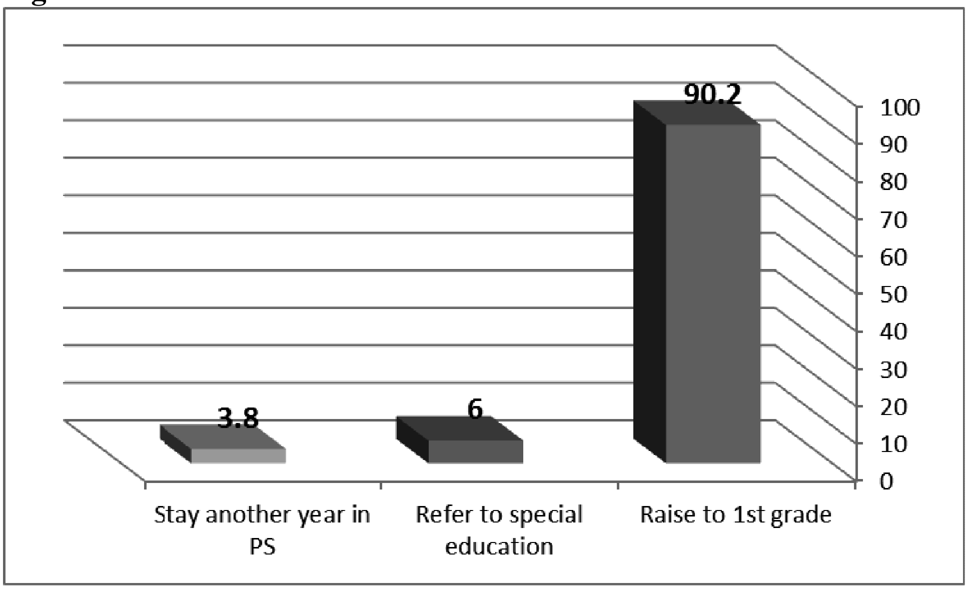
First Year scores were also on the high side, with means ranging from 88.4 to 94.2 (on a scale of 1 to 100, 100 indicating the highest knowledge).
Preschool teachers were asked to report on the child suitability to advancing to the first grade. As can be seen from Table 24 and Figure 13, PT found 90.2% of the

children as being suitable for advancing to the first grade. 6% children were evaluated as being best referred to a special education class and the remaining 3.8% were evaluated by PT as suitable for remaining another year in preschool (PS).

Table 21- Preschool's Teacher recommendations'

	N	**%**
Advance to 1st grade	166	90.2
Referred to special education	11	6.0
Remain another year in PS	7	3.8
Total	184	100.0

Figure 13- Distribution of Preschool's Teacher recommendations'



Due to the small number of children in the second and third categories these two categories were combined in order to make statistical Inferences possible.

5.6.3 Relationships between the three measures

To start evaluating the correlations between PT assessments of the children at T1 and the children's achievements on the computer program, at the same time. Table 22- presents the correlations between the two measures.

Table 22- Pearson's correlations between PT assessment and Computer Program achievements

	Motivation	Behaviour	Language and cognitive skills	Chances of success in the preschool	Participation in activities	Motor skills
Balloon Counting	.093	.072	-.069	-.091	.105	.208**
Balloons numbers	.093	.072	-.069	-.091	.105	.208**
Choose the Form	.057	.090	-.025	.015	.027	.089
Click the…	.118	.103	-.058	-.042	.135	.110
Counting and No.	-.050	-.159*	-.016	-.050	.072	-.064
Faces	.027	.137	-.001	-.025	.088	.126
Incomplete Shadow	.090	.092	-.024	-.040	.122	.146*
Magic Circle	.034	.118	-.055	-.090	.132	.130
More or Less	.090	.087	-.074	-.081	.156*	.173*
Remember Location	.118	.133	.009	-.029	.187*	.190**
Set order	.045	.151*	-.012	-.001	.133	.134
Triangles	.001	.011	-.078	-.088	.054	.059

**p<.05; **p<.01*

Pearson's correlation coefficient is used in order to test dependence between two continuous variables. In the present study Pearson correlations were calculated in order to examine the relations between two continuous variables e.g.: Teachers evaluation and performance on the computerized program.

As can be seen in Table 25, positive significant correlations were found between the PS evaluation of the child's Motor skills and their performance in some of the computer measures. These correlations indicate that better Motor abilities are associated with better performance in the computer program. Significant positive correlations were also found between 'participation in activities' and two of the computer program activities. (PS and CP) in T1 with achievements in T2.

In order to examine the relationships between PS's teacher assessments and 1st grade achievements, Pearson correlations were calculated. Correlations are presented in Table 23.

Table 23- Pearson correlations between PS's teacher assessments and 1st grade achievements

	Arithmetic	Reading	Dictation	Exercise	Understanding	Analogy
Motivation	.494**	.507**	.601**	.539**	.522**	.025
Behaviour	.315*	.422**	.431**	.302*	.222	.060
Language and cognitive skills	.460**	.642**	.395**	.401**	.386**	.057
Participation in activities	.128	.407**	.333**	.405**	.366**	.035
Motor skills	.506**	.613**	.439**	.531**	.536**	.159
Chances of success in school	.435**	.522**	.446**	.350**	.352**	.006

**p<.05; **p<.01; **p<.001*

As can be seen in Table 23, positive significant correlations were found between most of the PS teacher assessments to the 1st grade achievements. PS teacher assessments measured in the preschool - regarding child's motivation, behaviour, language and cognitive skills, motor skills and chances of success in school correlated positively with all 1st grade score except 'Analogy'.

Table 24 presents correlations between correlations between CP Assessment Scores and 1st grade achievements

Table 24- Pearson correlations between CP Assessment Scores and 1st grade achievements

	Arithmetic	Reading	Dictation	Exercise	Understanding	Analogy
Balloon Counting	-.164	-.203	-.181	-.078	-.142	.107
Balloons numbers	-.164	-.203	-.181	-.078	-.142	.107
Choose the Form	.037	.092	.077	.090	.099	.116
Click the…	-.160	-.307*	-.003	-.096	-.119	-.123
Counting & No.	.578**	.535**	.432**	-.282*	-.463**	-.100
Faces	.008	-.063	-.179	-.144	-.094	.069
Incomplete Shadow	-.087	-.137	-.159	-.089	-.059	-.040
Magic Circle	-.172	-.161	-.232	-.096	-.118	.161
More or Less	-.074	-.088	-.004	-.068	-.078	.140
Remember Location	-.128	-.070	-.214	-.004	-.063	.171
Set order	-.040	-.073	-.184	-.154	-.143	.122
Triangles	-.273*	-.222	-.237	-.145	-.110	-.277**

*p<.05; **p<.01; **p<.001

As can be seen in Table 27, no positive correlations were found between the CP (computer program) assessment and the 1st year achievements. On the contrary, some negative significant correlations were found between some of the subscales of the two measures.

In order to examine the validity of the PS recommendations for the child (Advance to 1st grade vs. Remain or refer to special education), 1st grade scores between the two groups have to be compared.

Comparisons were conducted *using T-test for independent measures*. Results are presented in Table 25 and in Figure 14.

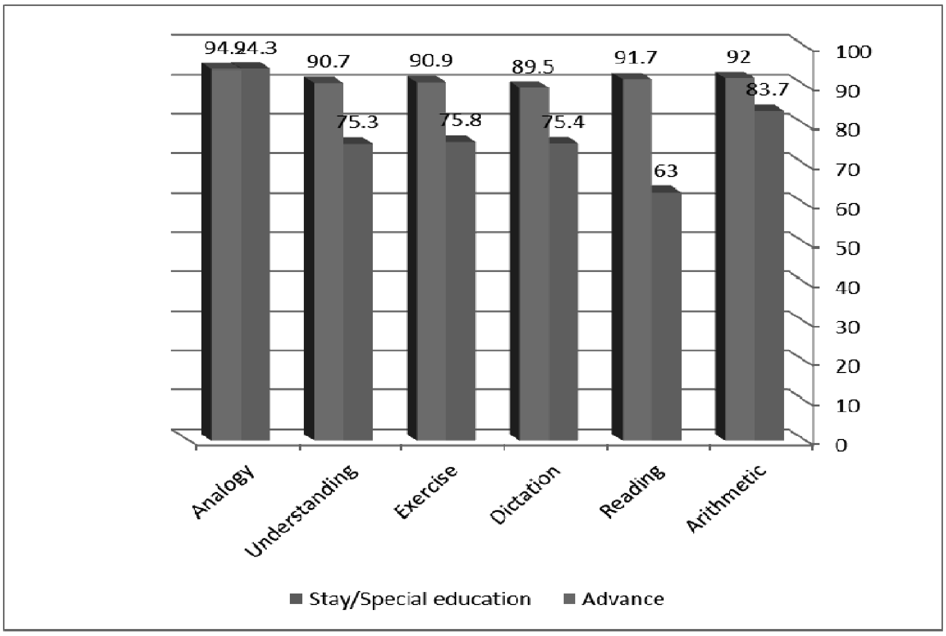
T-test for independent measures is being used in order to compare between two independent groups in one continuous variable. In the current study t-test was used in order to compare performance of students from two independent groups (stay in KG vs. Pass to 1st grade).

Table 25- Means and SD for 1st grade scores

	PS recommendation				
	Remain/Special education		Advance		
	Mean	Standard Deviation	Mean	Standard Deviation	t
Arithmetic	83.7	15.90	92.0	9.57	1.764
Reading	63.0	29.89	91.7	12.96	4.213*
Dictation	75.4	34.14	89.5	18.84	1.503
Exercise	75.8	42.49	90.9	9.35	2.305*
Understanding	75.3	42.66	90.7	14.11	1.895*
Analogy	94.3	10.99	94.2	7.78	0.044

*p<.05

Figure 14-Means and SD for 1st grade scores



As can be seen in the table and in the corresponding graph, children who were evaluated by their PT as being suitable for advancing to the 1st grade achieved better grades then children who were assessed as not being ready for the 1st grade. The differences between the two groups were significant for 'Understanding' and 'Reading'.

Finally, in order to examine which measures best predict the children's performance in 1st grade a Hierarchic regression analysis was conducted. Hierarchic regression analysis is used in order to predict the relative contribution of each independent variable to the explanation of the predicted variable. In this study hierarchic regression was used to examine how performance in different areas while in KG predicts students' performance in 1st grade. Predicted variables were an overall mean of 1st grade scores. As predicting variables all PS evaluations of the child (Motivation, Behaviour, Language and cognitive skills, Participation in activities, Participation in activities and Chances of success in school) were entered (computer program's scores were not entered, due to lack of significant correlations with the predicted variable). Findings are presented in Table 29.

Table 26- Hierarchic regression analysis predicting 1st grade achievements

	B	Std. Error	Beta	t	Sig.
Motivation	6.794	2.572	.426	2.642	.011
Behaviour	-.527	2.810	-.029	-.188	.852
Language and cognitive skills	2.250	4.321	.121	.521	.605
Chances of success in school	-.218	3.047	-.014	-.071	.943
Participation in activities	-.906	2.875	-.040	-.315	.754
Motor skills	8.154	3.870	.327	2.107	.040
PT recommendation	-1.756	6.684	-.041	-.263	.794

,p<p<.05

The regression model was found to be significant ($F(7,64)=7.808$, $p<0.001$), explaining 42.7% of the variance in 1st grade achievements. As can be seen in the table 26, the child's motivations and Motor skills, as evaluated by the PT were significant in predicting 1st grade achievements.

5.6.4 Summary of Findings

- No relationship was found between PT's evaluation and CP achievements.
- Correlations were found between PT's evaluation in T1 and child's achievements at T2 .
- PT's recommendation regarding remaining in the preschool or moving to a special educational framework was found to be valid: Children for whom such a recommendation was made, (but not implemented) showed lower achievements at the end of first grade than their peers.
- The regression model found that of all the variables in the teacher evaluation, the variables that predicts clearest and best achievements of the student's grade, are the child degree of motivation and their motor skills.

5.7 Conclusions:

Statistics—the science of learning from data, and of measuring, controlling, and communicating uncertainty—is the most mature of the data sciences. Over the last two centuries, and particularly the last 30 years with the ability to do large-scale computing, this discipline has been an essential part of the social, natural, biomedical, and physical sciences, engineering, and business analytics, among others. Statistical thinking not only helps make scientific discoveries, but it quantifies the reliability, reproducibility and general uncertainty associated with these discoveries. Because one can easily be fooled by complicated biases and patterns arising by chance, and because statistics has matured around making discoveries from data, statistical thinking will be integral to Big Data challenges. Rudin et al. (2014)

The Computerized program, designed so as to improve predictions of child's achievements in school, showed low reliability. It did not correlate with PT assessments nor did it predict the child's achievements in school.
It should be noted that the PT assessments are also not free of mistakes, and have limited predictive power. The use of a computerized assessment tool looks like an innovative way to assess a child's readiness to first grade, overcoming the preschool teacher biases and misconceptions of the child. However, the computerized tool needs to be improved in order to include additional skills that are more relevant to the 1st grade students.

This analysis is intended to allow:

1. Definition of the appropriate weights for each of the measured parameters in each test.
2. Definition of a differential (adaptive) profile that predicts specific difficulties in first grade studies, or predicting general failure in first grade.

On the basis of these profiles and the theoretical background regarding the meaning of success / failure in these parameters, a group with high risk to fail in first grade will be defined out of the complete testing pool. As the actual results of first grade performance of the students is gathered, another correction / validation process will be done.

Information-communication technology (ICT) offers so many outstanding possibilities for teaching and learning that its application has been growing steadily in every segment of education. Within the general trends of the utilization of ICT in education, technology-based assessment (TBA) represents a rapidly increasing share. Several traditional assessment processes can be carried out more efficiently by means of computers. In addition, technology offers new assessment methods that cannot be otherwise realized. It is without doubt that TBA will replace paper-based testing in most of the traditional assessment scenarios, and technology will further extend the territories of assessment in education, as it provides frequent and precise feedback for the participants in learning and teaching that cannot be achieved by any other means.

A variety of web-based adaptive assessment models have been proposed as alternatives to the assessing pre-school children, the next chapter will describe a model of an adaptive web-based assessment for School Readiness.

CHAPTER 6: A CROSS-PLATFORM MODEL FOR AN ADAPTIVE PLAY-BASED ASSESSMENT TOOL FOR SCHOOL READINESS

6.1 The model of web-based assessment

School readiness is an essential process to assess the level of a child before he/she joins grade one. The target is to determine whether a student is ready to smoothly adapt to the new educational system which differs from the preschool education attended by the child for almost six years though the period differs from country to country and from one educational system to another. Applying the same static assessment process is not effective and may lead to failure. Thus, it is required to provide a dynamic process that could smoothly adapt to the specific child under assessment. However, adaptation cannot be easily achieved without an automated system that strongly captures expertise in the domain. Further, to provide for wider availability of the system, it is important to develop a Web-based interface.

6.1.1 Structural design and application of knowledge assessment systems

Knowledge assessment is an integral part of the learning process. However, it is a very time and effort consuming activity in the traditional learning process, because it demands from the teacher to prepare assessment tasks or questions, to conduct assessment activities, to check and evaluate children's works, to provide feedback, among others. This is a main reason for the development of an automated system. Further, to increase the availability of the framework, it is important to provide a web-based assessment system.

The mentioned systems are used, on the one hand, to detect children's knowledge and skills, but, on the other hand, to regulate teaching and learning process on the basis of informative and tutorial feedback generated automatically by the system. The key factor of a successful application of any web-based assessment system is the level of its intelligence and adaptively. Intelligence mainly refers to the intelligent analysis of solutions provided by children, but the adaptivity is related to the adaptive presentation of assessment content. Children have different needs and these differences should also be taken into account by providing an individualized approach to each child. Otherwise, a *unified assessment* style can have a *negative impact* on the assessment process which may lead to worse results. Therefore, developers should provide an appropriate level of intelligence and adaptively in their web-based assessment system.

6.1.2 Concept of web-based assessment

According to University of Leicester (1999) web-based assessment is a common term for the use of computers in the assessment of child learning. However, today there is a variety of other widely used terms such as e-assessment, Internet-based assessment, online assessment, Computer-assisted assessment, etc. Actually, all of them mean the same, that is, the application of computers or, more precisely, of a web-based assessment system to knowledge assessment activities. In SQA (2004) the following tasks of web-based assessment systems are mentioned:

- The delivery of assessment tasks and results to children;
- Assessments taken in whole or part on computer;
- Computer marking of assessments;
- Electronic collation and transfer of grades and assessment data;
- Electronic delivery of training and support materials.

Web-based assessment systems can be used for initial, formative and summative assessment. *Initial assessment*, as a rule, is performed at the beginning of the learning process in order to gather diagnostic and prognostic information concerning children' knowledge and skills. *Formative assessment* is carried out during the instruction in order to obtain information about the regulation of the teaching and learning process, to identify obstacles that can be found in the learning process and to detect topics that need to be reinforced. *Summative assessment* takes place at the end of learning with aim to determine children's achieved level of knowledge and skills in a given domain. Computer-assisted assessment, (2004); Aguilar, (2007)
According to CAA Centre (2002) the same term "web-based assessment" is defined narrowly and refers to the use of computers in assessment, encompassing delivering, marking and analysis of assignments or examinations, as well as collation and analysis of data gathered from optical mark readers. This definition clearly distinguishes two basic forms of web-based assessment which exist nowadays:

- *Systems*, where children submit their works or answers using a computer that further makes their analysis and evaluation;
- *Optical mark readers*, which scan, interpret and evaluate paper forms of tests completed by children through the marking answers on test questions.

The first mentioned basic form of web-based assessment can be divided into systems providing objective testing and systems supporting subjective testing (Seale, 2002). Systems based on objective tests are the most widespread systems of web-based assessment. They offer the child a set of questions, answers to which are pre-defined CAA Centre (2002), in other words, assessment is not subjective, because no judgment has to be made on the correctness of an answer at the time of marking, Bull (2003). Thus, in such systems the child is offered a question and he/she inputs an answer. The system compares the entered answer with the answer defined by the teacher/instructor and provides the feedback to the child. There are different types of questions, but the main ones are the following, SQA (2004):

- Multiple choice questions (children are asked to select one answer from a list of possible answers);
- Multiple response questions (children are asked to select any number of answers from a list of possible answers);
- Graphical hotspot (children are asked to select areas of the screen by moving a marker to the required position or filling in a block in a particular position linked to a graphic illustration on a specially designed paper answer sheet);
- Text/numerical questions (children are asked to input text or numbers in the particular field using the keyboard).
- Once the mouse is controlled, further training should introduce young learners in the use of pressing buttons. Since "drag and drop" and "double click" are too complex actions at this age, they should be practiced to prevent children’s rejection of using a mouse.

Computer-assisted objective testing systems vary significantly in their functional complexity. Simple systems act as authoring tools providing the possibility for the teacher to construct questions manually. Complex testing systems are able to create questions automatically on the basis of the dynamically selected learning content provided by the teacher. Such systems combine various techniques of natural language processing to construct questions.

6.1.3 Advantages and drawbacks of web-based assessment systems

In general, the use of web-based assessment systems provides a number of advantages, Computer-assisted assessment (2004); Seale (2002); Anghel and Salomie (2003); Lambert (2004); Computer aided assessment (2000); Mogey and Watt (1996):

- A wide range of topics can be tested quickly;
- Large groups of children can be assessed quickly;
- Provision of the potential for frequent assessments and, as consequence, the regular monitoring of the progress of children;
- A variety of media (images, video, audio, etc.) can be included in assessment questions or tasks;
- Extensive feedback can be provided to teachers through various diagnostic reports;
- Decrease in time needed for supervising and marking of assessments;
- Greater flexibility regarding place and time of assessment;
- Elimination of any prejudices in relation to children;
- Instant feedback to children;
- Reduced mistakes in comparison with human marking;
- Results can be automatically entered into administration systems.

Despite all the advantages, web-based assessment systems have also some drawbacks, Computer-assisted assessment (2004):

- Implementation of an assessment system can be costly and time-consuming;
- Difficult to reproduce freedom of paper examination – e.g. scanning exercises to choose which to make;
- Assessors need training in assessment design, IT skills and examinations management;
- Children require adequate IT skills and experience of the assessment type;
- Good system maintenance is required to avoid downtime during examinations.

Considering objective testing the following advantages can be identified in addition to the already mentioned advantages of web-based assessment systems:

- It is easy enough to define questions, because a wide experience is accumulated in the development of knowledge assessment systems based on objective tests;
- Objective testing can be used for initial, formative and summative assessment, as well as for other kinds of assessment, for example, self-assessment.

Moreover, one of the most promising advantages of the application of web-based assessment systems based on objective tests seems to be the possibility of automatic bidirectional translation of questions and answers from one language to other language(-s), as it is implemented in the web-based assessment system, Alfonseca, Carro, Freire, Ortigosa, Perez, and Rodriguez (2005). Thus, it allows an assessment system to be used by children and teachers from different nationalities, because the author of a course simply writes the questions in his/her own language (for example, in Spanish) and the child (for example, an English speaker) receives the question translated automatically into English, writes the answer, and the system automatically translates it into Spanish and compares it against the teacher's answer.

However, systems of *objective testing* have the following drawbacks:

- Objective testing does not allow the child to offer original answers, so there are restrictions on knowledge and skills which can be assessed. According to Bull, (2003); Mogey and Watt (1996) such systems allow evaluation only of the first four levels in widely accepted in pedagogy Bloom's taxonomy, Bloom (1956), which includes three levels of lower order skills (knowledge, comprehension, and application), and three levels of higher order skills (analysis, synthesis, and evaluation). In Bull (2003) this assertion is said to be erroneous, but it is pointed out that designing test questions to assess higher order skills can be time consuming and requires skills and creativity;
- Objective testing assesses only factual knowledge instead of child's understanding about their interconnectedness and significance in the learning course;
- Objective tests encourage children guessing.

Subjective testing, in turn, provides the following advantages, Module III: Objective and Subjective Tests and Construction of Test Items, (2008); Designing Test Questions (1998):

- It allows the child to offer original answers and judgments, to demonstrate ability to organize knowledge and express opinions, thus, higher order cognitive levels can be assessed;
- Children can display a broader range of knowledge about a particular topic;
- Children less likely to guess.

Systems of subjective testing use methods of artificial intelligence, especially natural language processing and classification algorithms. This fact is the reason for the main drawbacks of such systems: dependency on a subject and natural language, as well as complex structure and functional mechanisms. Moreover, the use of essays and free text responses for systematic assessment is a questionable issue due to a high cognitive load for children. Other drawbacks are the following, Module III: Objective and Subjective Tests and Construction of Test Items (2008); Designing Test Questions (1998): limitations of the extent of content covered by assessment and more subjective assessment due to the taking into account such factors as style and originality of assignments.

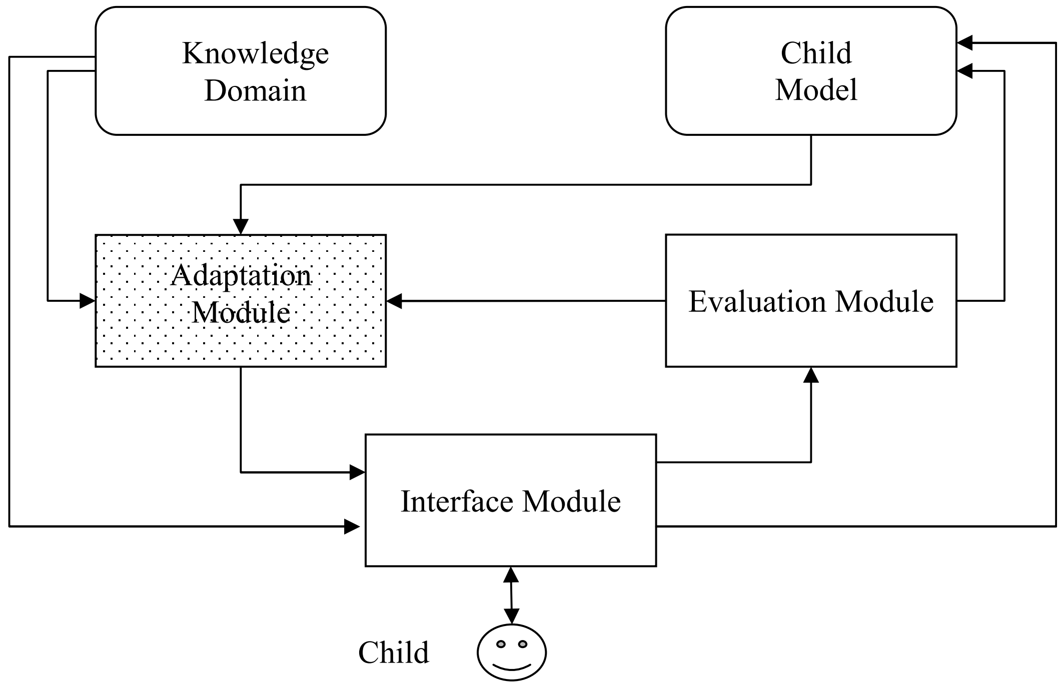
6.1.4 General architecture of a web-based assessment system

In general web-based assessment systems are designed to be used by three types of users – an administrator, a course instructor (a teacher) and a child. The administrator updates records of courses, instructors and children are also gives access rights to both instructors and children. The course instructor organizes curriculum, designs tasks and views assessment results. The child takes published tests or performs tasks, Lukashenko, Vilkelis, and Anohina (2008); Marinagi, Kaburlasos, and Tsoukalas (2007).

The analysis of web-based assessment systems intended both for objective and subjective testing shows that almost each system has its own architecture, Papanikolaou and Grigoriadou (2004); Georgouli (2008). There are two main reasons for such architectural differences. Firstly, each web-based assessment system has its own behavioural model. Secondly, each developer has its own preferences on dividing system functionality into structural units.

Trying to recap information about available architectures and their similarities a general architectural model of a *modified* web-based assessment system is presented in Figure 15.

Figure 15- General architecture of a *modified* web-based assessment system



Source: Lukashenko and Anohina. (2003)

The architecture above incorporates the following structural units:

1. *Interface* (*or Interaction*) *Module* that is responsible for the provision of interaction between a user and the system. The main tasks of this component are the following: to present tasks and feedback, to activate the other modules according to the child's actions, to collect data concerning the child's observable behaviour and to update the child model with the newly acquired information. The interface module passes child's solutions to the evaluation module for their evaluation. If the child set some preferences regarding the interface and behaviour of the system the interface module also stores these parameters in the child model.
2. *Adaptation Module* that is responsible for the selection of tasks suitable for a particular child taking into account the child's level of knowledge, skills and preferences. Adapted tasks from the adaptation module are passed to the interface module for their presentation to the child. The mentioned module is

the core of the web-based assessment system because it provides the intelligent solution analysis, Brusilovsky and Peylo (2003). There are two fundamentally different types of instructional (or selection) models for adaptation module: rule-based model and algorithm-based model. Desmarais and Baker (2012).

3. *Evaluation (or Diagnostic) Module* that is responsible for the evaluation of child's solutions and generation of feedback. Evaluation results are used further mainly to update knowledge level in the child model. Results of each completed task are also passed to the adaptation module and to choice the next assessment tasks. They are also passed after each task to the adaptation module for the selection of the next assessment task.
4. *Domain (or Expert) Knowledge* which stores all possible questions and solutions defined by the teacher or the instructor. Domain knowledge is passed to the adaptation module to adapt assessment tasks to the child needs before assessment takes place, and to the interface module to show the child the correct solutions after assessment is completed.
5. *Child (or Learner) Model* which stores information about a child such as general information, knowledge level, preferences, etc. The child profile is passed further to the adaptation module to adapt assessment scenario to the child needs.

The adaptation module is depicted by the dot filled box in Figure 15 because this component is optional and there are systems which do not provide adaptively to a particular child and, therefore, offer the same assessment scenario for all children regardless of their level of knowledge and skills and preferences, i.e., such systems are not able to generate individual assessment plans.

6.1.5 Intelligent and adaptive support in web-based assessment systems

The analysis of web-based assessment systems shows that there are two important features of such systems, level of *intelligence* and level of *adaptively*. A system is called to be *adaptive* if it uses principles and methods of artificial intelligence, Brusilovsky and Peylo (2003) (such as the processing of natural language, knowledge representation, inference mechanisms and machine learning) in its structure and operation.

In turn, *adaptively* is defined as the capacity of the system to change behaviour automatically without a deliberate action on the user's part, Thévenin and Coutaz (1999). The *adaptively* and *intelligence* are features of high importance due to the fact that children have different needs and these differences should also be considered in web-based assessment through the provision of an individualized approach to each child. Otherwise, if a unified assessment style does not match the style of a particular child it can have negative impact on assessment process by leading to worse results, Wen, Graf, Lan, Anderson, Kinshuk, and Dickson (2007). Therefore, in order the assessment process implemented through the use of a web-based assessment system to be effective an intelligent and adaptive approach should be applied. Web-based assessment systems become more flexible and useful for children with different preferences and learning needs by incorporating a certain level of intelligence and providing a certain level of adaptively.

According to Brusilovsky and Peylo (2003) intelligence is concerned with the intelligent solution analysis and the intelligent problem solving support. Unlike systems which do not incorporate intelligent solution analyzers and, as a result, are capable of telling only whether the child's solution is correct or not, systems performing the intelligent solution analysis can tell what is wrong or incomplete and which missing or incorrect pieces of knowledge may be responsible for the error. The intelligent problem solving support concerns with the provision of intelligent help during the problem solving process and the generation of tutorial feedback to the child both during the assessment process and at the end of it.
The intelligent help can be given in forms of hints or leading questions relevant to the current situation in problem solving, Its main task is to allow the child to activate his/her thinking processes in order to obtain the correct solution of a task. In turn, tutorial feedback can be directed towards filling in gaps in knowledge simultaneously with the knowledge assessment by providing pieces of relevant learning material or towards facilitation of further direction of learning.

It is possible to conclude that systems of subjective testing are mainly intelligent systems because they perform not only the analysis of text in natural language through the use of corresponding methods of artificial intelligence, but also checking of matching of the text to criteria corresponding to the content, style, originality and identification of reasons of mismatching. In turn, the greater part of objective testing systems is not intelligent because they do not provide the intelligent solution analysis and the intelligent problem solving support. The mentioned systems typically compare the child's submitted answer with the teacher's predefined answer without the identification of the reasons of the mismatching between the mentioned answers, as well as the provision of very simple feedback in form of short sentences pointing out whether the answer is/ is not correct.

In other knowledge assessment systems, Gütl, Dreher, and Williams (2005); Wen, Graf, Lan, Anderson, Kinshuk, and Dickson (2007); Aguilar, Gomez and Kaijiri (2001); Kinshuk (2008); Lazarinis and Retalis (2007) both previously mentioned terms - the intelligent solution analysis and the intelligent problem solving support - can be closely related. If a system is not able to perform the intelligent solution analysis then no tutorial feedback or individualized help can be generated.

The adaptively in web-based assessment systems refers mostly to the adaptive presentation of assessment content and means the ability of a system to generate an individual assessment scenario (tasks sequence). If a system is not adaptive then for all children the same assessment scenario is applied. In contrast, an adaptive web-based assessment system, Alfonseca et al (2005); Kinshuk (2008); Lazarinis et al. (2007) provides an individual assessment scenario for each child taking into account child's prior knowledge level, preferences and already given solutions.

Objective testing can be adaptive. In this case the terms "computer adaptive assessment" or "computer adaptive testing" are used. In adaptive testing questions of knowledge assessment are adjusted to the learner's knowledge level. In most cases the widely known Item Response Theory (IRT) is used to generate an individual assessment scenario. In accordance with IRT selection of the next question depends on answer given to the previous question(s). The procedure is described in Computer adaptive assessment (2005) in detail. At the beginning of the assessment the child receives a question of average difficulty. If he/she gives a wrong answer, he/she receives a less difficult question. Otherwise, the child receives a more difficult question. This process continues until the predetermined test termination criteria have been met. In such an approach each child receives a unique set of questions, which allows more accurate determination of his/her achievement level. Thus, children at a low achievement level are not required to respond to questions that are very difficult and far beyond their achievement level, but children at a high achievement level are not required to answer questions that are too simple for them.

In Kinshuk (2008) the system's ability to support an individualized approach is divided into adaptively and adaptability. *Adaptively* requires the system to automatically adapt to the child's current level of domain competence and other similar attributes, whereas *adaptability* requires the system to provide suitable interfaces by which the child can customize the system according to his own preferences.

The intelligent and adaptive support in web-based assessment systems can be achieved by the use of a child model which is discussed in the next section in detail.

6.1.6 Use of the child model in web-based assessment systems

Child or learner modelling is related to the task of keeping a record of many aspects of a child. This record is called a child (or a learner) model. The child model reflects specific characteristics of the child and thus it is used as the main source of the adaptive behaviour of any web-based assessment system, Alfonseca et al. (2005); Gouli et al. (2004); Wen et al. (2007); Perez-Marin (2007).

The information held in the child model is divided into domain dependent information or dynamic information that changes during the assessment process and domain independent information or static information that is constant through the assessment process. Regarding the domain dependent information, the child model keeps information about the child's knowledge level, the child's errors, the child's behaviour during his/her interaction with the system (number of help asked, frequency of errors made, time of response, etc.). The domain independent information is the general information about the child such as the username, child's favourite feedback components and knowledge units (i.e., definition/description, example, and image), last time/date the child logged on/off, etc. The child model is dynamically updated during the child's interaction with the system in order to keep track of the child's "current state".

Information about the child can be obtained from different sources:

- From user-filled forms at the initial stage of the use of the system when the child is asked to answer a questionnaire about his/her personal data and preferences; in some cases psychological tests can be applied in order to get information about child's preferred learning style;

- From child observable behaviour when he/she works with the course (e.g., pages visited, time spent in each page, navigation path followed, chosen options, etc.);
- From results concerning solving of practical problems and tasks;
- From the observations of the child through the use of different sensors Hartley and Mitrovic (2002); Nkambou (2006); Kapoor and Picard (2005).

Thus the process of the acquisition of information about the child can run in different modes, Perez-Marin (2007): *passive* (when the system infers the model of children without explicit help from them), *active* (when children may be asked questions by the system to assist it) or *interactive* (when children play an active role in the development and maintenance of their own model).
According to Lazarinis et al. (2007) storing all the information in the child model in standardized formats allows for alternative externalizations of the child models and sharing of the information with other systems. Child models are thus reusable by different assessment and teaching systems and other applications.
Different applications could interpret and portray the available data differently.

6.2 Implementation of the model

Children at preschool acquire knowledge and language skills associated with different abilities through educational games. The game introduces learning activities by using playful elements as a source of motivation. The success of the game depends on an optimum relationship between challenge, fantasy, curiosity and control. This is also applied to educational computer games. Moreover, if these games contain features which have the capacity to adapt the instructional presentation dynamically according to the characteristics of a particular child's progress, these are referred to as adaptive computer games.

In this sense, the *web-based adaptive hypermedia system* (WAHS) makes the individualized assessing school readiness at preschool possible by means of adaptive computer based educational games. In the process of generating interactive games, the professional/admin chooses a set of games as appropriate for the child's educational level and domain of knowledge. The client side of WAHS sends both the child's identification and the identification of the selected game to the server side, which in turn selects the most appropriate multimedia elements (graphics and audio) in the content database. These elements, which are associated to the game according to the child's characteristics -the educational level and the psychomotor skills captured in the mouse interaction style-, are adapted by WAHS.

The architecture that makes both content and presentation adaptation feasible and presenting how WAHS dynamically choose the next educational activity/game considering the child's characteristics and the result of the played educational activity/game. Likewise, the process of generating several educational adaptive games, Count Balloon Strings, Incomplete Shadow, Picture Recognition, Match Rhyming Words etc. by modifying their difficulty, mouse interaction style and the content according to a particular child's features and progressing level in solving the games.

The personal computer is now the most used resource in the preschool classroom, ICT in Early Learning is much more than this. Highly innovative work, Hoppe (2006); Jerónimo, Gabriel, and Sturm (2006) is being carried out using programmable toys, floor robots, digital cameras, scanners, mobile telephones, cassette recorders and video recorders.
Playing games to learn basic life skills has been an important learning strategy from the earliest times, and remains so today, especially for early instruction at home.

Preschool children acquire learning, approaches and skills associated with different abilities through educational games. The game introduces learning activities by using playful elements as a source of motivation. The success of the game depends on an optimum relationship between challenge, fantasy, curiosity and control, Habgood, Ainsworth, and Benford (2005); Park (2012). This is also applied to computer-controlled games where a video display such as a monitor or television is the primary feedback device. They are seductive, deploying rich visual and spatial aesthetics that draw players into fantasy worlds that seem very real on their own terms, exciting awe and pleasure. The fact is that, for children and youth, computer games "are the most frequently used interactive media", Beentjes, Koolstra, Marseille, and van der Voort (2001).

Educational computer games motivate via fun (‘part of the natural learning process in human development’), via challenge and instant, visual feedback within a complete, interactive virtual playing environment, whereby ambience information creates an immersive experience, sustaining interest in the game. To encourage development they should allow the children to choose and to control the activity they want to develop. There are higher levels of creativity in children that use games whose structure is less rigid, i.e. facilitating free choice, Adams (2006). Also, children show greater interest in computer games that respond in real time to their interactions, Kolucki and Lemish (2011). The multimedia content that combines in an effective way the audio, the text and the images (static as well as dynamic) can stimulate the children’s learning and keep their attention during long periods of time, Berk (2006). In this stage where they have not yet acquired reading and writing skills, the audio presentation of the instructions to complete the activities is very important.

If the educational computer game has the capacity to adapt the instructional presentation dynamically according to the characteristics of a particular child and his/her progress, it is called an adaptive game. This kind of game offers personalized learning experiences to preschool children. Dynamically generated educational games compose the visible user interface of WAHS, Agudo, Sánchez, and Sosa (2005), a web based adaptive hypermedia whose aim is to assess the child if he/she ready for school, and WAHS adapts both the content and the navigation according to child learners’ characteristics.

6.3. What is an adaptive hypermedia system?

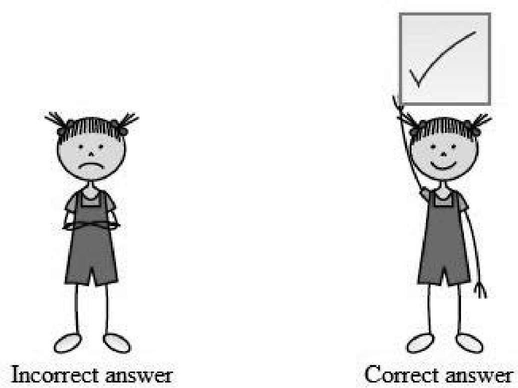
Hypermedia is developed as a result of linking two technologies: multimedia and hypertext. A computerized multimedia application involves different audiovisual means to represent the information (e.g. text, images, sound and video). The on-line play-based assessment, on the other hand, consists of a series of activities connected or linked among them in a way that users can pass from one activity to another in the order they wish and according to the user’s needs, interests and/or point of view.

Consequently, the hypermedia allows us to structure the information in a non sequential way and that information can integrate different means (i.e. text, graphics, sound and video). Hypermedia benefits in the learning process are unquestionable. On the one hand, it enables the child to freely explore the knowledge depending on their necessities and goals. On the other hand, the information is transmitted by using different sensory channels, important in the didactic process. However, in these systems the child can freely explore the knowledge (information) appropriate or not to their cognitive level.

Intelligent tutoring system (ITS), in the tool mentioned in Section 6.4, is developed by *WebGL*, is a computerized system designed to teach knowledge in a subject and skill. An ITS presents the child an activity (game) whose level of difficulty is appropriate to the child's age and background. The ITS compares the child's solution with the correct solution registered, and then, informs the child of the result as a feedback answer (see figure 16). The results model is updated with the activity result and a Machine Learning Algorithm, Oxman and Wong (2014) (discussed in the next chapter) will choose the next educational activity/game considering the child's characteristics and results and then the task model presents the next activity. The ITS is interesting because depending on the child's response it modifies in an automatic way its proposal to adapt to the learning speed and the detected knowledge level. However, it is a highly instructive system where the child has little or no control over the learning process.

Feedbacks are performed whether the child answers correctly or not. The feedback is performed audibly and graphically.

Figure 16- Feedback answers



The integration of an intelligent tutoring system in a hypermedia system originates an *adaptive hypermedia system* (AHS), Brusilovsky (1998); Brusilovsky (2001). The AHS profits from both systems: the tutoring part takes advantage of the flexibility and use of different audiovisual methods that the hypermedia part provides. And the latter one benefits from the adaptation to the child so that the tutor performs as a more customized educational system.

In this sense, the web-based adaptive hypermedia system makes the individualized assessing at early ages possible. Thanks to its hyper textual structure and multi-sensorial richness, children can develop their innate curiosity and complete the educational activities / games they wish as soon as they are adapted to their level.

6.4 Adaptive Cross-Platform Hypermedia System for Adaptive Assessment of School Readiness

This section will describe the architecture that makes possible both content and presentation adaptation and will present how *Adaptive Cross-Platform Hypermedia System for Adaptive Assessment of School Readiness* (ACPHSAASR) chooses the appropriate educational activities/games by activating the Machine Learning Algorithm on a suggested set of activities/games depending on their difficulty level of the activity/game, the weight of the specific category/subject, the weight of the specific skill, the given activity/game time, the terms the skill have to meet, the actual play time of the child, the number of correct answers, choosing one of the solve, help, backward, forward, start buttons on the screen, mouse interaction style like random clicks, random moves, if the activity meet one of the restrictions on the current activity, and the content according to a particular child's features.

6.4.1 Cross-Platform architecture

ACPHSAASR has a three-layered architecture. This type of architecture is an enhancement of the traditional two-level client/server architecture. Just like in such a conventional type, the three layered architecture separates user interface from business logic (programming) by distinguishing access to information from business (working with a database).

The Cross-Platform system presents the information to the user with *WebGL with Java Script* (User Interface) and provides the adaptation in the server by means of *Java Servlets* that decide the best task/activity for the child (Machine Learning Algorithm), the Intelligent Tutor will build the game according to child age and difficulty level.

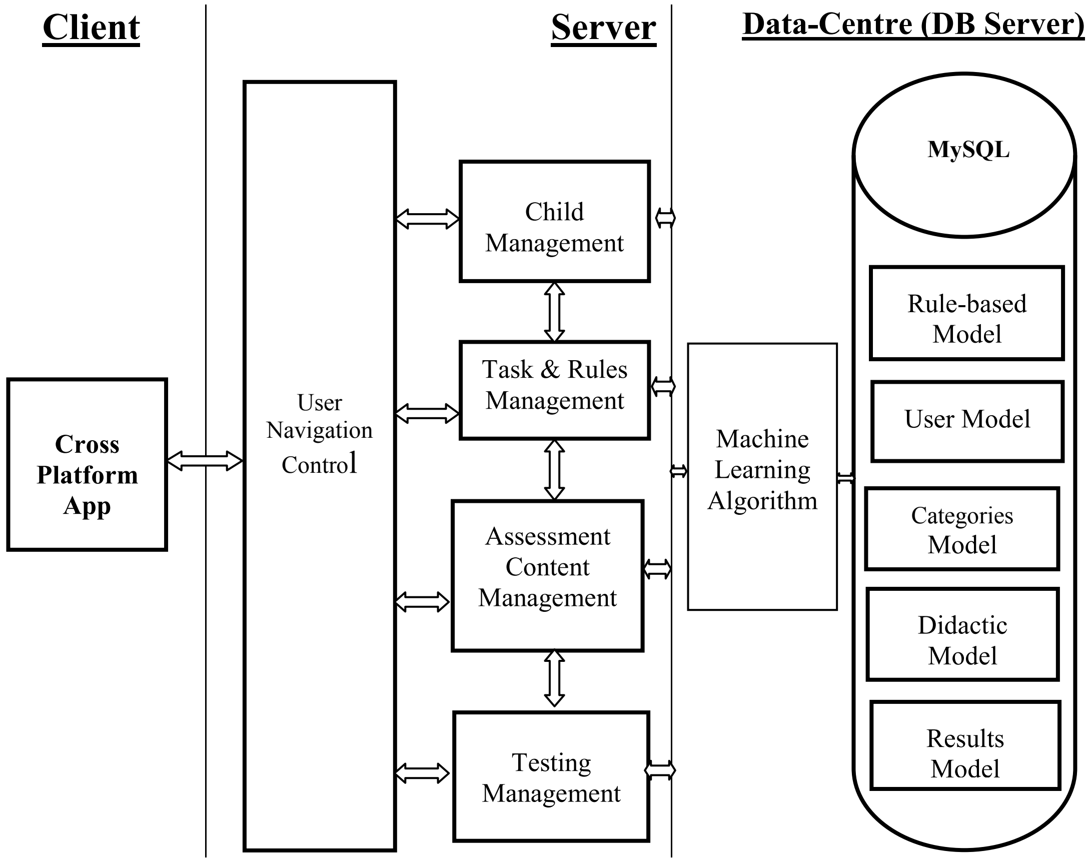
The ACPHSAASR is divided into five parts (Figure 17): Navigation Control, Child management, Task and Rules management, Assessment Content management, and Testing Management. The Navigation Control allows connecting User interface. The Task and Rules management according to the task and rules database and the results model consults the Machine Learning Algorithm in order to decide (according to the rules and results) the next task to do. The Child management handles the user model that stores the child's characteristics. The Testing Management stores the games' results. Lastly, intelligent tutor builds the next activity by consulting the Assessment Content management that stores the information on each task.

6.4.2. Adaptation Parameters

The characteristics which compose the user model of ACPHSAASR and will adapt educational video games to preschool children are determined by the educational level which refers to the child's knowledge regarding the domain of knowledge, the psychomotor and cognitive skills captured through the observation of the interaction style with the mouse, cognitive abilities, arithmetic readiness, Language Development, Phonological Awareness, and the acquired knowledge. Since pre-reading and pre-writing stages emphasize educational input such as visuals, listening, and gestures, learning styles should differ significantly at these early stages. Because multimedia activities, which combine video, sound, text, animation and graphics to stimulate different senses, are addressed to heterogeneous groups of children, such tasks should be developed by accounting for all children's needs and preferences.

The three-tier architecture of ACPHSAASR keeps the structure and the multimedia components that compose the didactic domain (hyperspace) independent. This fact allows extending the user's model with more parameters of adaptation.

Figure 17- The three-tier architecture of ACPHSAASR



Three educational difficulty levels will be distinguished according to pre-school curricula: level 1-*easy*, involving a conceptual phase addressed to four year old children, level 2-*intermediate*, corresponding to five years old, and level 3-*hard*, addressed to six years old. In terms of knowledge, both the initial mental capacity and his/her progress with the use of the system are considered. Advancement is recorded in the user model so that the system can adapt to the child's progress.

Whereas many children are proficient in their interactions with computers, tablets and smart phones and some others have even adapted to electronic game interfaces, this condition is not easily applicable for all children. As ACPHSAASR computer games must be accessible to all children, the system will adapt the young user's mouse interaction style to the psychomotor skills of the child.

These adaptation parameters affect the choice of the content of the next activity/game. The multimedia elements that comprise each game according to the content management adapt to the child's educational level in terms of concepts and content, enabling the most appropriate multimedia element to be loaded from the ACPHSAASR subject assessment content database. As these games are interactive, the mouse interaction style will be accommodated to the psychomotor skills of the child. In the ACPHSAASR, the mouse interaction style is linked to the educational level, which means that specific psycho-motor skills are assumed for all children in each level. In future developments, ACPHSAASR will evaluate the learning activities of each child and his/her psychomotor skills independently when using the mouse, computer interaction which can be assessed by examining the speed at which children execute the operation, the number of mistakes they make and how comfortable children feel while using the mouse (Donker & Reitsma, 2007).

6.4.3 Didactical Domain and Adaptation Mechanism

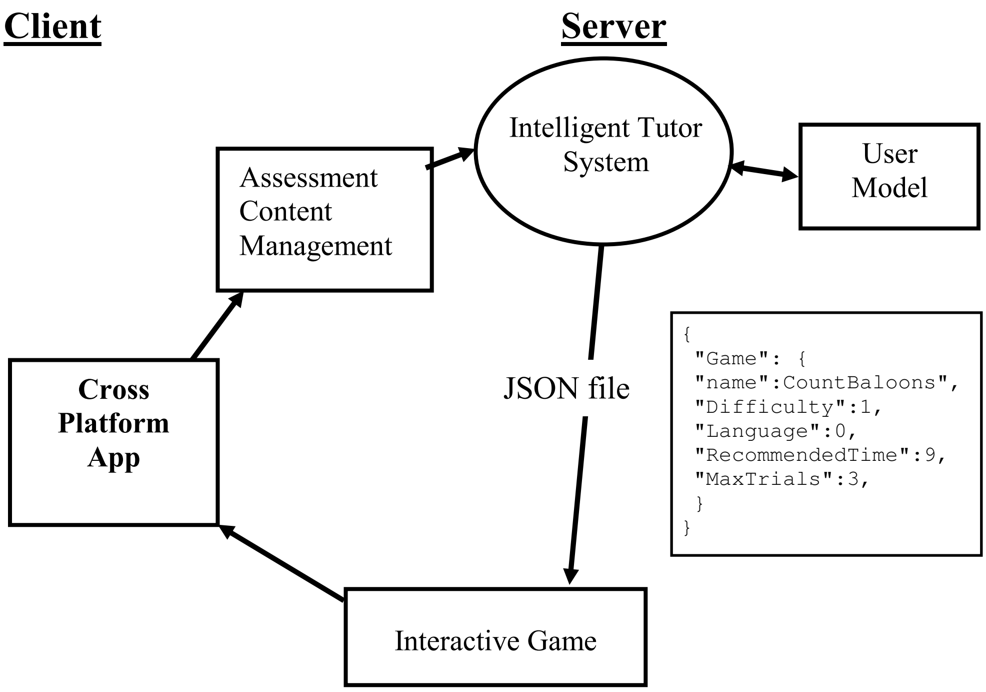
The didactic domain consists of five units and comprises points of interest for pre-schoolers: Mouse Training, Arithmetic Readiness, Cognitive Development, Language Development, and Phonological Awareness.

Each game unit includes four parts of activities: vocal instructions, presentation, playing and evaluation. The first part is aimed to direct the child how to play the game by listening to information and descriptive hints; the second part is aimed to familiarizing the child by reviewing a demo of the game by interactive means. The third part is the playing time aimed by means of interactive game. The fourth part is saving the evaluation of the acquired knowledge into the didactic unit according to the child's results. So, before accessing the evaluation part, input and interaction parts should have been successfully achieved. Each part includes one activity scene which compose the educational game that child must complete. The educational level and the acquired knowledge determine the following task to be faced.

When the Assessment Content Management selects an educational activity, the intelligent tutor looks up the corresponding user model to determine how to mount the activity and with which multimedia elements. With this information the intelligent tutor builds a configuration file. This file is sent to the child host and the browser loads the adaptable HTML5 Canvas game template and the multimedia elements, then, dynamically builds the most suitable activity for this particular child (Figure 18).

The configuration file is a JSON document that stores the specific values for each adaptation parameter. By means of this file, content (educational objectives), language, difficulty, and mouse interaction style (double click, drag & drop, one click, etc.) will be decided.

Figure 18- Game adaptation mechanism



When the child finishes up an activity, the information is registered and evaluated by the system. This assessment updates the user model, enabling the child to complete educational activities which adapt to the newly acquired knowledge.

6.5 Conclusions

Most of the adaptive systems integrate some textual information in their user interface because they are addressed to users who are expected to have some reading/writing skills. However, in this case, the users are children (3 to 6 years old) who do not have reading/writing skills. In other words, at this early age, children have not yet acquired reading and/or writing skills, so the multimedia content plays a leading role, and adapting it to the user's characteristics is pedagogically beneficial.

This chapter has described a three-tier adaptation mechanism to personalize educational web-based games according to several special characteristics of preschool children. These games compose the user interface of ACPHSAASR, a Cross-Platform adaptive hypermedia system designed for assessing pre-school children. This mechanism is based on a JSON configuration file. The schema of this file is easily extensible to other adaptation parameters.

The next chapter will present the Machine Learning Algorithm (Modified Genetic Algorithm) in detail.

CHAPTER 7: THE POWER OF ON-LINE GENETIC ALGORITHM IN STEALTH ASSESSMENT FOR SCHOOL READINESS

Assessment of children for school readiness is a crucial process that requires extensive effort to select the sequence of tests most appropriate for the particular case to be investigated. Indeed, the success of the assessment depends highly on the diversity, flexibility and comprehensiveness of the tests available and the ability of the applied system to decide on the specific sequence of tests to be utilized for each child based on his/her skills which should be discovered dynamically as the assessment progresses.

Given the huge search space for the test cases to be utilized in the assessment process, it is preferred to apply an optimization technique capable of finding an appropriate test case that better fits the skills of a given child. It was decided to use a genetic algorithm (GA) based approach for the optimization process. Any other optimization technique could have been used and utilizing the genetic algorithm is a personal decision to complement the framework developed for this thesis. Genetic algorithms have been widely and successfully used in various application domains. Fortunately, the results reported in this thesis demonstrate the effectiveness of the utilized genetic algorithm in handling the assessment process to decide on school readiness.

Assessment of a person's abilities and skills is an important task for organizations. Examples include evaluating a child's readiness for school or determining an employee's aptitude for a position. The assessment involves various parameters related to the test subject's aptitude, such as motor skills, linguistic development, or deductive capabilities, among others. The assessment may be conducted by various bodies, such as public education systems, commercial testing companies, and recruiters.

To facilitate the assessment process in a systematic way less influenced by the attitude of a specific domain expert, it is preferred to develop and employ web-based assessment systems which integrate the skills of professional domain experts.

A recent innovation is an adaptive web-based stealth assessment that analyzes the subject's skill and dynamically adapts the assessment tests accordingly.

A web-based stealth assessment is used for evaluating school readiness of a child by having the child play a series of games comparing the child's performance with a database of performance results for a population. The web-based stealth assessment includes a processor for processing the child's performance data, for comparing the performance data with the performance results of the population, and for applying a GA to determine the most appropriate next test for the child.

7.1 Introduction

The *genetic algorithm* (GA) has arisen from a desire to model the biological processes of natural selection and population genetics, with the original aim of designing autonomous learning and decision-making systems, Holland (1975). Since its introduction, and subsequent popularization, Goldberg (1989), the GA has been frequently utilized as an alternative optimization tool to conventional methods. The correctness of the GA as an abstraction of natural evolution has been challenged, for example by Channon and Damper (2000), but this issue should not be of undue concern to the researcher, who is using the GA for its robust search and optimization properties.

Several analogous algorithms have been proposed in the literature, such as *evolution strategies* (ES) and *evolutionary programming* (EP). These, together with GAs, have been classified under the umbrella group of *evolutionary algorithms* (EAs) Spears *et al*, (1993).

This chapter describes how the genetic algorithm methodology can be applied to problems in play-based assessment of school readiness. The suitability of the GA towards this type of problem is discussed, and the methods for incorporating the characteristics of learning problems, such as constraints on child performance, are outlined.

The application of GAs to learning can broadly be classified into two distinct areas: off-line design and on-line optimization. Off-line applications have proved to be the most popular and successful. On-line applications tend to be quite rare because of the difficulties associated with using a GA in real-time and directly influencing the operation of the system. GAs has been applied to controller design and to system identification and also to adaptive learning systems. In each case, either the parameters or the structure can be optimized, or – potentially – both.

7.2 What are genetic algorithms?

7.2.1 Overview

Genetic algorithms (GAs) are global, parallel, search and optimization methods, founded on Darwinian principles, Darwin (1859). They work with a population of potential solutions to a problem. Each individual within the population represents a particular solution to the problem, generally expressed in some form of genetic code. The population is evolved, over generations, to produce better solutions to the problem.

GAs encode the decision variables of a search problem into finite-length strings of alphabets of certain cardinality. The strings which are candidate solutions to the search problem are referred to as *chromosomes*, the alphabets are referred to as *genes* and the values of genes are called *alleles*. For example, in a problem such as the travelling salesman problem, a chromosome represents a route, and a gene may represent a city. In contrast to traditional optimization techniques, GAs work with coding of parameters, rather than the parameters themselves.

To evolve good solutions and to implement natural selection, a measure for distinguishing good solutions from other solutions will be needed. The measure could be an *objective* function that is a mathematical model or a computer simulation, or it can be a *subjective* function where humans choose better solutions over worse ones. In essence, the *fitness* measure must determine a candidate solution's relative fitness, which will subsequently be used by the GA to guide the evolution of good solutions.

Another important concept of GAs is the notion of *population*. Unlike traditional search methods, genetic algorithms rely on a population of candidate solutions. The population size, which is usually a user-specified parameter, is one of the important factors affecting the scalability and performance of genetic algorithms. For example, small population sizes might lead to premature convergence and yield substandard solutions. On the other hand, large population sizes lead to unnecessary expenditure of valuable computational time.

7.2.2 Who can benefit from Genetic Algorithm?

Genetic Algorithms are proven to be an enormously powerful and successful problem solving strategy especially for domains where extensive search is not feasible due to the huge space; GAs demonstrate the power of evolutionary principles. Moreover, the solutions they come up with are often more competent, more elegant, more complex as compared to other traditional problem solving techniques. A Genetic Algorithm is beneficial to tackle a wide range of problems from various domains, once the correct mode of representation for the problem is chosen plus the relative fitness of solutions is compared correctly. A Genetic Algorithm is useful and efficient when:

1. The search space is large, complex or poorly understood.
2. Traditional non-linear search methods fail.
3. No mathematical analysis is available.
4. Fitness landscape is non-linear and changes over time.
5. Multi-modal or n-dimensional search space exists.

7.2.3 Why Genetic Algorithm?

Genetic Algorithms can identify and exploit regularities in the environment, and converges on solutions (can also be regarded as locating the local maxima) that were globally optimal. This method is very effective at finding optimal or near optimal solutions to a wide variety of problems, because it does not impose limitations required by traditional methods such as gradient search, random search etc. The Genetic Algorithm technique has advantages over traditional non-linear solution techniques that cannot always achieve an optimal solution.

Genetic algorithms have been successfully applied in many diverse areas, such as function optimization, De Jong (1975), the traveling salesman problem, Grefenstettte, Gopal, Rosmaita,, and Gucht (1985); Goldberg and Richardson (1987), scheduling, Cleveland and Smith (1989); Syswerda and Palmucci (1991), evolving neural network design, Harp, Samad, and Guha (1989), Miller, Todd, and Hegde (1989), evolving computer programs, Fogel, Owens, and Walsh (1966), Cramer (1985), Fujiki and (1987), Koza (1992), Koza (1994), data analysis and predicting, Packard (1990), fuzzy rule base design, system identification, Kristinsson and Dumont (1992), computer vision, Bhanu, Lee, and Ming (1991), computer control, Karr (1991), and machine learning, De Jong (1988); Grefenstette (1988); Dorigo and Schnepf (1993). Goldberg's book, Goldberg (1989), Back's book, Back (1996), and Melanie Mitchell's book, Mitchell (1997) provide detailed review of these applications.

Genetic algorithm search strategies differ from conventional optimization and search procedures in several fundamental ways. Goldberg (1989) summarizes these as follows:

1. GAs operate with coded versions of the problem parameters rather than the parameters themselves, i.e., GA works with the coding of solution set and not with the solution itself.
2. Almost all conventional optimization techniques search from a single point but GAs always operate on a whole population of points (strings), i.e., GA uses population of solutions rather than a single solution for searching. This plays a major role to the robustness of genetic algorithms. It improves the chance of reaching the global optimum and also helps in avoiding local stationary point.
3. GA uses fitness function for evaluation rather than derivatives. As a result, they can be applied to any kind of continuous or discrete optimization problems. The key point to be performed here is to identify and specify a meaningful decoding function.
4. GAs use probabilistic transition operates while conventional methods for continuous optimization apply deterministic transition operates, i.e., GAs does not use deterministic rules.

7.2.4 GA general outlines

Once the problem is encoded in a chromosomal manner and a fitness measure for discriminating good solutions from bad ones has been chosen, will start *evolving* solutions to the search problem using the following steps:

1. *Initialization.* The initial population of candidate solutions is usually generated randomly across the search space. However, domain-specific knowledge or other information can be easily incorporated.
2. *Evaluation.* Once the population is initialized or an offspring population is created, the fitness values of the candidate solutions are evaluated.
3. *Selection.* Selection allocates more copies of those solutions with higher fitness values and thus imposes the survival-of-the-fittest mechanism on the candidate solutions. The main idea of selection is to prefer better solutions to worse ones, and many selection procedures have been proposed to

accomplish this idea, including roulette-wheel selection, stochastic universal selection, ranking selection and tournament selection.

4. *Recombination.* Recombination combines parts of two or more parental solutions to create new, possibly better solutions (i.e. offspring). There are many ways of accomplishing this, and competent performance depends on a properly designed recombination mechanism. The offspring under recombination will not be identical to any particular parent and will instead combine parental traits in a novel manner, Goldberg (2002).
5. *Mutation.* While recombination operates on two or more parental chromosomes, mutation locally but randomly modifies a solution. Again, there are many variations of mutation, but it usually involves one or more changes being made to an individual's trait or traits. In other words, mutation performs a random walk in the vicinity of a candidate solution.
6. *Replacement.* The offspring population created by selection, recombination, and mutation replaces the original parental population. Many replacement techniques such as elitist replacement, generation-wise replacement and steady-state replacement methods are used in GAs.
7. Repeat steps 2–6 until a terminating condition is met.

7.3 On-line GA

The increasing diffusion of mass services based on new information technologies (ITs) poses new requirements and goals on adaptive systems which are seemingly contradictory, such as the problem of providing adaptive personalized services to a mass of anonymous users, Binder at el. (1997). Sometimes models of user behaviour, Kobsa and Wahlster (1989) for the new services do not even exist, and, in addition, services and technologies appear and disappear very quickly thus subverting vanishing the effort of building accurate models.

The growing interest in self adaptive and self modelling systems is partially motivated by these reasons. The two leading approaches to self adaptation, i.e. genetic algorithms, Holland (1975); Whitley (2001) and neural networks, Anderson, (1975); Hagen at el. (1996) are characterized by somewhat symmetrical features which are worth pointing out: Neural Networks (NNs) tends to be online systems while GAs operate offline. GA usually operates offline in the sense that they can be seen as building a simulated application environment in which they evolve and select

the best solution among all the generations, under the well-known Darwinian principle of "survival of the fittest".
Some works, Masui (1992); Peñalver and Merelo (1998) have introduced "real world" issues into the GA loop, in the interactive GAs approach, Takagi (2001) the user is inserted in the algorithm with the role of providing the fitness functions by interacting with the GA, in other works still following the offline approach, Dorigo and Schnepf (1993); Becker and Seshadri (2003) about machine learning by GA, historical real data are used as fitness function.
Despite their offline nature GA are able to exhibit highly dynamical behaviour. The main reason is that the knowledge about "reasoning" structure of GA is embedded in the population chromosomes: when the population evolves the structure evolves as well. GA concepts such as cross over and mutation have no counterpart in NNs approach, but they are a powerful tools which can allow a GA to make fast hill climbing of local minimum and plateau in optimization problems, Whitley (2001).
The idea of bringing these adaptive features in the online system scenario is made more challenging from the facts that the population of clients asking for services is evolving over time, then their response to services changes.
This chapter will propose a new approach, namely online genetic algorithm (online GA) which tries to combine timely responses with the adaptive behaviour of GAs. The basic idea of online GAs is to evolve populations by using the application world as a fitness function, under the principle "the real world is the fitness".
The goal of systems based on online GAs is to give a timely response to a massive set of clients requesting services, and to be able to adapt services to clients, both changing over time in unknown and unpredictable way.
The principles and the architectural scheme of the online genetic algorithm will be integrated into a stealth assessment for school readiness.

7.4 Stealth Assessment

Technologies, both hard and soft; see Shute and Zapata-Rivera (2008), along with educational and psychological measurement approaches, have advanced a lot in the past couple of decades.
Now it can be more accurate and efficient to diagnose student competencies at various levels during the course of learning. With regard to *low-level diagnoses* (i.e., at the problem or task level, addressing how the person handled a given problem),

new technologies allow us to embed assessments into the learning process; extract ongoing, multifaceted information (evidence) from a learner; and react in immediate and helpful ways. On a more general level, support learning by using automated scoring and machine-based reasoning techniques will infer things that would be too hard for humans (e.g., estimating competency levels across a network of skills, addressing what the person knows and can do, and to what degree).

These *competency-level diagnoses* then provide the basis for improved instruction, self-reflection, and so on.

One critical problem faced here is how to make sense of what can potentially become a deluge of information. What is wheat and what is chaff?

The preferred solution involves using evidence-cantered design (ECD), which supports both levels of diagnosis, and thus can be used for formative and summative purposes, and more importantly to enhance student learning, Mislevy, Steinberg, and Almond (2003). It clarifies the "wheat" in performance data.

Stealth assessment is seamlessly woven directly into the fabric of the instructional environment to support learning of important content and key competencies. This represents a quiet, yet powerful process by which learner performance data are continuously gathered during the course of playing/learning and inferences are made about the level of relevant competencies, Shute, Ventura, Bauer, and Zapata-Rivera (2009). Inferences on competency states are stored in a dynamic model of the learner. Stealth assessment is intended to support learning and maintain *flow*, defined as a state of optimal experience, where a person is so engaged in the activity at hand that self-consciousness disappears, sense of time is lost, and the person engages in complex, goal-directed activity not for external rewards, but simply for the exhilaration of doing, Csikszentmihalyi (1990). Stealth assessment is also intended to remove (or seriously reduce) test anxiety, while not sacrificing validity and reliability, Shute, Hansen, and Almond (2008). The goal is to eventually blur the distinction between assessment and learning.

Key elements of the approach include: (1) evidence-cantered assessment design, which systematically analyzes the assessment argument concerning claims about the learner and the evidence that supports those claims, Mislevy et al. (2003); and (2) formative assessment and feedback to support learning, Black and Wiliam (1998a); (1998b); Shute (2008). Additionally, stealth assessment provides the basis for instructional decisions, such as the delivery of tailored content to learners, Shute and

Towle (2003); Shute and Zapata-Rivera (2008). Information is maintained within a learner model and may include cognitive as well as non-cognitive information for a broader, richer profile.

The main assumptions underlying stealth assessment research are that:

(1) learning by doing (required in game play) improves learning processes and outcomes; (2) different types of learning and learner attributes may be verified and measured during game play; (3) strengths and weaknesses of the learner may be capitalized on and bolstered, respectively, to improve learning; and (4) formative feedback can be used to further support student learning, Gee (2003); Shute (2007); (2008); Shute, Hansen, and Almond (2008); Squire (2006).

7.5 Basic Components of the Proposed GA based Method

A problem affecting current adaptive web-based stealth assessment is due to the fact that there are so many possible sets of solutions that great deal of the processing time and processor power are required to reach an optimal or near optimal solution.

The presented approach provides an improved online-GA for adaptive web-based stealth assessment methods and systems. The improvement consists of applying constraints to the chromosomes so as to optimize the solution set. Two types of constraints are used: hard constraints, which filter out solutions that violate non-negotiable requirements and soft constraints, which carry a penalty, reducing a chromosome's fitness evaluation.

7.6 Closer Look at the Employed GA-Process

The GA based method is described by an example driven approach, with reference to the accompanying Figures, in which components are designated in *italic*.

Figure 19- An adaptive web-based assessment tool in accordance with a preferred embodiment of the present method

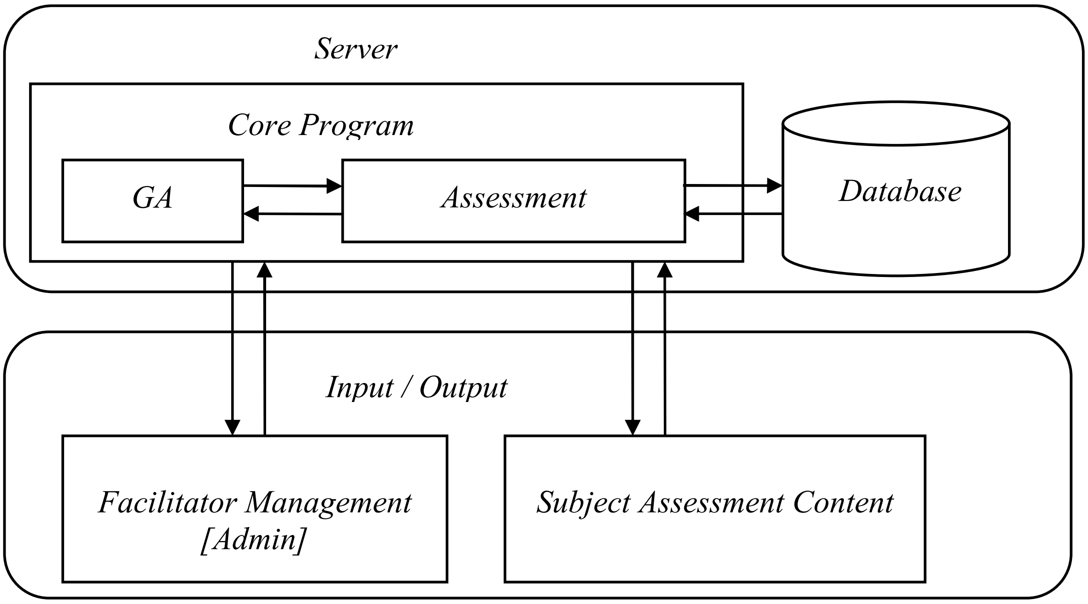


Figure 19 illustrates an exemplary web-based assessment tool, which can be adapted to include the present method. *Server* is a computing device, which can operate standalone or on a network such as the Internet, an Intranet, or any other network that can serve a plurality of users. *Server* is provided with a *Core Program* that comprises a *GA component* and an *Assessment Component*.

GA component receives from *Assessment Component* the user's performance data at various stages of the assessment and evolves for each such stage an optimal or near optimal solution concerning the content to use for the next stage of assessment.

Assessment Component receives the solution from the *GA component*, builds the assessment output using content in *Database* according to the received solution, and sends the assessment output to an *Input/output unit*.

Input/output unit can be one or more of various known computer peripherals for enabling a user to communicate with the computer program. For example, a display or speakers for output and a keyboard, a mouse, or a touch screen for input.

Input/output unit can be implemented in various ways known to the art of computing, such as a dedicated terminal, an independent computer, or part of the same computer as *server*. If physically separate from *server*, *input/output unit* can be connected to *server* via various communication links known in the art, such as direct serial or parallel connection or TCP/IP Ethernet connection. *Input/output unit* comprises subject *assessment content unit*, wherein assessment information is presented to a subject, for example on a display, and the user's response is received, for example via a keyboard, touch screen and mouse. *Input/output unit* can also comprise *facilitator management [Admin]* unit, whereby a facilitator can control system feed behaviour. Finally, it is worth mentioning that although the tool is adapted for assessment of the school readiness of children it can be adapted for other purposes, such as job-candidate evaluation.

Table 27- A representative table of data structures for use with a genetic algorithm to generate new assessment session content

Data Structure: New assessment session Information	**Data Structure: Performance Result Record**
Level number	Level number
Maximal number of tries	Number of tries
Maximal time	Actual play time
Minimal time	Actual play time
Maximal number of help clicks	Number of help clicks
Number of needed right answers	Number of right answers
Number of possible wrong numbers	Number of wrong answers

7.7 From User to GA

When the subject completes an assessment session (Table 28), a *performance result record* (Table 29) of the result is passed to the *GA unit*, which is in charge of selecting the next assessment session (or group of assessment sessions) for that category of the assessment. *Performance result record* includes results of the assessment session and also information about the user (for example, age or experience level) and the difficulty level of the assessment session. *Performance result record* is produced from information received by *assessment unit* from a subject interacting with subject *assessment content*. *Performance result record* is used by *GA unit* to create a chromosome that embeds the performance formula. *GA unit* then creates a population based on that chromosome and evolves subsequent generations using crossover and mutation until some stopping criterion is met (typically that a chromosome meets a fitness evaluation threshold or maximum number of generations is reached). The fittest chromosome is translated into a record of *new assessment session information* (Table 30). The information is used by the *assessment unit* to select the content from *database* for the next assessment session.

An exemplary GA algorithm is presented in the following sections. There are two main cases: The first case is an assessment system with no memory, in which performance depends only on the most recent result. The second case is an assessment system with n-cell memory which evaluate the user's performance according to the last n-1 assessment sessions that he participated in. In the latter case, it can draw information regarding the user's history and his/her learning curve.

7.8. Chromosome Generation and Selection

Each chromosome is a suggestion for a choice of content for the next assessment session. The chromosome is a vector of genes that are properties of an assessment session. For instance, the i-th element of the vector, which is the i-th gene in the chromosome, contains the maximal time that the assessment session should last.
The chromosome population consists of a preset number of chromosomes. The speed of convergence of the iterating GA depends strongly on the initial population. The range that the initial population covers includes (or come close to including) the current skill of the user, under the assumption that the learning and skill curves are consistent and continuous. If they are not, a regression procedure can be added.

Table 28- The assessment session record (*Ch*romosome)

#	Field	Description
1	Competency	i.e. = "Arithmetic Readiness"
2	Skill	i.e. = "Count Balloons"
3	Assessment session	No. of different appearances of games in the same skill
4	Age	Child age (3-8 years)
5	Experience level	Experience level of the child: 0-Beginner, 1-Average, 2-Advance
6	Difficulty level	Difficulty level of the assessment session: 0-Easy, 1-Intermidiate, 2-Hard
7	Min game time	The min time for the game (In seconds)
8	Max game time	The max time for the game (In seconds)
9	Max right answers	How many right choices in the assessment session [single choice or multi-choice]
10	Weight	Weight that serve as a kind of priority
11	HC1	Satisfy HC1
12	HC2	Satisfy HC2
13	HC3	Satisfy HC3
14	SC1	Satisfy SC1
15	SC2	Satisfy SC2
16	SC3	Satisfy SC3
17	SC4	Satisfy SC4
18	SC5	Satisfy SC5
19	SC6	Satisfy SC6

Table 29- The *Performance Re*sult record

#	Field	Description
1	Date	
1	Semester	Up to 3 semesters in the year
2	Child id	
3	Phase	Up to 7 times to complete playing the whole set of competencies, skills and assessment sessions [=the whole test]
4	Competency	i.e. = "Arithmetic Readiness"
5	Skill	i.e. = "Count Balloons"
6	Assessment session	No. of different appearances of games in the same skill
7	Age	Child age (3-8 years)
8	Experience level	0-Beginner, 1-Average, 2-Advance
9	Difficulty level	0-Easy, 1-Intermidiate, 2-Hard
10	Weight	Weight that serve as a kind of priority
11	Actual time	Average of the time that took the child to solve the game (In seconds)
12	Max right answers = Objects count	How many right choices to be selected
13	Wrong answers	How many wrong answers the child did
14	Correct answers	What is the total correct choices
15	Trials	How many times the child clicked before answer all right choices or timeout?
16	Click Solve	Did not click on the Solve button[0,1]
17	Game Interruption	Exit without solving the game [0,1]
18	Backward	Did not click on the Backward button [0,1]
19	Forward	Did not click on the Forward button [0,1]
20	Help	Number of help clicks
21	Random clicks	The number of times the child clicked random clicks on random places/areas in the game
22	Random moves	The number of random mouse moves
23	HCB1	Is HC1 was violated [0,1]
24	HC1-Penalty	Constant weight that serve as a kind of penalty for violating hard constraint
25	HCB2	Is HC2 was violated [0,1]
26	HC2-Penalty	Constant weight that serve as a kind of penalty for violating hard constraint
27	HCB3	Is HC3 was violated [0,1]
28	HC3-Penalty	Constant weight that serve as a kind of penalty for violating hard constraint
29	SCB1 [Click Solve]	Is SC1 was violated [0,1]
30	SC1-Penalty	Constant weight that serve as a kind of penalty for violating soft constraint
31	SCB2	Is SC2 was violated [0,1]
32	SC2-Penalty	Constant weight that serve as a kind of penalty for violating soft constraint
33	SCB3	Is SC3 was violated [0,1]
34	SC3-Penalty	Constant weight that serve as a kind of penalty for violating soft constraint
35	SCB4	Is SC4 was violated [0,1]
36	SC4-Penalty	Constant weight that serve as a kind of penalty for violating soft constraint

37	SCB5	Is SC5 was violated [0,1]
38	SC5-Penalty	Constant weight that serve as a kind of penalty for violating soft constraint
39	SCB6	Is SC6 was violated [0,1]
40	SC6-Penalty	Constant weight that serve as a kind of penalty for violating soft constraint
41	Score [=0-100]	Total score of the assessment session (calculated)

The current skill of the user is drawn from the last game played. Hence, an appropriate chromosome for that game is the base chromosome from which to create the initial population. There are two ways of creating the population of chromosomes: one is according to a *uniform distribution* around the base chromosome and the other is according to a *normal distribution* around the base chromosome with preset standard deviation parameter vector $\vec{\sigma} = (\sigma_1, \sigma_2, \ldots, \sigma_l)$, where σ_i is the standard deviation from the base for gene i.

Given large enough deviation values, the first generation of chromosomes will contain the user's current state and the appropriate offer with high probability for the next assessment exercise. The standard deviation vector is balanced to the best trade-off empirically.

After the chromosome population is created, the algorithm starts to create new generations in which better chromosomes produce new chromosomes using crossovers and mutations. A chromosome is better than another chromosome when its evaluation value yields better scoring.

The evaluation function is a sum of two terms, the first is a *difficulty term* and the second is a *penalty term*. The difficulty term is a distance function between the chromosome information and the learning curve factor, Yelle (1979) of the user: δ. The target is the chromosome that best achieves minimal distance between the anticipated δ and the difference between the chromosome information and the given results. Furthermore, learning factor δ is adjusted to the user after each activation of the GA, i.e., δ is a grade for the improvement in the GA anticipation for the user. Of course, δ is negative when the user is having difficulties with the current skill needs.

The fitness sub-function would make a decision whether the offered game is suitable for the user according to his performance result in the last game and will yield an appropriate improvement factor δ. The improvement factor will be used to determine his fitness in the next game. For example, starting with an improvement factor $\delta_{initial} = 0$ or any other preset value that corresponds to the normal learning curve of the user. In the next round the improvement factor will be a value that states whether the user's skills are increasing or decreasing and it will be the value δ that appropriate to the chromosome that was chosen. If the user's result was insufficient, meaning the game was too difficult for him, then the next game that would fit him should not be harder than the previous one (maybe even easier) and hence, the improvement factor will be increased to be zero or a small positive value, such that the game after it will have more or less the same difficulty to make sure the user's skill has really improved and is stable in his current level.

Assuming δ is given, the optimal chromosome *Ch* will yield the closest improvement to δ. Hence, the fitness evaluation function is such that the difference between the optimal chromosome and the last result is as close as possible to δ. If functions f_i are positive metrics, then the optimal chromosome satisfies:

$$\min_{Ch \in population} \left\| \begin{array}{l} f_1\left(Re.GameTime - Ch.MaxTime\right)+ \\ f_2\left(Ch.MaxHelpClicks - Re.HelpClicks\right)+ \\ f_3\left(-Re.MaxTries\right)+ \\ f_4\left(-Re.WrongAnswers\right)+ \\ f_5\left(-Re.SolveClicks\right)+ \\ f_6\left(-Re.ExitClicks\right)+ \\ f_7\left(-Re.BackwardClicks\right)+ \\ f_8\left(-Re.ForwardClicks\right)+ \\ -\delta \end{array} \right\|$$

Where *Ch* is the chromosome and *Re* is the performance result.
The functions f_i can be any loss functions, Krause (2010); Rosasco, De Vito, Caponnetto, Piana, and Verri (2003). The L_∞ norm metric functions seem to be satisfying; however, other metric functions can be experimentally tested, such as L_2 norm metrics.
An alternative method for integrating the improvement factor is an n-cell memory machine, where the last n-results are included in the fitness evaluation procedure and then the embedded δ factor is computed within the fitness evaluation. In this method, the input to the evaluation function is the chromosome as well as the performance results record that the user achieved by interacting with the web-based assessment.

Theoretically, there is no difference between the two methods, since they both use the same amount of information, hence have the same power of computation.

7.9. Empowering the GA Process with Constraints

Due to the specific setting of the problem, it is necessary to dictate the occurrence or prevention of several events. These dictates arise from the psychological and logical aspects of the games and the requirements of a reasonable order of the gaming procedure. Therefore, there is a set of conditions that the user must follow. The modification of the GA to include this set of conditions comprises the proposed method, which is described in more detail in this section. The conditions are divided into two groups, according to the level of the seriousness of the condition. Some conditions are merely advice to the tester, and can be treated as guidelines for testing the user. Other conditions form a necessity and must be adhered to.

The logical difference between the two kinds of conditions dictate different methods of implementation, hence they are divided into two sets of constraints: soft constraints (SC) that may be broken and hard constraints (HC) that must be satisfied.

7.9.1. The Soft Constraints

The penalty term is imposed on the GA due to requirements of the web-based assessment. The design of the web-based assessment contains several constraints. The constraints will be divided into two categories, hard constraints (HC) and soft constraints (SC). The HCs are induced from "must" and "must not" statements in the design. The SCs are induced from "recommended" and "strongly recommended" statements in the design.

Table 30- A representative table of soft constraints (SCs) in accordance with a preferred embodiment of the present method

Variable	Soft constraints title	Penalty
SC1	It is strongly recommended that the user does not click the “Help” button more than once.	01
SC2	It is preferred that the user does not click “Solve” button	02
SC3	It is preferred that the user does not click “Exit” button	02
SC4	It is preferred that the user does not click “Forward” button	02
SC5	It is preferred that the user does not click “Backward” button	02
SC6	It is preferred that the user finishes the assessment session before the maximal assigned time	02

The solution presenting the integrating of SCs into the system is a penalty term in the fitness evaluation function. A penalty value will be assigned for each constraint and it will be added in the fitness evaluation function when the constraint is broken. A list of the *SCs* can be seen in Table 30.

The penalty term in the fitness evaluation function is as follows:

$$\sum_{i=1}^{\#SCs} C(i).SCB(i, Chromosome)$$

Where *#SCs* is the number of soft constraints, *C(i)* is the penalty factor for constraint *i* and *SCB()* is a Boolean function implemented as follows:

$$SCB(i, Chromosome) = \begin{cases} 0, & Chromosome\ satisfies\ SC(i) \\ 1, & otherwise \end{cases}$$

Hence the fitness evaluation function for a chromosome is:

$$FitnessEvaluation(Chromosome) = Difficulty(Chromosome) + \sum_{i=1}^{\#SCs} C(i).SCB(i, Chromosome)$$

As formulated above, there is some redundancy, because certain terms also appear in the *SCs* penalty term. This does not affect the quality of the solution, since it will only increase the penalty on these terms.

7.9.2. The Hard Constraints

The hard constraints (HCs) are induced from requirements that are presented by the use of "must" or "must not" statements. A representative list of HCs is shown in Table 31.

Table 31- A representative table of hard constraints (HCs) in accordance with a preferred embodiment of the present method

Variable	Hard constraints title	Penalty
HC1	The user must start with the “Mouse Training” game if he is a new user	1500
HC2	The user must start with games of ‘Arithmetic Readiness”	1000
HC3	The user must play “Counting Sticks” before playing “Counting Numbers”	1000
HC4	The user must not repeat the same assessment session more than twice	500
HC5	The user must play games that are appropriate for his age.	1000
HC6	The user must play at least one game from each level	1000

The HCs come to insure the integrity and completion of an assessment process, the HC's insure the transition between all major competencies and skills, so the child will be assessed in all required areas. It must be clear that violation of a HC will not be allowed in any case.

Figure 20- A pseudo code naïve implementation of a hard constraint filter in accordance with a preferred embodiment of the present method

```
HCFilter (Input : chromosome ch)
Begin
    Loop for i from 1 to #HC
        If HC(i) is not satisfied in chromosome ch then
            if HC(i) is fixable then
                fix chromosome ch
                continue loop
            Else
                disregard chromosome ch
                return
            End
        End
    End
    Accept chromosome ch
    Return
End
```

Figure 20 is a pseudo code naïve implementation of an HC filter. An input *chromosome* is checked for *satisfying HCs*. If it is satisfied, the chromosome is *Output*, if not; it is *checked* to see whether it can be *fixed*. If it can, it is *fixed* and again *checked* against the *HCs*; otherwise an *error* is generated. The set of HCs are integrated in the system after the best chromosome in the population is chosen. Making an offer for a new assessment session from the chromosome consists of a scoring technique for the set of possible assessment sessions given in a table according to the values of the chromosome genes. The HCs are checked when matching an assessment session for the chromosome. In case one of the HC is not satisfied, then it is made impossible to choose the corresponding assessment session. For example, if HC3 is not satisfied, meaning that the game "Counting Sticks" is appropriate, but the user hasn't played "Counting Numbers" yet, then it will be marked as it is impossible to choose "Counting Sticks" by changing its score.
Some HCs can be satisfied before activating the GA, such as the HC1. In this case, it can be checked if the user is new, skip the GA, and choose the "Mouse Training" game. HC2 is treated similarly.

7.9.3 Computing the Result Evaluation

The Result Evaluation of a game that was played by a certain user is a weighted sum of his performance in various qualities, such as the relative time consumption, the score, the number of "help" button clicks and the usage of the "solve" option, etc. Each quality is measured by a function Q_i for some i. Each quality is multiplied by a weight value $w(i)$, which is preset to be an appropriate importance value of the quality. For instance, the time consumption quality measurement can be formulated as follows:

$$Q_{time}(\mathrm{Re}\,sult, GameInfo) = \frac{Actual\ Playing\ Time - Minimal\ Playing\ Time}{Maximal\ Playing\ Time - Minimal\ Playing\ Time}$$

The quality of "help" button usage can be formulated as follows:

$$Q_{help}(\mathrm{Re}\,sult, GameInfo) = \left(\frac{Actual\ Number\ of\ \mathrm{Re}\,questing\ Help\ Button}{Maximal\ Number\ of\ Helps\ to\ \mathrm{Re}\,quest}\right) \times \left(\frac{HelpPenalty}{DifficultyLevel}\right)$$

Some other qualities:

$$Q_{solve}(\mathrm{Re}\,sult, GameInfo) = \left(\frac{Click\ on\ Solve\ Button \times ClickonSolvePenalty}{DifficultyLevel}\right)$$

$$Q_{exit}(\mathrm{Re}\,sult, GameInfo) = \left(\frac{Click\ on\ Exit\ Button \times ClickonExitPenalty}{DifficultyLevel}\right)$$

$$Q_{Backward}(\mathrm{Re}\,sult, GameInfo) = \left(\frac{Click\ on\ Backward\ Button \times ClickonBackwardPenalty}{DifficultyLevel}\right)$$

$$Q_{Forward}(\mathrm{Re}\,sult, GameInfo) = \left(\frac{Click\ on\ Forward\ Button \times ClickonForwardPenalty}{DifficultyLevel}\right)$$

The Fitness Sub-Function

The idea of penalty functions is to transform a constrained optimization problem into unconstrained one by adding certain value to the objective function based on the amount of constraint violation present in the solution:

Fitness Sub-Function = $f(x)$ - Ψ

Where

$$f(x) = \mathrm{Re}\,sultScore - \sum_{\forall i} (Q_i \times w_i) - \delta$$

and,

$$\mathrm{Re}\,sultScore = \left(100 \times \frac{CorrectAnswers}{MaxRightAnswers}\right) - \left(WrongAnswers^2 + Trials^3\right)$$

and,

$\delta = ActualPlayingTime \times e^{-difficultyLevel}$

and let's assume the penalty function Ψ of the following form, Hadj-Alouane and Bean (1992); Hamida and Schoenauer (2002):

$$\Psi = \alpha \times (\sum_{i=1}^{m} G_i(x) + \sum_{j=1}^{n} H_i(x))$$

Where *m* and *n* is the number of hard and soft constraints respectively.

G_i and H_j are functions of the constraints violation g_i(x) and , $h_j(x)$.

A common form of G_i is: $G_i = \max(0, g_i(x))$

A common form of H_j is: $H_j = |h_j(x)|$

$$g_i(x) = \left(\frac{1}{1 + (SC(i) \times SCB(i))}\right)$$

and, $h_j(x) = \left(\frac{1}{(HC(j) \times HCB(j))} - 1\right)$

The penalty factor α is adapted based on the desired proportion of feasible solutions in the population T_{target} and the current proportion at generation t$_{Tt}$

if ($T_t > T_{target}$) then $\alpha(t+1) = \alpha(t) / fact$, otherwise $\alpha(t+1) = \alpha(t) \times fact$

Where $fact > 1$ is a user-defined parameter, a recommended value is around 1.1 .

A recommended value of T_{target} is around 0.6.

The adaptive penalty function that takes a feedback from the optimization process is called the fitness Sub-Function and presented as below:

$$(*)\ FitnessSubFuncation\_Value = \mathrm{Re}\,sultScore - \sum_{\forall i}\left(Q_i \times w_i\right) - \delta - \Psi$$

7.10 The Modified Genetic Algorithm

Figure 21- Top Level Description of the Modified GA Process with Constraints

```
Load all constraint data from a constraint(s) file(s).
While the population size is less than the maximum:
{
    Create the first generation of l chromosomes using normal distribution.
    Repair the new chromosome by using the constraint data.
    Evaluate the fitness of each chromosome by using the FitnessSubFunction.
    Enter the new chromosome into the population.
}
While the cost of the best chromosome is greater than zero:
{
    Discard a portion of costly chromosomes.
    Repeat until the population size is maximum:
    {
    Breed a new chromosome.
    Mutate the new chromosome.
    Repair the new chromosome by using the constraint data.
    Evaluate the fitness of each chromosome by using the FitnessSubFunction.
    Enter the new chromosome into the population.
    }
}
```

7.11 Future work

In order to provide further usage of readiness assessment, plausible learning mechanisms will be discussed in this section. The motivation of learning aims at information reuse of the assessment results in social aspects; in other words, the assessment of school readiness can be further used if the outcome can be interactively interpreted with a structured network from which a learning protocol focusing on the assessment evolution is incurred. Another reason for this structured learning attributes to the non-deterministic nature of genetic algorithms, that is to gauge the robustness or behavioural patterns of assessments from the web-based assessment. It is expected that the reuse of assessed information by learning aids the optimization processes, leading to enhanced features of this innovative tool presented in previous section. To enable the aforementioned learning capabilities, it is required to resort to current computational trends in social network, Janus and Offord (2007); Kagan et al. (1995), which can be categorized to unsupervised learning in consideration of noisy environment in assessment processes. Two possible ways: learning by copying and analyzing group behaviour, are described in order.

7.11.1 Learning by Copying

In process *core program* of Figure 19, the communication between *GA* and *assessment* components can be further analyzed. As presented in the previous section, the evaluation of chromosomes is a sum of measures, and the evolution of chromosomes relates to the computation in choosing the next user section. The concern is that the learning process is somehow mystified by the measure; and this can be alleviated by a copy learning mechanism in social network perspective. The learning process is modelled as a copying process among individuals over a series of in serial of assessment sessions, in this case, the genes on chromosomes to be evaluated, in the each stage of prompting new assessment sessions after GA. It is argued that the most effective learning process is to simply copy what is useful and discard what is not (by imposing penalties) among individual components. In regard of assessing user input, it is highly likely that each gene (information) on different chromosomes (combination of choices) evolves differently, and so if genes can be weighted (similar to the notion of "*C(i)*"), the communication between GA and assessment can evolve by copying certain set of genes from previous assessment sessions on pertaining chromosomes. This deviates from the point measure, and actually the learning path can be provided in reference to selection of genes copied and discarded. As simple as it sounds, the argument is influential by automating the evolution of the assessment process. The expected payoff of a known selection can be found by Rendell et al. (2010); Janus and Offord (2007) with details of the winning strategies:

$$(*) \qquad w_{exp} = w(1 - p_{est})^i + w'(1 - (1 - p_{est})^i)$$

Where w is the current weight and acquired i stages ago, w' is the estimated mean weight for all genes, and p_{est} is an estimate the probability of changing the choice of contents of each chromosome. The copy learning process is to be implemented between GA and the assessment module in the *core program* as in Figure 19.

7.11.2 Group Behaviour

It will be of great use if the web-assessment tool can depict the group behaviour of users, as the readiness ability can vary among groups of children under different circumstances, leading to the need for administrators to understand the discrepancies. The behaviour can be structured in network methodology as follows: On individual basis, the genes whose evolutionary patterns are known from previous learning process can be structured as nodes in networks. For example, gene *i* is linked with gene *j* if the payoff on certain stage of evaluation is greater than preset threshold, this is analogous to the selection pressure from phenotype to genotype mapping in computational biology. Further, links can be weighted by the payoff in aforementioned the equation (*). The group behaviour can be thought as the combination of such networks for all individuals, for example, averaging the weighs of links to produce the group network. As a consequence, the global picture of assessment behaviours can be structured as networks based on assessment stages (*core program*) and gene-cantered chromosomal level. The visualization of such network for group A can be compared with that for group B, and further explorations can be done on graph similarity search so as to quantify the behaviours and graphical patterns.

7.11.3 The Multi-Sessions Mode

Another mode of activation for the web-based assessment has been investigated, i.e., introducing a set of sessions to the user in each round. According to the average result in the set of sessions a chromosome was created and the GA was activated to choose a different set of sessions for the user to play. The only addition that has been introduced to this mode is a pre-determined association of sessions in sets. Each set contains a pre-determined number of sessions that all belong to the same category and are all of the same level.

The added value of that mode of activation is avoiding singular non-average results that might have occurred. These singular non-average results can be a result of a one-time event that does not indicate anything about the true ability and performance of the user.

Computationally, this mode is better because it requires a smaller number of activations of the GA. The runtime of the GA is one of the heaviest bottlenecks of the web-based assessment; thus reducing the number of times needed to run it is a good optimization step.

7.12 Concluding Remarks

The power of evolution has surely refined each and every step it has undergone in its way, and one cannot reject its usefulness in anyway because without it none of the immeasurable advances in debt to genetic algorithms would have been possible, and of course, the main driving force being Charles Darwin's simple, powerful intellectual insight: that the random chance of variation, together with law of selection, is a problem solving technique of massive and limitless application. The algorithm is one of the best problem solving "tools" in the present scientific and commercial world.

Though its theoretical journey, as research continued to be productive, genetic algorithms soon jumped into the commercial sector. Today, a Genetic Algorithm is related to "solving problems of everyday interest" in many diverse fields. Due to its intrinsic parallelism, the comprehensiveness with which this algorithm is applied in so many areas is no less than astounding. However, several improvements can be made in order that a Genetic Algorithm could be more generally applicable. Future work will continue in process of building robotic systems through evolution and many more specific tasks and as research is ongoing, the academic research would surely witness some of the most flawless advancements in Genetic Algorithm application fields.

Any decision-making without a clear understanding of future trends risks reduced profits or increased losses. Therefore people look for ways to predict events and values or delay the decision until there is a clear indicator to follow. Using prediction algorithms can make the management of the future much more predictable.

In order to provide further usage of predicting school readiness, a plausible discussion will be held about learning mechanisms focusing on predictive modelling as one of the most-used data mining technologies and has been applied to many engineering and scientific disciplines. With the aim of focusing on the data mining techniques, a prediction model to evaluate the readiness of a preschool child based on the socio-economic factors will be proposed in the next chapter.

CHAPTER 8- PREDICTION MODEL OF SCHOOL READINESS

8.1. Educational Data Mining

Educational Data Mining (EDM) is the application of Data Mining (DM) techniques to educational data, and so, its objective is to analyze these types of data in order to resolve educational research issues. Barnes, Desmarais, Romero, and Ventura (2009) DM can be defined as the process involved in extracting interesting, interpretable, useful and novel information from data, Fayyad, Piatetsky-shapiro, and Smyth (1996). It has been used for many years by businesses, scientists and governments to sift through volumes of data like airline passenger records, census data and the supermarket scanner data that produces market research reports, Han and Kamber (2006).

EDM is concerned with developing methods to explore the unique types of data in educational settings and, using these methods, to better understand students and the settings in which they learn, Baker (2010). On one hand, the increase in both instrumental educational software as well as state databases of student information has created large repositories of data reflecting how students learn, Koedinger, Cunningham, Skogsholm, and Leber (2008). On the other hand, the use of the Internet in education has created a new context known as e-learning or web-based education in which large amounts of information about teaching-learning interaction are endlessly generated and ubiquitously available, Castro, Vellido, Nebot, and Mugica (2007). All this information provides a gold mine of educational data, Mostow and Beck (2006). EDM seeks to use these data repositories to better understand learners and learning, and to develop computational approaches that combine data and theory to transform practice to benefit learners. EDM has emerged as a research area in recent years for researchers all over the world from different and related research areas such as:

- Offline education try to transmit knowledge and skills based on face-to-face contact and also study psychologically on how humans learn. Psychometrics and statistical techniques have been applied to data like student behaviour/performance, curriculum, etc. that was gathered in classroom environments
- E-learning and Learning Management System (LMS). E-learning provides online instruction and LMS also provides communication, collaboration,

administration and reporting tools, Nagarajan and Wiselin Jiji (2010). Web Mining (WM) techniques have been applied to student data stored by these systems in log files and databases. Romero, Ventura, Zafra, and de Bra (2009)

- Intelligent Tutoring (ITS) and Adaptive Educational Hypermedia System (AEHS) are an alternative to the just-put-it-on-the-web approach by trying to adapt teaching to the needs of each particular student. Romero and Ventura (2010). Data Mining has been applied to data picked up by these systems, such as log files, user models, etc. Romero and Ventura (2010)

The sources of information to be mined are heterogeneous. They include databases of the students' profile, log assessments of the user's interaction with the system, evaluation records, background knowledge, educational content, learning objects, student models, tutoring strategies, meta-data, federative teaching services, and many more repositories. Therefore, a sample of Educational Data Mining **(**EDM) applications is shown in this section according to the source of knowledge.

8.1.1. Student Modelling

Student models represent information about student's characteristics (e.g., student's knowledge, motivation, skills, personality, and learning preferences). An interesting EDM work oriented to student modelling is the comparison of student skill knowledge methods carried out by Ayers et al. (2009). The study analyzes three methods for estimating students' current stage of skill mastery, such as: common conjunctive cognitive diagnosis model, sum-score method, and capability matrix. Therefore, they try to estimate for a given topic the degree of skill achieved (e.g., complete, partial, none).

8.1.2. Tutoring

Tutoring corresponds to the traditional support that a human tutor offers to students to solve problems of a specific domain. This kind of functionality is fully implemented in intelligent tutoring systems (ITS). Regarding the application of DM in the tutoring field, the work achieved by Barnes, Stamper, Lehman and Croy (2008) uses hints generated from historical data to develop logic proofs. Hints are outcome by a reinforcement learning technique based on Markov decision processes.

With reference to the framework stated by Guo and Zhang (2009), it uses DM algorithms based on evolutionary computation to characterize dynamic learning processes and learning patterns for encouraging students' apprenticeship. The approach supports tutoring and collaboration functionalities to provide content that meet students' accessibility needs and preferences. The framework, also, pursues to match content to students' devices. These kinds of services are valuable for people with special abilities

8.1.3. Content

Content corresponds to the knowledge domain resources that are tailored to teach a lesson, record the students' behaviour, and evaluate students' apprenticeship. This resource is a kind of learning object that contains text, sound, image, video, virtual reality, animation, and many more multimedia options. An example of the DM application to content is given by Pavlik, Cen and Koedinger (2009). They set a transfer model of the knowledge domain of related practice item-types using learning curves. The item-types mean a set of practice items that are alike. Such a model represents the pair wise knowledge component relationships between item-types in the domain.

Another DM contribution to the content line is the work fulfilled by García, Romero, Ventura and Castro (2009). They built a system to find, share and suggest the suitable modifications to improve the effectiveness of a course and its content. Their approach includes rule mining to discover valuable information through students' assessments like "if-then" recommendation rules. The system holds a collaborative recommender module to share and score the recommendation rules obtained by teachers and specialists in education with common profiles.

8.1.4. Assessment

The record of the user interaction with a Web-based Educational Systems (WBES) during each session is fulfilled by the assessment module. Based on the information stored, it is possible to supervise the behaviour, performance, outcomes, customs, preferences, and many more issues about: who is the student? And what has she/he been doing? As an instance of DM applications to assessment, there is a method for mining multiple-choice assessment data set by Madhyastha and Hunt (2009). The method estimates similarity of the concepts given by multiple choice responses. As an outcome, a similarity matrix shows the distance between concepts in a lower-dimensional space. Such a view reveals the relative difficulty of concepts among the students. In addition, concepts are clustered, and unknown responses in the context of previously identified concepts are acknowledged. The method is used to answer questions related to the similarity of concepts and the difficulty of convincing students to modify an erroneous concept.

With the aim of focusing on the DM processes, Pechenizkiy, Trčka, Vasilyeva, Aalst, and De Bra (2009) stated a DM research line called "Process Mining". The line pursues the development of mining tools and techniques devoted to extract processes-related knowledge from event logs recorded by the system. One EDM application of process mining is devoted to analyze assessment data. The approach analyses assessments from recently organized online multiple-choice tests. It, also, demonstrates the use of process discovery, conformance checking and performance analysis techniques.

8.1.5. Conclusions

As the Internet and World Wide Web are rapidly developing, the technologies that support the educational processes come to replace the traditional educational systems. More and more teachers provide their teaching material to their students through simple or more sophisticated electronic means and experts in various fields continually provide knowledge to the public, usually in the form of web pages. According to Brusilovsky and Miller (2001), Adaptive and Intelligent Web-Based Educational Systems provide an alternative to the traditional 'just-put-it-on-the-Web' approach in the development of Web-based educational courseware. In their work Brusilovsky and Pyelo (2003) mention that Adaptive and Intelligent Web-Based Educational Systems attempt to be more adaptive by building a model of the goals, preferences and knowledge of each individual student, and by using this model throughout the interaction with the system in order to be more intelligent by incorporating and performing some activities which are traditionally executed by a human teacher – such as tutoring, assessing, or preparing corresponding content.

8.2. Poverty and Education

Through a combination of international development frameworks such as the Millennium Development Goals (MDGs), the Education for All (EfA) goals and the World Fit for Children (WFfC) targets, countries are working towards a society in which all children will complete primary or basic education at a minimum Kamerman (2002).

It is true that more children enter school, however, it is apparent that many of them are enrolling too late or too early, repeating grades, dropping out or failing to learn. United Nations Educational, Scientific and Cultural Organization (2007)

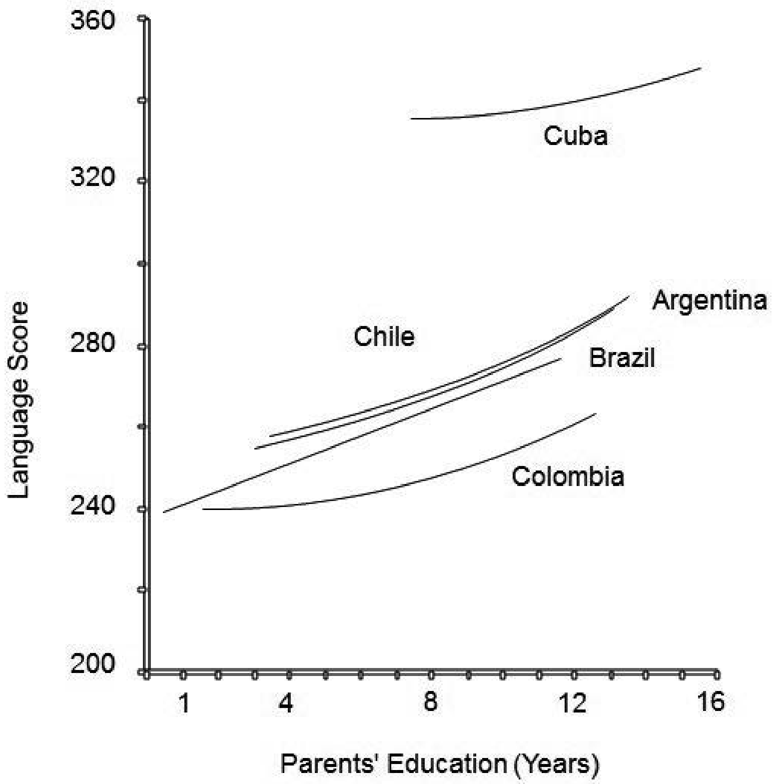
School readiness is the foundation of equity and quality education. It is gaining global support as a viable means to help young children reach their full developmental potential and engage in lifelong learning. School readiness is linked to improved academic outcomes in primary and secondary school and positive social and behavioural competencies in adulthood.

With respect to high school outcomes and academic achievement, the links to school readiness have also been established, Rouse, Brooks-Gunn, and Mclanahan (2007). Data from several developing countries, including Brazil, Jamaica and the Philippines, indicate a strong association between early skills and later high school completion, controlling for a host of influencing factors such as family income and education, Grantham-McGregor et al. (2007).

According to a study by Barros and Mendonça (1999), "poor children who attended one year of preschool stayed in primary school 0.4 years longer than children who did not attend preschool. For each year of preschool, children have a 7-12 percent increase in potential lifetime income, with the larger increases gained by children from families whose parents had the least amount of schooling", Praag (2002).

The study by Willms and colleagues (2001) from Latin American countries shows in Figure 22, that Cuba shows much better performance than other major Latin American countries. The Cuban results different from those of Chile, Brazil, Argentina, and Colombia because of the education system and the investment in mothers and children.

Figure 22- Socio Cultural Gradients for Language Scores by Country



Source: Willms and Somers (2001)

<u>*8.3 Social network analysis*</u>

Social network analysis (SNA), which consists in generating patterns that allow, identifying the underlying interactions between users of different platforms, has been an area of high impact in the last years. The appearance of social networking services, such as Facebook or Twitter, has caused a renewed interest in this area, providing techniques for the development of market research using the activity of the users within those services.

However, SNA techniques do not just concentrate on social networks, but also focus on other fields, such as marketing (customer and supplier networks) or public safety, Krebs (2002). One of the fields in which they are also applied is education, Rabbany, Takaffoli, and Zaiane (2011).

Thanks to SNA, it is possible to extract different parameters from the student activity in online courses, e.g., the students' level of cohesion, their degree of participation in forums, or the identification of the most influential ones. This kind of analyses might

be helpful for teachers to understand their students' behaviour, and as a consequence, help them to get better results.
SNA is also useful for generating new data as attributes, which can be subsequently processed using data mining techniques to obtain student behaviour patterns. In the educational field, there is a well-defined area called educational data mining, Romero and Ventura (2010). Building accurate performance and dropout predictors, which help teachers to prevent students from failing their subjects, is one of the main problems tackled in this area. For this purpose, classification techniques, by means of prediction models, are usually applied to uncover the students' behaviour, e.g., amount of time dedicated to accomplish certain tasks or activity in forums that results in a pass, a fail, or a dropout. For the issue of prediction, SNA provides a new useful framework that might improve the accuracy of those models.

In this chapter, survey data was analyzed from the Life school for Creativity and Excellence and another 3 different schools for three consecutive academic years. In the data analyzed, SNA helps to uncover behaviour patterns and build models that predict the performance and dropouts of children accurately.

We propose a prediction model to evaluate the readiness of a child to start school based on the social factors mentioned above in addition to the computerized assessment results. In this work, data mining techniques were used, including clustering, classification, and social network analysis, Berger et al. (2008). Due to the difference in school readiness assessment from one school to another, the classification model was built in a way that allows schools to modify the classifier to be used to add features that are used in the particular school.

8.4 Predicting School Readiness by Using Data Mining Techniques

This chapter proposes to apply data mining techniques to predict school readiness. Real data on 306 preschool children was used from 4 different elementary schools: (1) Life school for Creativity and Excellence a private school located in Ramah village, (2) Sisters of Saint Joseph missionary school located in Nazareth, (3) Franciscan missionary school located in Nazareth and (4) Al-Razi public school located in Nazareth, and white-box classification methods, such as *induction rules* were employed. Experiments attempt to improve their accuracy for predicting which children might fail or dropout by first, using all the available attributes; next, selecting the best attributes; and finally, rebalancing data and using *cost sensitive classification*. The outcomes have been compared and the models with the best results are shown.

8.4.1. EDM techniques

Recent years have shown a growing interest and concern in many countries about the problem of school failure and the determination of its main contributing factors. The great deal of research, Araque, Roldán, and Salguero (2009) has been done on identifying the factors that affect the low performance of students (school failure and dropout) at different educational levels (primary, secondary and higher) using the large amount of information that current computer can store in databases. All these data are a "gold mine" of valuable information about students. Identifying and finding useful information hidden in large databases is a difficult task, Quadril and Kalyankar (2010). A very promising solution to achieve this goal is the use of knowledge discovery in databases techniques or data mining in education, called educational data mining, EDM, Romero and Ventura (2007). This new area of research focuses on the development of methods to better understand students and the settings in which they learn, Romero and Ventura (2010).

There are good examples of how to apply EDM techniques to create models that predict dropping out and student failure specifically, Kotsiantis, Patriarcheas, and Xenos (2010). These works have shown promising results with respect to those sociological, economic, or educational characteristics that may be more relevant in the prediction of low academic performance. It is also important to notice that most of the research on the application of EDM to resolve the problems of student failure and drop-outs has been applied primarily to the specific case of higher education, Kotsiantis (2009) and more specifically to online or distance education, Lykourentzou (2009). However, very little information about specific research on preschool, elementary and secondary education has been found, and what has been found uses only statistical methods, not DM techniques, Parker (1999). Although "Statistics and visualization" cannot formally be considered data mining, statistics can be often included as the starting point of any study. Romero and Ventura (2007). There are several important differences and/or advantages between applying data mining with respect to only using statistical models, Aluja (2001):

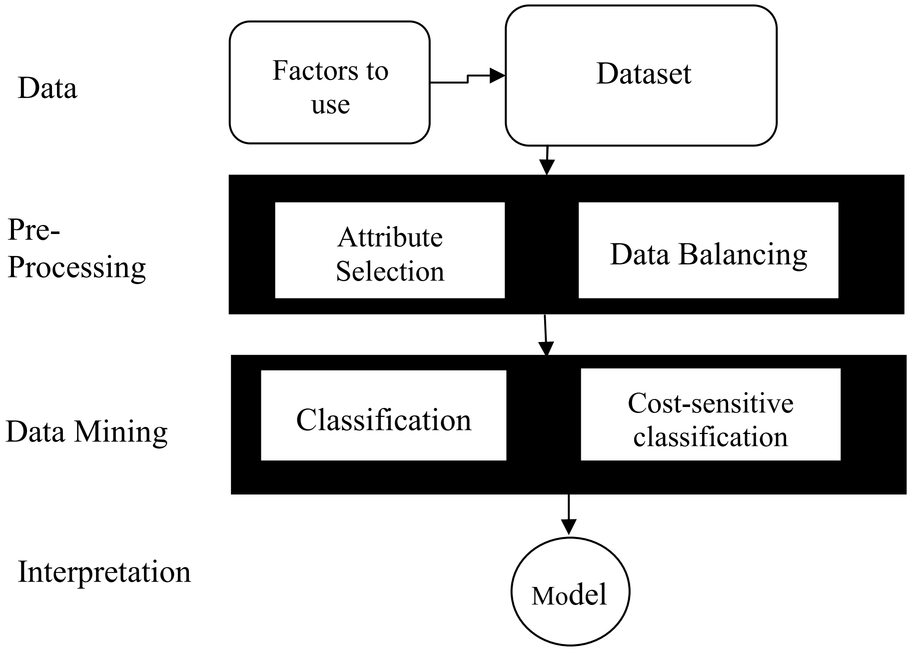
1. Data mining is a broad process that consists of several stages and includes many techniques, among them the statistics. This knowledge discovery process comprises the steps of pre-processing, the application of DM techniques and the evaluation and interpretation of the results.
2. Statistical techniques (data analysis) are often used as a quality criterion of the verisimilitude of the data given the model. DM uses a more direct approach, such as to use the percentage of well-classified data.
3. In statistics, the search is usually done by modelling based on a hill-climbing algorithm in combination with a verisimilitude ratio test-based hypothesis. DM is often used as a meta-heuristics search.
4. DM is aimed at working with very large amounts of data (millions and billions). The statistics alone do not usually work well in large databases with high dimensionality.

This chapter proposes to predict child readiness at pre-school in elementary education by using DM. In fact, the goal is to detect the factors that most influence child readiness in pre-school by using association rules mining, clustering and classification techniques. Also different techniques of DM have been used because the problem is complex, i.e., the data is characterized by high dimensionality (there are many factors that can influence) and it is often highly unbalanced (the majority of children pass and too few fail). The final objective is to detect as early as possible the children who show these factors in order to provide some type of assistance for trying to avoid and/or reduce school failure.

8.4.2. Method

The method proposed in this chapter for predicting the school readiness of children belongs to the process of Knowledge Discovery and Data Mining (see Figure 23). The main stages of the method are:

Figure 23- The Process of Knowledge Discovery and Data Mining



Source: Márquez-Vera et al. (2013)

1. *Data gathering*. This stage consists in gathering all available information on children. To do this, the set of factors that can affect the children's performance must be identified and collected from the different sources of data available. Finally, all the information should be integrated into a dataset.
2. *Pre-processing*. At this stage the dataset is prepared to apply the data mining techniques. To do this, traditional pre-processing methods such as data cleaning, transformation of variables, and data partitioning have to be applied. Other techniques such as the selection of attributes and the re-balancing of data have also been applied in order to solve the problems of high dimensionality and imbalanced data that are typically presented in these datasets.
3. *Data mining*. At this stage, DM algorithms are applied to predict child readiness like a frequent pattern mining, clustering or classification problem. To do this task, it is proposed to use:
    a. *Frequent pattern mining algorithm*, e.g., Apriori, was applied to find groups of students sharing same characteristics. This is achieved by considering students as items and characteristics of students as transactions. Then frequent sets of students are found by analyzing their common characteristics. Every frequent set of students with

cardinality larger than one reveals some interesting information about the students inside the set. The support of the set reflects the strength of the relationship between the students in the set by considering their characteristics.

b. *Clustering of students using hierarchical clustering or k-means,* k-means clustering aims to partition n observations into k clusters in which each observation belongs to the cluster with the nearest mean, serving as a prototype of the cluster, this will allow us to investigate each group of students forming one cluster and their distribution within the cluster. Students closer to the centre of the cluster are more interesting and solid entities inside the cluster than those closer to the boundary of the cluster. The study also investigtes how the outcome from the frequent pattern mining process matches the outcome from the clustering process. It is anticipated that students who end up in the same cluster are mostly together in the same frequent set of students.

c. *Classification algorithms based on splitting the data into training and test sets*. The training data will be used for building the classifier model and the test set will be used to evaluate the model. This method has two basic drawbacks:
(1) In problems where we have a sparse dataset we may not be able to afford the "luxury" of setting aside a portion of the dataset for testing
(2) Since it is a single train-and-test experiment, the estimate of error rate will be misleading if we happen to get an "unfortunate" split. The limitations of this method can be overcome with a family of re-sampling methods at the expense of more computations, like: Cross Validation, and Bootstrap. 10-fold cross validation is applied where the data is split into 10 disjoint subsets. Nine subsets form the training set: used to train the classifier, and the 10-th subset is used as the test set: used to estimate the error rate of the trained classifier.

The outcome from the frequent pattern mining and clustering will provide excellent input for constructing the social network of the students. This is essential because students who end up in the same frequent set or in the same cluster are likely to be similar and hence linked together. The weight of the link is determined based on the collective support of the sets in which the two students exist together combined with the value obtained from the distance separating the two students from each other and from the centroid of their cluster.

4. *Interpretation*. At this stage, the obtained models are analyzed to detect child readiness. To achieve this, the factors that appear and how they are related are considered and interpreted. Students in the same frequent set or cluster are expected to show the same trend and level of readiness. The degree of confidence in this result is determined by the support of the set of students produced by the frequent pattern mining process or based on the distance of the two students from the centroid of their cluster. The classifier model will support this result by either producing the same class for both students or not. However, in case the classifier does not produce same class for both students then the interpretation will be based on the frequent set and cluster analysis to understand why the two students could not end in the same class. In other words, the support of the dataset and the distance within the cluster will lead to good interpretation of how far away the student will be classified, i.e., are they very close to being in the same class or not.

The next step is a description of a case of study with real data from Arab children in order to show the utility of the proposed method.

8.4.3. Data Gathering

School failure of students is also known as the "one thousand factors problem", Márquez-Vera (2013), due to the large amount of risk factors or characteristics of the students that can influence school failure, such as demographics, cultural, social, family, or educational background, socioeconomic status, psychological profile, and study progress.

In this chapter, information has been used from pre-school children enrolled in *Life school for Creativity and Excellence* and three other schools for three consecutive academic years, Sep 2008- June 2013. The information used was only about pre-school children, where most children are between the ages of 5 and 6, as this is the year for moving from pre-school to 1st grade. All the information used in this study has been gathered from three different sources during the aforementioned period:

1. A general survey was designed and administered to all children in the middle of the year. Its purpose was to obtain personal and family information to identify some important factors that could affect school performance.
2. From a specific survey (Teacher questionnaire) which is completed when the children register for admission to kindergarten and pre-school in the school and also the results of the assessment conducted by the Kindergarten/Preschool teacher in the beginning of second semester (Feb-Mar).
3. The Teacher provides the scores/evaluations obtained by children in all subjects of the pre-school in the end of the academic year.

In Table 35, all the used variables in this study are shown grouped by data source.

8.4.4. Data Pre-Processing

Before applying DM algorithms it is necessary to carry out some pre-processing tasks such as cleaning, integration, discretization and variable transformation, Márquez-Vera (2013). It must be pointed out that a very important task in this chapter was data pre-processing, due to the quality and reliability of available information, which directly affects the results obtained. In fact, some specific pre-processing tasks were applied to prepare all the previously described data so that the classification task could be carried out correctly. Firstly, all available data were integrated into a single dataset. During this process those children without 100% complete information were eliminated.

All children who did not answer one of the specific surveys were excluded. Some modifications were also made to the values of some attributes.

A new attribute of the age of each student in years was created using the day, month, and year of birth of each student. Furthermore, the continuous variables were transformed into discrete variables, which provide a much more comprehensible view of the data. For example, the numerical values of the scores obtained by children in each subject were changed to categorical values in the following way:

Table 32- Variables used and information sources

Source	Variable
General survey	Classroom/group, number of friends, parental encouragement for study, religion, the type of personality, having a physical disability, suffering a critical illness, family income level, mother' s level of education, father' s level of education, number of brothers/sisters, position as the oldest/middle/youngest child, [Social factors]: *number of Peers in Class (Good, Average, Poor), number of Peers in neighbourhood (Good, Average, Poor)*, living in a large city, number of years living in the city, transport method used to go school, distance to the school, level of attendance during classes, interest in the subjects, level of difficulty of the subjects, level of motivation, quality of school infrastructure, level of teacher' s concern for the welfare of each student.
Specific survey (Teacher questionnaire)	Academic year, Age, sex, previous school, type of school, mother's occupation, father's occupation, number of family members, limitations for doing exercises, frequency of exercises, time spent doing exercises, scores obtained in Count Balloons, Count Balloon Strings, Identify the Number, Amount, Digit Matching, More or Less, Addition & Subtraction, Choose the Form, Magic Circle, Incomplete Shadow, Triangles, Analogy, Remember the Location, Sequence of Events, Identifying Faces, Hand Movements, Picture Selection, Picture Recognition, Series of Pictures, Series of Numbers, Backward Digital Series, Sound Units, Identify Rhymes, Match Rhyming Words, Opening Sound, Closing Sound
Department of school services (Evaluation)	Score in Arithmetic Readiness, score in Cognitive Development, score in Language Development, score in Phonological Awareness, score in Chess, score in Arts, and score in Computer skills.

Excellent: score between 95 and 100; Very good: score between 85 and 94; Good: score between 75 and 84; Regular: score between 65 and 74; Sufficient: score between 60 and 64; Poor: between 40 and 59; Very poor: less than 40 and Not presented.

Then, all the information was integrated in a single dataset and it was saved in the .ARFF format

8.5 Data Formatting

Data mining is an integral part of Knowledge Discovery in Databases (KDD), which is the overall process of converting a series of transformation steps, from data pre-processing to post-processing of data mining results. The data pre-processing has to do with gathering or collection of data, and data cleaning through data transformation. During data selection, the relevant data is gathered. Once the data has been assembled, its quality must be verified.

Incomplete (lacking certain attributes of interest, or containing only aggregate data), noisy (containing errors, or outlier values that deviate from expected), and inconsistent (for example, discrepancies in the codes used to categorize items) data are common. Data cleaning routines attempt to clean the data by filling in missing values; smoothing noisy data, identifying or removing outliers, and resolving inconsistencies. Finally, the cleaned data are transformed into a format suitable for data mining.

The data gathering process for this study involves the collection of the raw data about the children from Table 32.

According to the training data set, seven distinguishing features associated with each child (row): father's education, father's job, mother's education, mother's job, family size, child position as well as siblings and friends which are combined into one feature. These features represent the relationship between Socio-Economic Satus (SES) and school readiness as demonstrated in the literature, Rouse et al. (2005). These features represent four different aspects: parent's education, parent's job, family composition and peers including siblings and friends.

By analyzing the data it can give an idea on how each aspect, let's say parent's education may affect child's readiness regardless of other feature values and so on. For the parent's education, all children were classified in a training set based on their parent's education levels. Finding that parent's education provided in the data has six possible values, Primary, Secondary, 1st_degree, 2nd_degree, MD, PhD

Based on parent's jobs, jobs were classified into three classes: "UnEmployed", "Private" and "Government. The third aspect involves considering the family, including family size and child position within the family.

The fourth aspect considers the peers factor, including siblings and friends where friends cover both friends at school and in the local community at home. For every child, it was decided to explore his/her peers and check their achievement level by dividing them into four groups: good class peers, weak class peers, good neighbourhood peers and weak neighbourhood peers.

In accordance with the attribute's main pedagogical impact from the expert's points of view, respective classification attributes were defined as follow:

- Mother educational qualification whose labels are :{Primary, Secondary, 1st_degree, 2nd_degree, MD, PhD}

- Father educational qualification whose labels are: {Primary, Secondary, 1st_degree, 2nd_degree, MD, PhD}
- Mother occupation whose labels are: {UnEmployed, Private, Government}
- Father occupation whose labels are: {UnEmployed, Private, Government}
- Family size whose labels are: {='Big' if >4 members, ='Small' if <=4 members}
- Child position whose labels are: {='Late' if after 2nd child, ='Top' if before 2nd child}
- Good Class Peers whose labels are: {='Good' if<=2 peers, ='Weak' if>=2 peers}
- Weak Class Peers whose labels are: {='Good' if<=2 peers, ='Weak' if>=2 peers }
- Good Neighbourhood Peers whose labels are: {='Good' if<=2 peers, ='Weak' if>=2 peers}
- Weak Neighbourhood Peers whose labels are: {='Good' if<=2 peers, ='Weak' if>=2 peers}
- Ready4School whose labels are: {='NotReady' if not ready, ='Ready'=if ready}

Table 33- Child data format

S/N	Variable Name	Variable description/format	Variable Type
1	Age on entry	Students age on admission Continuous	Continuous
2	Gender	Male or Female Categorical	Categorical
3	Social class	Upper, Middle, Lower	Categorical
4	Mother’s educational qualification	Primary, SSCE, 1st degree, 2nd degree, PhD	Categorical
5	Father’s educational qualification	Primary, SSCE, 1st degree, 2nd degree, PhD	Categorical
6	Marital status of parents	Married, Divorced, Separated, Widowed	Categorical
7	Parent's relationship	Healthy, Problematic	Categorical
8	Mother’s occupation	Government worker, Private, Self employed	Categorical
9	Father’s occupation	Government worker, Private, Self employed	Categorical
10	Family size	Total number of children in family and parents	Continuous
11	Child’s position in the family	1st born, last born, only child, others	Categorical

12	Type of kindergarten attended	Private, Missionary school, Public	Categorical
13	Location of kindergarten	Rural, Semi-Urban, Urban	Categorical
14	Residence location	Rural, Semi-Urban, Urban	Categorical
15	Class Peers with level Good	Number of Peers in Class with grade level (70-100)	Continuous
16	Class Peers with level Weak	Number of Peers in Class with grade level (1-69)	Continuous
17	Neighbourhood Peers with level Good	Number of Peers in neighbourhood with grade level (70-100)	Continuous
18	Neighbourhood Peers with level Weak	Number of Peers in neighbourhood with grade level (1-69)	Continuous
19	Arithmetic Readiness score	Total Arithmetic Readiness result score (0-100)	Continuous
20	Cognitive Development score	Total Cognitive Development result score (0-100)	Continuous
21	Language Development score	Total Language Development result score (0-100)	Continuous
22	Phonological Awareness score	Total Phonological Awareness result score (0-100)	Continuous
23	Chess evaluation	Very Good, Good, Satisfying, Weak	Categorical
24	Arts evaluation	Very Good, Good, Satisfying, Weak	Categorical
25	Music evaluation	Very Good, Good, Satisfying, Weak	Categorical
26	Computer skills evaluation	Very Good, Good, Satisfying, Weak	Categorical
27	Science evaluation	Very Good, Good, Satisfying, Weak	Categorical
28	Ready4School	Ready, Not Ready	Categorical

8.6 Predictors of School Readiness and Social-Emotional Competence

Most research on school readiness has focused on family risk factors, and the ways that multiple risk factors in families negatively affect school readiness in children, Farkas and Hibel (2008). Families that experience economic, social, and/or psychological hardship, and have few resources to cope with these tend to experience higher rates of school "un-readiness" than do more advantaged families, Farkas and Hibel (2008).

There are some researchers who argue that the children's home environments do not provide the best support for the early development of their school readiness skills, especially in families who are low-income and come from culturally diverse backgrounds, Farver et al. (2006). Marks and Coll (2007) used an integrative theoretical model of child development formulated specifically for understanding development among children of colour.

Presently, researchers are expanding how to understand the ecological influences on the development of academic readiness skills, including both family and school-related factors, Connell (2001). Unfortunately, researchers still cannot determine which aspects of socioeconomic conditions (e.g., income, parental occupation) contribute to the improvement of a child's readiness for school, Rouse et al. (2005). In addition, the reader must be cautious of other researches who provide estimates of how much different factors contribute to the overall readiness gap. Given that these factors are highly correlated with one another, any one factor can pick up the effects of others, therefore making it extremely difficult to look at one factor individually. The next section describes the factors that were included in this chapter as predictors of school readiness and social-emotional competence.

8.7 Socio-demographic Variables

8.7.1 Socioeconomic Status or Income.

The literature suggests that income matters more for preschoolers than for older children and much more for poor children than for children from more economically advantaged situations, Duncan and Magnuson (2005). Accounting studies find that differences in SES explain about half a standard deviation of the initial achievement gaps, Rock and Stenner (2005).

Family SES appears to explain a great amount of variance of racial and ethnic gaps in school readiness, Rouse et al. (2005). Family SES is important for school readiness because it underlies many of the factors that affect school readiness, Rouse et al. (2005). Life for a family in a low socioeconomic household is very different than for a family living in a more advantageous situation, Duncan and Magnuson (2005). The first family may provide a lower quality home environment for a child and provide fewer learning opportunities in the home or in an outside lower-quality child care, Duncan and Magnuson (2005). The second family, however, may be the total opposite, where parents read to their children, visit museums, and engage in conversations.

In families with a low SES, parents are less likely to read or talk to their children than are parents in a more economically advantaged situation. The results of these behaviours are associated with school readiness given the relationship between school readiness and socioeconomic conditions and parenting behaviours, Rouse et al. (2005). Differences such as these suggest that SES plays a significant role in school readiness and why it is necessary to take it into account in studies of children's school readiness.

Studies have found a relationship between SES and school readiness. In an analysis of the data of the 1998 Early Childhood Longitudinal Study, ECLS-K: National Centre for Education Statistics (2001), Coley (2002) found that SES was related to proficiency across all reading tasks, where children in higher SES groups were more likely to be proficient than children in lower SES groups. SES was related to proficiency in all mathematics tasks, where children in higher SES groups were more likely to be proficient than were children in lower SES groups.

A relationship between SES and social-emotional competence has been demonstrated in the literature. Low-income children are at the highest risk of developing emotional and behavioural difficulties, Brooks-Gunn and Duncan (1997). McLoyd (1998) reported that poverty status and SES are significant predictors of children's early language skills and academic achievement, and social competence.

8.7.2 Family Size.

Head Start children tend to have mothers who come from large families and households that are less likely to have had either an adult male or an adult female working when the mother was 14, Currie and Thomas (1996).

Crowded home environments have been associated with disparities in children's social functioning, vocabulary growth rates, and cognitive abilities, Hart and Risley (1995). Parents have also been rated as being less responsive to their children when compared to those who were living in less crowded homes, Wachs and Camli (1991). The degree of stress associated with high density home environments has been shown to be negatively correlated with the frequency of parent to child speech, Wachs and Camli (1991). Farver and colleagues (2006) found that family size was negatively associated with children's literacy interest, such that children who engaged in literacy-related behaviours had smaller families. Scott and Seifert (1975) found that children from small families (one sibling or less) had higher scores on expressive language skills than children from large families (three siblings or more). In addition, Sameroff (1998) found that family size of four or more children was a risk factor in poor cognitive and social emotional development in preschool children.

It looked as if the number of adults and children living in the household is a predictor of school readiness and social-emotional competence. It was hypothesized that children from larger families would have lower school readiness and social-emotional competence.

8.7.3 Education of the Caregiver.

The most studied form of human capital is formal schooling, Duncan and Magnuson (2005). Research has shown that parental education plays a role in determining a child's educational experience, Perez and Martinez (1993). In addition, children who have highly educated parents typically obtain higher scores on cognitive and academic achievement tests than do children of parents who have less education, Duncan and Magnuson (2005). Other researchers have stated that children from low education parents tend to perform less adequately in cognitive skills than children from better educated parents, Roe and Bronstein (1988). In an analysis of the data of the 1998 Early Childhood Longitudinal Study, ECLS-K: National Centre for Education Statistics (2001), Coley (2002) found that having parents with less education put a student at-risk for school failure. Fowler and Cross (1986) found that maternal education was associated with academic achievement and successful grade completion.

In addition to these studies, other researchers have supported parental education's role in school readiness. Zill and colleagues (1995) found that level of maternal education was strongly related to each of the literacy-numeracy accomplishments. Farver and colleagues (2006) found maternal education to be correlated with receptive language.

8.7.4 Working Caregiver

The research on having a caregiver that works as a predictor of school readiness and social-emotional competence has been little studied and mixed.

Head Start children have been found to be less likely to have mothers that work, Currie and Thomas (1996). Duncan and Magnuson (2005) indicated that the research on the effects of occupation on young children is sparse. Rodriguez (2008)
Found that maternal employment increased the likelihood that children would experience "high stable" environments. Children in "high stable" environments had higher scores in school readiness than children in "low rise" environments.

Rodriguez (2008) indicates that given the financial benefits of working, mothers who are employed might be better able to invest in stimulating learning materials and engage in educational activities (e.g., visiting a museum) that may in turn promote learning in their children. Contrary to Rodriguez's (2008) findings, Brooks-Gunn, Han, and Waldfogel (2002) found that maternal employment by the ninth month was found to be linked to lower school readiness scores at 36 months. The effects were stronger when mothers were working 30 hours or more a week.

8.7.5 Peer Interactions.

Peer interactions are viewed as a developmental context for learning. Through interactions with their peers, young children practice the important skills necessary for competent social and academic adjustment to school, McWayne, Fantuzzo, and McDermott (2004). In the preschool classroom children use their peer play interactions to work through more complicated academic material presented during instructional periods. Also, peer play in preschool is one context where children learn and practice the new demands and expectations of the school, Farran (2000); Farran and Son-Yarbroug (2001). Thus peer interactions can be a positive force in a child's life that help them develop the necessary skills to adapt to more advanced social and academic challenges in preschool classrooms.

It is also known that peer interactions are related to children's adjustment to school, Ladd (1990). Children view friendships as a major concern when transitioning into new schools, Levine (1966). Peer interactions in elementary school have far-reaching effects, Peer Interactions and School Readiness Peer interactions are viewed as a developmental context for learning. Through interactions with their peers, young children practice the important skills necessary for competent social and academic adjustment to school, McWayne, Fantuzzo, and McDermott (2004). In the preschool classroom children use their peer play interactions to work through more complicated academic material presented during instructional periods. Also, peer play in preschool is one context where children learn and practice the new demands and expectations of the school, Farran (2000); Farran and Son-Yarbroug (2001). Thus peer interactions can be a positive force in a child's life that help them develop the necessary skills to adapt to more advanced social and academic challenges in preschool classrooms.

It is also known that peer interactions are related to children's adjustment to school, Ladd (1990). Children view friendships as a major concern when transitioning into new schools, Levine (1966). Peer interactions in elementary school have far-reaching effects, aggression and victimization, relational aggression and victimization, displayed and received pro-social behaviours, and school readiness will shed new light on the links between social-emotional development and children's early school success.

8.8 Apply Data Mining and Interpret Results

For this stage, WEKA was used (Waikato Environment for Knowledge Analysis), Witten and Frank (2005); it is an open source package which provides data mining algorithms for clustering, classification, and association. In this section, for each algorithm used in the study, the test characteristic and results obtained are shown (see appendix 9). These results can be presented in the form of tables or graphs.

8.8.1 Association Algorithms

For the association rules generation, Apriori algorithm was executed, Agarwal, Imielinski, and Swami (1993). For this algorithm, A generation of 100 rules were determined, based on the following parameters: a minimum support of 0.3 and minimum confidence of 0.9 as parameters, which have been set arbitrarily.
A set of IF-THEN rules were obtained from the algorithms. After an analysis, rules that were base on irrelevant information were eliminated.

8.8.2 The APriori algorithm

Apriori is an algorithm for frequent item set mining and association rule learning over transactional databases. It proceeds by identifying the frequent individual items in the database and extending them to larger and larger item sets as long as those item sets appear sufficiently often in the database. The frequent item sets determined by Apriori can be used to determine association rules which highlight general trends in the database.

Table 34- Some of the Best Rules Obtained with the Apriori Algorithm

Reliability	Rules—Generated	Rules—Interpretation
1.00	Family_size=0; Father_occupation=1 ==> Ready4School=1	Small family, father has a private job.
1.00	Mother_occupation=1; Family_size=0; Father_occupation=1 ==> Ready4School=1	Small family, father and mother have a private job.
1.00	Father_educational_qualification=0 ; Child_position=1; Father_occupation=1 ==> Ready4School=1	The father has a private job with primary education and a middle child in the family.
1.00	Mother_occupation=1; Good_Class_Peers=0; Father_occupation=1 ==> Ready4School=1	The father and mother have a private job and at the most 2 good class peers.
1.00	Mother_occupation=1 ; Good_Neighbourhood_Peers=0; Father_occupation=1 ==> Ready4School=1	The father and mother have a private job and at the most 2 good neighbourhood peers.
1.00	Child_position=1; Good_Class_Peers=0; Father_occupation=1 ==> Ready4School=1	The father has a private job and at the most 2 good class peers and a middle child in the family.
1.00	Father_educational_qualification=0; Mother_occupation=1; Child_position=1; Father_occupation=1 ==> Ready4School=1	The father and mother have a private job and the father with primary education and a middle child in the family.
1.00	Child_position=1 ; Good_Neighbourhood_Peers=0; Father_occupation=1 ==> Ready4School=1	The father has a private job with a middle child and at the most 2 good neighbourhood peers.
1.00	Mother_occupation=1; Weak_Neighbourhood_Peers=0; Father_occupation=1 ==> Ready4School=1	The father and mother have a private job with at the most 2 weak neighbourhood peers.
1.00	Father_educational_qualification=0 ; Good_Class_Peers=0; Father_occupation=1 ==> Ready4School=1	The father has a private job with primary education with at the most 2 good class peers.
1.00	Mother_educational_qualification=0; Mother_occupation=1; Child_position=1; Father_occupation=1 ==> Ready4School=1	The father and mother have a private job and a mother's secondary education with a middle child in the family.

8.8.3 Clustering Algorithms

For clustering testing, the following algorithms were used: SimpleKmeans, MacQueen (1967) and EM (Expectation Maximization), Dempster, Laird, and Rubin

(1977). In each algorithm, the number of clusters was calibrated to generate the greater amount of clusters having mutually exclusive attributes.

8.8.4 The k-means algorithm

The *k*-means algorithm is a simple, straightforward algorithm to assign instances to clusters. Each cluster is defined by a cluster centroid, and instances belong to the cluster for which their Euclidian distance to the centroid is the smallest. For each cluster a new centroid is found by taking the average over the cluster instances, which may lead to shifts of instances between clusters. This iterative process ends when the centroids stop changing. In Table 35 and 36, some clusters obtained are presented.

Table 35- Clustering results - *SimpleKmeans* (full training data)

		Cluster#				
Attribute	Full Data	0	1	**2**	3	4
	(306)	(84)	(73)	**(87)**	(31)	(31)
Mother_educational_qualification	Secondary	Secondary	1st_degree	**Secondary**	1st_degree	Secondary
Father_educational_qualification	Secondary	Secondary	1st_degree	**Secondary**	Secondary	Secondary
Mother_occupation	Private	Private	Private	**Private**	Private	Government
Father_occupation	Private	Private	Private	**Private**	Private	Private
Family_size	4.7026	4.9643	4.6849	**4.5862**	4.3548	4.7097
Child_position	1.9346	2.2738	1.7671	**1.8621**	1.5806	1.9677
Good_Class_Peers	2.9641	4.0476	2.9726	**1.9195**	3.2903	2.6129
Weak_Class_Peers	2.8203	3.0357	2.9041	**2.5517**	3.1290	2.4839
Good_Neighbourhood_Peers	2.8725	2.7976	2.8630	**3.0920**	2.7097	2.6452
Weak_Neighbourhood_Peers	2.8268	3.2857	2.8082	**2.1954**	2.8065	3.4194
Ready4School	Yes	Yes	Yes	**Yes**	Yes	Yes

Table 36- Clustering results - *SimpleKmeans* (percentage split)

		Cluster#				
Attribute	Full Data	0	1	2	3	**4**
	(201)	(39)	(35)	(38)	(37)	**(52)**
Mother_educational_qualification	Secondary	Secondary	Secondary	Secondary	Secondary	**1st_degree**
Father_educational_qualification	Secondary	Secondary	Secondary	Secondary	Secondary	**1st_degree**
Mother_occupation	Private	Private	Private	Private	Private	**Private**
Father_occupation	Private	Private	Private	Private	Private	**Private**
Family_size	4.7164	4.6667	4.5429	4.8158	4.7297	**4.7885**
Child_position	1.9353	1.7949	1.9429	2.1316	2	**1.8462**
Good_Class_Peers	3.0149	2.7692	3.1143	2.6053	3.6757	**2.9615**
Weak_Class_Peers	2.8358	2.9487	1.9143	1.9474	4.1892	**3.0577**
Good_Neighbourhood_Peers	2.9701	4.2821	3.9429	1.7895	1.7568	**3.0577**
Weak_Neighbourhood_Peers	2.7015	1.9231	4.2286	1.5789	3.2973	**2.6538**
Ready4School	Yes	Yes	Yes	Yes	Yes	**Yes**

In table 38 and table 39, the clusters 2 and 4 are frequent, then all of their subsets must also be frequent, the other item sets (clusters) are infrequent then all their supersets must also be infrequent. Maimon and Rokach (2010).

8.8.5 The Expectation-Maximisation (EM) algorithm

The EM algorithm is a probabilistic clustering algorithm. Each cluster is defined by probabilities for instances to have certain values for their attributes, and a probability for instances to reside in the cluster. For numerical values it consists of a mean value and a standard deviation for each attribute value, for discrete values it consists of a probability for each attribute value.

Table 37- Clustering results - *EM* (full training data)

	Cluster			
	0	1	2	3
	(0.28)	**(0.55)**	(0.03)	(0.14)
Mother_educational_qualification				
Primary	1.0814	1.0554	2.9917	4.8716
Secondary	3.2824	**153.2146**	2.4290	38.0740
1st_degree	79.6616	15.3416	6.9338	3.0630
2nd_degree	3.4803	1.3248	1.0118	1.1831
MD	2.4575	1.0126	1.5276	1.0023
PhD	1.0180	1.0016	1.0003	1.9801
[total]	90.9811	172.9506	15.8943	50.1740
Father_educational_qualification				
Primary	1.0821	1.0583	2.9918	5.8678
Secondary	16.9678	**154.3899**	6.3541	37.2882
1st_degree	65.7893	14.1211	3.2292	2.8604
2nd_degree	1.5708	1.2655	1.0100	2.1537
MD	4.5712	1.1158	1.3092	1.0038
PhD	1.0000	1.0000	1.0000	1.0000
[total]	90.9811	172.9506	15.8943	50.1740
Mother_occupation				
UnEmployed	6.8854	20.8486	2.7372	6.5288
Private	51.9359	**136.8048**	1.5246	34.7347
Government	29.1598	12.2972	8.6324	5.9106
[total]	87.9811	169.9506	12.8943	47.174
Father_occupation				
UnEmployed	1.0022	1.9410	1.0030	1.0538
Private	75.8401	**153.3461**	9.9799	40.8338
Government	11.1388	14.6634	1.9113	5.2864
[total]	87.9811	169.9506	12.8943	47.1740
Family_size				
Big	60.3667	**94.1779**	1.3863	45.0691
Small	26.6144	74.7727	10.5080	1.1049
[total]	86.9811	168.9506	11.8943	46.174
Child_position				
Late	11.5188	4.1964	1.0385	40.2463
Top	75.4623	**164.7542**	10.8557	5.9277
[total]	86.9811	168.9506	11.8943	46.1740
Good_Class_Peers				
Good	34.1558	67.3908	5.5991	13.8542

Weak	52.8254	**101.5597**	6.2951	32.3198
[total]	86.9811	168.9506	11.8943	46.174
Weak_Class_Peers				
Good	36.6143	**85.5786**	1.2019	22.6051
Weak	50.3668	83.3719	10.6924	23.5689
[total]	86.9811	168.9506	11.8943	46.174
Good_ Neighbourhood _Peers				
Good	38.6347	67.2160	8.3640	21.7853
Weak	48.3464	**101.7345**	3.5303	24.3887
[total]	86.9811	168.9506	11.8943	46.1740
Weak_ Neighbourhood _Peers				
Good	38.9568	78.6484	4.6824	22.7124
Weak	48.0243	**90.3021**	7.2119	23.4616
[total]	86.9811	168.9506	11.8943	46.174
Ready4School				
NotReady	6.2312	19.2632	5.2429	5.2627
Ready	80.7499	**149.6873**	6.6514	40.9113
[total]	86.9811	168.9506	11.8943	46.1740

The EM clustering scheme generates probabilistic descriptions of the clusters in terms of mean and standard deviation for the numeric attributes and value counts (incremented by 1 and modified with a small value to avoid zero probabilities) - for the nominal ones. That shows the given instance belongs to each cluster with some probability.
The overall likelihood is a measure of the "goodness" of the clustering and increases at each iteration of the EM algorithm. The larger this quantity, the better the model fits the data. Increasing the number of clusters normally increases the likelihood, but may lead to overfitting.

In the full training data mode the rule generated is the following:
Mother_educational_qualification= Secondary AND Father_educational_qualification= Secondary AND Mother_occupation= Private AND Father_occupation= Private AND Family_size= Big AND Child_position= Top AND Good_Class_Peers= Weak AND Weak_Class_Peers= Good AND Good_ Neighbourhood _Peers= Weak AND Weak_ Neighbourhood _Peers= Weak THEN Ready

This above rule says the ready for school is affected by mother and father qualification and occupation and also the child position in the family, the rest of the parameters do not a have a strong relation to the readiness for school.

Table 38- Clustering results - *EM* (percentage split)

	Cluster=0	1	2	3
	(0.67)	(0.18)	(0.14)	(0.01)
Mother_educational_qualification				
Primary	1.0014	1.0048	1.0009	1.9929
Secondary	**118.7411**	2.5448	3.6229	1.0912
1st_degree	17.5305	32.1962	26.2287	1.0447
2nd_degree	1.0682	2.8270	1.1051	1.9997
MD	1.0190	2.1451	1.8354	1.0005
PhD	1.0000	1.0000	1.0000	1.0000
[total]	140.3602	41.7178	34.7929	8.1291
Father_educational_qualification				
Primary	1.0014	1.0048	1.0009	1.9929
Secondary	**125.1342**	4.8114	11.9522	1.1021
1st_degree	11.1159	32.1136	16.6646	1.1059
2nd_degree	1.0169	1.0269	1.0293	1.9269
MD	1.0918	1.7610	3.1459	1.0012
PhD	1.0000	1.0000	1.0000	1.0000
[total]	140.3602	41.7178	34.7929	8.1291
Mother_occupation				
UnEmployed	11.0942	3.4893	4.3554	2.0611
Private	**113.1045**	23.4636	15.4609	1.9710
Government	13.1615	11.7650	11.9766	1.0969
[total]	137.3602	38.7178	31.7929	5.1291
Father_occupation				
UnEmployed	1.9509	1.0013	1.0385	1.0094
Private	**122.6440**	30.0981	28.2693	2.9886
Government	12.7653	7.6184	2.4851	1.1311
[total]	137.3602	38.7178	31.7929	5.1291
Family_size				
Big	**90.4762**	33.3225	9.0878	3.1135
Small	45.884	4.3953	21.7051	1.0156
[total]	136.3602	37.7178	30.7929	4.1291
Child_position				
Late	22.4184	9.2881	1.2288	2.0647
Top	**113.9418**	28.4297	29.5641	2.0643
[total]	136.3602	37.7178	30.7929	4.1291
Good_Class_Peers				
Good	47.9633	9.1317	18.8523	3.0528
Weak	**88.3969**	28.5862	11.9406	1.0762
[total]	136.3602	37.7178	30.7929	4.1291
Weak_Class_Peers				
Good	**70.3994**	16.4449	7.0645	3.0912
Weak	65.9608	21.273	23.7284	1.0378
[total]	136.3602	37.7178	30.7929	4.1291
Good_ Neighbourhood _Peers				
Good	53.0704	15.6327	14.2677	2.0292
Weak	**83.2898**	22.0851	16.5252	2.0999
[total]	136.3602	37.7178	30.7929	4.1291
Weak_ Neighbourhood _Peers				
Good	67.2351	16.4299	19.2255	3.1095
Weak	**69.1251**	21.288	11.5674	1.0196
[total]	136.3602	37.7178	30.7929	4.1291
Ready4School				
NotReady	17.2763	2.5023	7.2169	2.0045

Ready	**119.0839**	35.2156	23.5760	2.1245
[total]	136.3602	37.7178	30.7929	4.1291

In the percentage split with 66% training mode the rule generated is the following:
Mother_educational_qualification= Secondary AND
Father_educational_qualification= Secondary AND
Mother_occupation= Private AND Father_occupation= Private AND
Family_size= Big AND Child_position= Top AND Good_Class_Peers= Weak AND
Weak_Class_Peers= Good AND Good_ Neighbourhood _Peers= Weak AND
Weak_ Neighbourhood _Peers= Weak THEN Ready

The above rule is identical to the previous rule and same conditions will yield to readiness for school.

8.8.6 Classification Algorithms

Some of the attributes that define the clusters were considered as a class. This is achieved using ID3 (induction decision trees), Quinlan (1986) and J48, Ye and Baldwin (2005) algorithm. These tests are intended to verify the effectiveness in the classification rules generation from both systems and thus provide corroboration if rules are similar. Various tests were verified with ID3 and J48 algorithms with the already mentioned dataset.

A set of IF-THEN-ELSE rules were obtained from the algorithms. After an analysis, rules with irrelevant information were eliminated. Tables 42 and 43 show some of the best rules obtained.

8.8.7 The J48 algorithm

A decision tree is a tree in which each branch node represents a choice between a number of alternatives, and each leaf node represents a decision.

Decision tree are commonly used for gaining information for the purpose of decision-making. Decision tree starts with a root node on which it is for users to take actions. From this node, users split each node recursively according to decision tree learning algorithm. The final result is a decision tree in which each branch represents a possible scenario of decision and its outcome.

8.8.8 The ID3 algorithm

ID3 builds a decision tree from a fixed set of examples. The resulting tree is used to classify future samples. The example has several attributes and belongs to a class (like yes or no). The leaf nodes of the decision tree contain the class name whereas a non-leaf node is a decision node. The decision node is an attribute test with each branch (to another decision tree) being a possible value of the attribute. ID3 uses information gain to help it decide which attribute goes into a decision node. The advantage of learning a decision tree is that a program, rather than a knowledge engineer, elicits knowledge from an expert.

Table 39- Some of the Best Rules Obtained with the ID3 Algorithm

	Rules—Generated	**Rules—Interpretation**
1	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Private AND Mother_educational_qualification = Secondary AND Weak_Neighbourhood_Peers = Good AND Good_Neighbourhood_Peers = Good Family_size = Big THEN Ready	The readiness of the child is based here on parental secondary education, parental private job level, and good neighbourhood peers and big family size, respectively.
2	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Private AND Mother_educational_qualification = Secondary AND Good_Class_Peers = Good AND Family_size = Big AND Child_position = Late THEN Ready	The readiness of the child is based here on parental secondary education, parental private job level, good class peers, big family size, and child position is late respectively. Child's peers are not affecting the result.
3	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Private AND Mother_educational_qualification = Secondary AND Family size = Big AND Child_position = Top THEN Ready	The readiness of the child is based here on parental secondary education, parental private job level, big family size, and child position is 1st or second respectively.
4	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Private AND Mother_educational_qualification = 1st_degree THEN Ready	The readiness of the child is based here on parental secondary and first academic degree education, parental private job level
5	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Private AND Child_position = Top AND Family_size = Big THEN Ready	The readiness of the child is based here on parental secondary education, parental private job level, big family size, and child position is third or above respectively.
6	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Private AND Family_size = Small AND Child_position = Top THEN Ready	The readiness of the child is based here on father secondary education, parental private job level, small family size, and child position is 1st or second respectively.

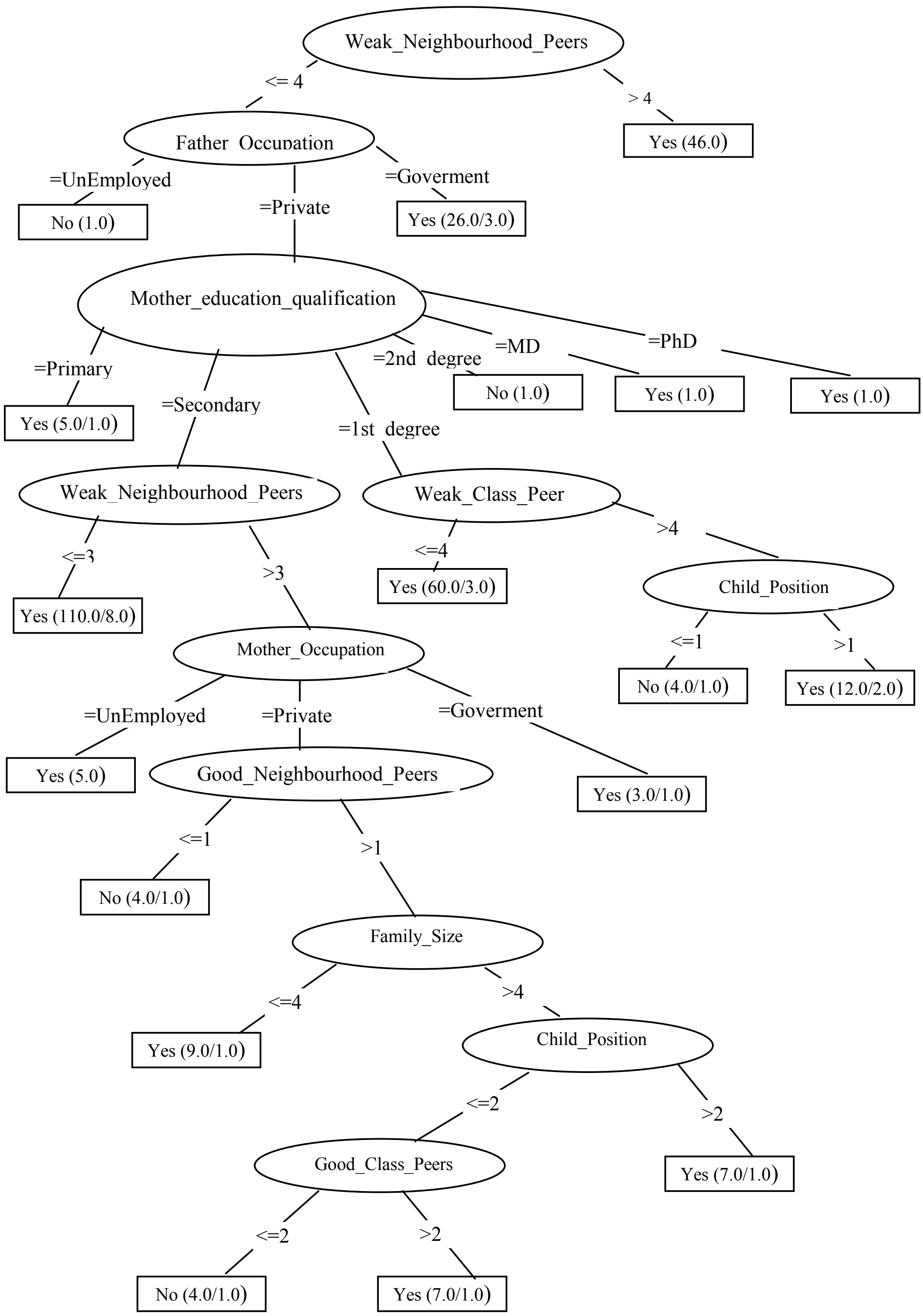
7	Father_occupation = Private AND Father_educational_qualification = Secondary AND Mother_occupation = Government AND Good_Neighbourhood_Peers = Good AND Family_size = Big THEN Ready	The readiness of the child is based here on father secondary education, father private job level, mother government job level and big family size respectively
8	Father_occupation = Private AND Father_educational_qualification = 1st_degree THEN Ready	The readiness of the child is based here on father 1st degree education and father private job level.
9	Father_occupation = Private AND Father_educational_qualification = 2nd_degree AND Mother_educational_qualification = PhD THEN Ready	This rule is very interesting because it fit my own child case.
10	Father_occupation = Government AND Weak_Neighbourhood_Peers = Good AND Good_Class_Peers = Good THEN Ready	The readiness of the child is based here on father government job level, good weak neighbourhood peer and good class peer respectively.

Table 40- Some of the Best Rules Obtained with the J48 Algorithm

	Rules—Generated	Rules—Interpretation
1	Father_occupation = Private Mother_educational_qualification = 1st-degree	The father has a private job and the mother with academic degree.
2	Father_occupation = Private Mother_educational_qualification = 1st-degree Weak_class_Peers <= 4	The father has a private job and the mother with academic degree with minimum weak class peers.
3	Father_occupation = Private Mother_educational_qualification = 1st-degree Weak_class_Peers <= 4 Child_position > 1	The father has a private job and the mother with academic degree with minimum weak class peers and more than one child in the family.
4	Father_occupation = Private Mother_educational_qualification = Primary	The father has a private job and the mother with primary educational level, this is very typical for the Arab community inside Israel.
5	Father_occupation = Private Mother_educational_qualification = Secondary Weak_Neighbourhood_Peers <= 3	The father has a private job and the mother with secondary educational level, and child has 1-3 weak neighbourhood peers.
6	Father_occupation = Private Mother_educational_qualification = Secondary Mother_occupation = UnEmployed	The father has a private job and the mother with secondary educational level, and the mother unemployed, identical to rule (4).
7	Father_occupation = Private Mother_educational_qualification = Secondary Mother_occupation = Private Good_Neighbourhood_Peers >1 Family_size <= 4	The father and mother have a private job and the mother with secondary educational level, and child has more than one good neighbourhood peers and a small family members.
8	Father_occupation = Private Mother_educational_qualification = Secondary Mother_occupation = Private Good_Neighbourhood_Peers >1 Child_position >2	The father and mother have a private job and the mother with secondary educational level, and child has more than one good neighbourhood peers

		and a middle child in the family.
9	Father_occupation = Private Mother_educational_qualification = Secondary Mother_occupation = Private Good_Neighbourhood_Peers >1 Child_position <=2 Good_Class_Peers >2	The father and mother have a private job and the mother with secondary educational level, and child has more than one good neighbourhood peers and a middle child in the family and more than one good class peers.

Figure 24- The Decision Tree for J48 algorithm



8.9 Results and Discussion

8.9.1 Data Analysis

In this chapter 5 different data mining algorithms were provided (Apriori, *k*-means, EM, ID3 and J48) for association, clustering and classification to predict if the child is ready according to socio-economic factors: father's education, father's job, mother's education, mother's job, family size, child position as well as siblings and friends.

Predicting school readiness can be a difficult task not only because it is a multifactor problem (in which there are a lot of personal, family, social, and economic factors that can be influential) but also because the available data are normally imbalanced. To resolve these problems, use of different DM algorithms and approaches for predicting school readiness had been discussed. Several experiments had been carried out using real data from different preschool classes in 4 different preschool children in the Arab community in Israel. Different classification, clustering and association approaches were applied for predicting the readiness status or final child performance at the end of the preschool. Furthermore it was shown that some approaches such as selecting the best attributes, cost-sensitive classification, and data balancing can also be very useful for improving accuracy.

It is important to notice that gathering information and pre-processing data were two very important tasks in this work. In fact, the quality and the reliability of the used information directly affect the results obtained. However, this is an arduous task that involves a lot of time. Specifically, data from a paper and pencil survey had been picked out and data from three different sources was integrated to form the final dataset.

The criteria described below

In general, regarding the DM approaches used and the classification, clustering and association results obtained, the main conclusions are as follows:

1. Classification, clustering and association algorithms can be used successfully in order to predict a child readiness for school and, in particular, to model the difference between ready and not ready children.
2. The number of attributes were reduced from the 71 initially available attributes to the best 11 attributes, obtaining fewer rules and conditions without losing classification performance.

3. Two different ways to address the problem of imbalanced data classification by rebalancing the data and considering different classification costs were shown. In fact, rebalancing of the data has been able to improve the classification results obtained in TN rate, Accuracy, and Geometric Mean.

Regarding the specific knowledge extracted from the DM models obtained, the main conclusions are as follows:

1. White box classification algorithms obtain models that can explain their predictions at a higher level of abstraction by IF-THEN rules. In this case, induction rule algorithms produce IF-THEN rules directly, decision trees and ID3 can be easily transformed into IF-THEN rules. IF-THEN rules are one of the most popular forms of knowledge representation, due to their simplicity and comprehensibility. These types of rules are easily understood and interpreted by non-expert DM users, such as instructors, and can be directly applied in decision making process.
2. Concerning the specific factor or attributes related with child readiness, there are some specific values that appear most frequently in the classification models obtained. For example, the values of parents' occupation that appear most frequently in the obtained classification rules are the value "Private". Other factor frequently associated with parents' education are being over 12 years of education, i.e. "Secondary" and "1st_Grade", also the family size is up to 5 members (Including both parents), and a middle child position in the family is the dominant.
3. This study was focused solely on social-demographic attributes to confirm the conventional results obtained only through empirically-based research.
4. Results have found a relationship between SES and school readiness. Children in higher SES group were more likely to be ready for school more than children in lower SES group.
5. The results approved the hypothesis that children from small families (three siblings or less) are more ready for school than children from large families (four siblings or more).
6. The results supported parental education's role in school readiness and found that level of maternal education was strongly related to school readiness of the child, mothers who are educated might be better able to invest in

stimulating learning materials and engage in educational activities that may in turn promote learning in their children.

7. It is known that peer interactions are related to children's adjustment to school, but in this case the preschool children are still related to parents, brothers and sisters, so neighbourhood peers are not affecting the readiness in this stage, when a preschooler plays with brothers and sisters, he/she will receive pro-social behaviours from brothers and sisters, and school readiness will shed new light on the links between social-emotional development and children's early school success.

Starting from the previous models (rules and decision trees) generated by the DM algorithms, a system to alert the teacher and their parents about children who are potentially at risk of unready can be implemented. As an example of possible action, once children were found at risk, it proposed that they would be assigned to training activities in order to provide them with both improvement and guidance for motivating and trying to prevent child unready.

Present study shows that school and neighbourhood peers of the child are not always affecting the readiness value of the child. The investigation shows that other factors, father occupation, mother academic level, family size and child's position in the family, have got significant influence over the child's performance.

8.9.2 Conclusions

In this chapter, an adapted methodology was presented for the application of data mining techniques to 5 different socio-economic features, trying to discover relevant parameters affect the child readiness.

The results show that the use of methods and data mining techniques are useful for the discovery of knowledge from information available. Clustering tests provided us with relevant information about the attributes that define each group. The classification and association tests supplied information significant of the key attributes that provide information to the knowledge-based rules to be used by the teachers and school.

This study will help the teacher to improve the child's performance, to identify those children who needed special attention to reduce unready induction and take appropriate action at the right time. Also this study will help parents to be aware of individual factors that may cause the child not to do well at school. This is also helpful for school administrators to better plan for better school-friends environment. This is very important information for teachers and parents to know so they can improve the readiness status for the child in these early stages.

Finally, as the next step in this research, the aim is to:

1. Carry out more experiments using more data from different preschools (public, private and missionary) to test whether the same performance results are obtained with different DM approaches.
2. To focus on the school and neighbourhood peers attributes influencing the school readiness.
3. To examine and test more new attributes like: Marital status of parents, Location of kindergarten, Residence location, Care giver and more.

CHAPTER 9: CONCLUSIONS AND FUTURE ENHANCEMENTS

A computerized assessment was created to evaluate the user's readiness for school in a wide variety of tests. The computerized assessment is play-based, hence enables the user to use it without having to go through the assessment feeling he/she's being tested. The true novelty of this computerized assessment is its ability to learn the user behaviour and reuse its history during the test course, this assessment was sequential and the child has no ability to choose the next activity, the child can leave the assessment and return later to continue playing. In Chapter five, the computerized assessment showed a low reliability and did not correlate with preschool teacher assessment nor did it predict the child's achievements in the first grade. So in Chapter six, a computerized assessment was improved to an adaptive web-based assessment (cross-platform stealth assessment) by adding appropriate weights for each of the measured parameters in each skill and adding an adaptation module that not necessarily visible to the child with integrating two fundamentally different types of instructional (or selection): rule-based model and algorithm-based model. In chapter seven, the integration of an online-GA in the adaptive web-based stealth assessment was described as the perfect natural choice to help stake-holders to predict readiness of pre-school children; also, different approaches were investigated to learn the user's performance and improvement, using various learning methods from statistical learning theory. In Chapter eight, it was tried to benefit from some mining algorithms and techniques in order to improve the decision making on child's readiness to go to school, the model provided has the ability to analyze the data associated with children, to predict readiness values based on attributes and to predict missing attribute values based on the knowledge of readiness as well. This analysis and the prediction will largely help to improve child's ability to go to school and will also help teachers to deal with children the best way in order to overcome children's difficulties and bad situations and as a result to improve their abilities.

The research future goal is to expand the proposed model to be applied in different domains such as:

1. It is expected that the reuse of assessed information by learning aids the optimization processes, leading to enhanced features of the integrating modified on-line GA into the stealth assessment as an innovative tool as

presented in Chapter 7. The aim is to enable additive learning capabilities so it can resort to current computational trends in social network, Janus and Offord (2007); Kagan et al. (1995), which can be categorized to unsupervised learning in consideration of noisy environment in assessment processes.

2. The development of a modular, adaptive web-based tutoring framework for preschool skills training considered major design goals, anticipated uses and applications. The design process also considered enhancing one-to-one (individual) and one-to-many (collective or team) training experiences beyond the state of practice for CBTS (computer-based tutoring systems).
3. To propose to improve the classification performance on predicting child readiness through the combination of multiple classifiers and then further improve the classification performance by learning an appropriate weighting of the data features via a Genetic Algorithm (GA), Crespo (2013). It can be presented as two methods for the combination of multiple classifiers (CMC): offline CMC being the simplest and less effective method consists in finding the overall error rate of several individual classifiers and choosing the one with the lowest overall error; and online CMC which interprets every individual classifier's prediction as a vote on a specific class. The class getting the highest number of votes will then be the one used as the final predicted result, Minaei-Bidgoli, Kashy, Kortemeyer, and Punch (2003).
4. The extensive use of information and communication technologies (ICTs) constitutes a fairly new dimension in the study of migration and diasporic communities that has recently begun attracting the attention of scholars from a variety of disciplines and methodologies. This is still very much an under-researched area, particularly regarding the study of the use of ICTs by migrants within the Western countries. Oiarzabal and Reips (2012).
5. The current system can be expanded to cover all levels of education. This will allow the evaluators to follow up closely the development of the skills of various students to determine the factors that could develop higher motivation and enthusiasm to learning as well as the reasons for losing the motivation and hence change in focus students may suffer from.

REFERENCES

English Resources

Abdous, M., He, W. & Cherng-Jyh, Y. (2012). Using Data Mining for Predicting Relationships between Online Question Theme and Final Grade. *Educational Technology & Society.* 15 (3), pp.77-88.

Achenbach System of Empirically Based Assessment™, Available at: http://www.ASEBA.org (Accessed: 2014).

Adams, K. (2006) *The Sources of Innovation and Creativity*, National Center on Education and the Economy.

Adams, M., Forman, B., & Lundberg, A. (In 2001). *Care phonological awareness among children*. 1st ed. Praeger Publishing.

Agarwal, R., Arnold, N., Dowling, T., & Mircheva, B. (2014) Finland: Selected Issues, Washington: International Monetary Fund.

Agarwal, R., Imielinski, T., & Swami, A. (1993). Mining association rules between sets of items in large databases. *ACM SIGMOD International Conference on Management of Data, Washington, DC.*, pp.207-216.

AGS Publishing™ . [ONLINE] Available at: http://www.agsnet.com. [Last Accessed 2013].

Agudo, J. Enrique, S, E., Rico, M., & Dominguez, E. (2007). Second Language Learning at Primary Levels using Adaptive Computer Games. *World Conference on Educational Multimedia, Hypermedia and Telecommunications.* 1 (1), pp.3848-3857.

Agudo, J.E., Sánchez, H. & Sosa, E. (2005). Adaptive hypermedia systems for English learning at Pre-school. *Recent research developments in learning technologies.* , pp.300-304

Aguilar G., Gomez A., & Kaijiri K. (2001). Question model for intelligent questioning systems in engineering education. *Recent research Proceedings of the Frontiers in Education Conference, 2001. – Washington: IEEE Computer Society.* pp.7-12

Aguilar G., Gomez A., & Kaijiri K. (2007). Learners and Knowledge: A New Personalization Factors Perspective for Adaptive Computer-based Assessment Systems. *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications. Chesapeake, VA: AACE.* (), pp.2143-2148

Aguilar G., & Kaijiri K. (2007). Design Overview of an Adaptive Computer-based Assessment System, *Interactive Educational Multimedia*, vol. 14, pp.116-130.

Ahmed B. E. A., & Elaraby I. S. (2014). Data Mining: A prediction for Student's Performance Using Classification Method. *World Journal of Computer Application and Technology.* vol. 2, no. 2, pp. 43-47.

Aldrich, C. (2009). Virtual worlds, simulations, and games for education: A unifying view. *Innovate: Journal of Online education*, vol. 5, no. 5.

Alejandro, P., Rafael D., & José, de J. (2009). Educational data mining: a sample of review and study case. *World Journal on Educational Technology*. vol. 2, pp. 118-139.

Alfonseca, E., Carro R. M., Freire M., Ortigosa A., Perez D., & Rodriguez P. (2005). Authoring of Adaptive Computer Assisted Assessment of Free-text Answers. *Educational Technology & Society*. vol. 8, pp.53-65.

Al-Radaideh, Q., Al Ananbeh, A., & Al-Shawakfa, E. (2011) A Classification Model for Predicting the Suitable Study Track for School Students. *International Journal of Research and Reviews in Applied Sciences, IJRRAS.* vol. 8, no. 2.

Almond, R. G., Steinberg, L. S., & Mislevy, R. J. (2001). *A Sample Assessment Using the Four Process Framework*. (CSE Tech. Rep. 543). Los Angeles: University of California, National Center for Research on Evaluation, Standards, and Student Testing (CRESST).

Al-Radaideh, Q., & Al Nagi, E. (2012). Using Data Mining Techniques to Build a Classification Model for Predicting Employees Performance. *International Journal of Advanced Computer Science and Applications (IJACSA)*, vol. 3, no. 2.

Aluja, T. (2001). La minería de datos, entre la estadística y la inteligencia artificial, *Quaderns d'Estadística Invest. Operat*., vol. 25, no. 3, pp. 479–498.

Anastasi, A. (1990). *Psychological tests*. Open University Press. [Hebrew]

Anastasi, A. & Urbina, S. (1997). *Psychological Testing*. 7th ed. New Jersey: Prentice-Hall. Inc.

Anastasi, J. S., Burns, M. C., Pope, A., Grande, J. R., & Cone, S. (1997). False memories can be distinguished from actual memories. *Poster presented at the 9th Annual Meeting of the American Psychological Society*, May 23-26.

Anastasi, J. S., Coleburn, J. H., Brownlee, K. D., & Cone, S. (1997). Effects of a warning on the misleading post-event suggestibility effect. *Poster presented at* *the 1997 Annual Meeting of the Southeastern Psychological Association*, April 3-6.

Anastasi, J. S., Rhodes, M. G., Carter, J. S., Gaddy, J. R., & Tortorello, T. (1998). False memories: Encoding or retrieval factors? *Poster presented at the 1998 Annual Meeting of the Southeastern Psychological Association*, March 26-29, 1998.

Anastasi, J. S., Rhodes, M. G., & Burns, M. C. (2000). Distinguishing between memory illusions and actual memories utilizing phenomenological measurements and explicit warnings. *American Journal of Psychology*, vol. 100, pp. 1-26.

Anderson, L. W., & Krathwohl, D. R. (2001). *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Addison-Wesley Longman.

Anderson, J. A. (1995). *An Introduction to Neural Networks*. MIT Press Boston.

Anghel, C., & Salomie I. (2003). JADE Based solutions for knowledge assessment in eLearning Environments [Electronic resource] , TILAB & University of Limerick. – http://jade.tilab.com/papers/EXP/Anghel.pdf – 03.10.2008.

Araque, F., Roldán, C., & Salguero, A. (2009). Factors influencing university drop out rates, *Computers & Education*., vol. 53, no. 3, pp. 563–574.

Alzoubi, O., Fossati, D., Eugenio, B. D., Green, N. & Chen, L. (2011). Predicting Students' Performance and Problem Solving Behavior from iList Log Data. *ICCE 2013, 21st International Conference on Computers in Education*. Bali, Indonesia, November 2013.

Asmal, K. (2001). Address by Professor Kader Asmal, MP, Minister of Education, at the launch of the White Paper for *Early Childhood Development and the Nation-wide audit of ECD provisioning in South Africa*, Pretoria, 28 May 2001. Pretoria: Sol Plaatje House.

Assessment Reform Group (2002). Assessment for learning: 10 principles. Research based principles to guide classroom practice [online]. Available: http://methodenpool.uni-koeln.de/benotung/assessment_basis.pdf.

Assing, R. (1998). BASC Parent Rating Scale (Spanish translation): Validity study. Paper presented at the Annual Meeting of *the American Psychological Association* (San Francisco, August, 1998).

Athey, I. (1984). Contributions of play and development. In T.D. Hawkey & A.D. Pellegrini (Eds.), Child's Play: Development and Applied (pp. 9-28). Hillsdale, NJ: Erlbaum.

Atmore, E. (2007). Update on Early Childhood Development in South African and Implication for non-profit organisations. Paper presented at *Ntataise Conference, vanderBijlpark*, 20 August 2007.

Attwell, G., & Hughes, J. (2010) *Pedagogic Approaches to Using Technology for Learning*, UK: LLUK publication.

Ayers, E., Nugent, R., & Dean, N. (2009). A pilot study on logic proof tutoring using hints generated from historical student data. Paper presented at the 2nd International Conference on *Educational Data Mining (EDM'09)*, Cordoba, Spain.

Bachour, N., Hoteit, F., Mukalid, S., & Sleem, M. (2002). Preschool Education in Lebanon. Beirut, Lebanon: *Lebanese Association for Educational Studies*.

Back, T. (1996) *Evolutionary Algorithms in Theory and Practice*, New York: Oxford.

Badian, N. A., McAnulty, G. B., Duffy, F. H., & Heidelise, A. (1990). Prediction of dyslexia in kindergarten boys. *Annals of Dyslexia*, Vol. 40, Issue 1, pp. 152-169.

Badian, N.. (1984). Reading Disability in an Epidemiological Context: Incidence and Environmental Correlates. *Journal of Learning Disability*. March 1984, Vol. 17, No. 3, pp. 129-136, doi:10.1177/002221948401700301.

Baker, R. (2010). Data Mining for Education. To appear in McGaw, B., Peterson, P., & Baker, E. (Eds.) *International Encyclopaedia of Education* (3rd edition). Oxford, UK: Elsevier.

Baker, R., & Yacef, K. (2009). The State of Educational Data Mining in 2009: A Review and Future Visions. *Journal of Educational Data Mining*, Article 1, Vol. 1, No 1.

Barker, R. (ed) (2009). *Making Sense of Every Child Matters -- Multi-professional practice guidance*. Policy Press.

Barnes, T., Desmarais, M., Romero, C., & Ventura, S. (2009). Educational Data Mining 2009: *2nd International Conference on Educational Data Mining*, _Proceedings. Cordoba, Spain

Barnes, T., Stamper, J., Lehman, L., & Croy, M. (2008). A pilot study on logic proof tutoring using hints generated from historical student data. Paper presented at the *1st International Conference on Educational Data Mining* (EDM'08), Montreal, Canada.

Barnett, W. S. (2007). Early education: A sound public investment. Paper presented at the 2007 *Tennessee Early Childhood Summit*. Retrieved October 4, 2007, from http://www.state.tn.us/education/prek/documents/Early_ED_Invest.pdf.

Barnett, W. S. & Hustedt, J. T. (2005) 'Head Start's Lasting Benefits', Infants & Young Children, 18(1), pp. 16-24.

Barr, D. (2004). *ICT - Integrating Computers in Teaching: Creating a Computer-Based Language-Learning Environment*. Peter Lang. Oxford. 240 pp ISBN 978-3-03910-191-7 [Book (authored)].

Barros, R. P., & Mendonça, R. (1999). *Costs and Benefits of Preschool Education in Brazil*. Rio de Janeiro: Institute of Applied Economic Research.

Bayer, Jaroslav, Bydžovská, H., Géryk, J., Tomáš Obšívač, T., & Popelínský, L. (2012). Predicting drop-out from social behaviour of students. In Kalina Yacef, Osmar Zaïane, Arnon Hershkovitz, Michael Yudelson and John Stamper. Proceedings of the *5th International Conference on Educational Data Mining* - EDM 2012. Greece: www.educationaldatamining.org, 2012. s. pp. 103 - 109, 7 s. ISBN 978-1-

BBC News (2012) Finland country profile, Available at:http://news.bbc.co.uk/2/hi/south_asia/country_profiles/1023629.stm (Accessed: 6 February 2012).

Becker, L. A. & Seshadri, M. (2003). GP-evolved Technical Trading Rules Can Outperform Buy and Hold, in *3rd International Workshop on Computational Intelligence in Economics and Finance*. Retrieved from: http://digitalcommons.wpi.edu/computerscience-pubs/147.

Beentjes, J. W. J., Koolstra, C. M., Marseille, N. & Van der Voort, T. H. (2001) Children's Use of Different Media: For How Long and Why? In: Livingstone, S. & Bovill, M. (Eds.), Children and Their Changing Media Environment (pp. 85-111). A European Comparative Study. Mahwah, NJ & London: Lawrence Erlbaum Associates.

Behrouz, M., Bidgoli, N. (2012) Case Study: Data Mining of Associate Degree Accepted Candidates by Modular Method. *Communications and Network*, Vol. 4, pp. 261-268.

Bensky, M. (1992). Predicting student achievement in first grade - kindergarten readiness according to: Group readiness test and teacher assessments. Thesis for a master's degree, University of Haifa. [Hebrew]

Bergen, J. R., Sladeczek, I. E., Schwarz, R. D., & Smith, A. N. (1991). Effects of a measurement and planning system on kindergartners' cognitive development and educational programming. *American Educational Research Journal*, Vol. 28, No. 3, pp. 683–714

Berger, L., et al. (2008). First-year maternal employment and child outcomes: Differences across racial and ethnic groups, *Children and Youth Services Review,* Vol. 30, pp. 365-387.

Berk, L. E. (2006) *Child Development*, Boston: Allyn & Bacon.

Bertram, A. & Pascal, C. (1999). *The OECD thematic review of early childhood education and care: Background Report for the United Kingdom*. Worcester: Centre for Research in Early Childhood.

Bertram, A. D. & Pascal, C. (2002). Early Years Education: An International Perspective ,Centre for Research in Early Childhood, Birmingham.

Bertram, A. D. & Pascal, C. (2002) International Review of Early Years Curriculum and Assessment, QCA, NFER, London.

Bertram, A. D. & Pascal, C. (2000) OECD UK Thematic Review of Early Childhood Background Paper, DfEE, London.

Bertram, A. D., & Pascal, C., Bokhari, S, Holtermann, S., John, K., & Nelson, C. (2003) Evaluation of Early Excellence Centre Pilot Programme, DfES, London.

Bertram, T., & Pascal, C. (2002). What counts in early learning. In Contemporary perspectives in early childhood curriculum, eds. O.N. Saracho & B. Spodek, pp. 241–56. Greenwich, CT: Information Age.

Bhanu, B., Lee, S., & Ming, J. (1991) 'Self-optimizing image segmentation system using a genetic algorithm', In R. K. Belew and L. B. Booker, editors, *Proceedings of the Fourth International Conference on Genetic Algorithms and Their Applications*, San Mateo, CA, pp. 362-369.

Binder, J., Koller, D., Russell, S., & Kanazawa, K. (1997). *Adaptive probabilistic networks with hidden variables. Machine Learning*.

Birrell, H. V., Phillips, C. J., & Stott, D. H. (1985). Learning style and school attainment in young children. *School Psychology*, Vol. 6, No. 4, pp. 207-218.

Black, M. & Powell, D. (2004). *Commonly used Assessment and Screening Instruments*. HIPPY USA.

Black, P. & Wiliam, D. (1998). *Inside the black box: raising standards through classroom assessment* (London: School of Education, King's College).

Black, P. & Wiliam, D. (1998a). Assessment and classroom learning. *Assessment in Education: Principles, Policy, and Practice*, Vol. 5, No. 1, pp. 7–74.

Black, P. & Wiliam, D. (1998b). *Inside the black box: Raising standards through classroom assessment*. London: School of Education, King's College.

Blair, C. (2002). School readiness. Integrating cognition and emotion in a neurobiological conceptualization of children functioning at school entry. *American Psychologist*, Vol. 57, No. 2, pp. 111-127.

Bloom, B. S. (1956). *Taxonomy of educational objectives. Handbook I: The cognitive domain.* – New York: David McKay Co Inc., – P.207.

Blum, M. S. (1969). Alarm pheromones. *Annual Review of Entomology*. Vol. 14, No. 1, pp. 57–80.

Bouckaert, R. R., Frank, E., Hall, M., Kirkby, R., Reutemann, P., Seewald, A., & Scuse, D. (2013). WEKA Manual for Version 3-7-10. University of Waikato, Hamilton, New Zealand.

Boyer, E. L. (1991). *Ready to learn: A mandate for the nation*. Princeton, NJ: The Carnegie Foundation for the Advancement of Teaching.

Bracken, P., & Thomas, P. (2000) Cognitive therapy, Cartesianism and the moral order. *European Journal of Psychotherapy, Counselling and Health,* Vol. 2, No. 1 pp. 325-344.

Bracken, B. A. (2006). *The Bracken Basic Concept Scale*– Third Edition: Receptive (BBCS-3:R). San Antonio, Texas: Harcourt Assessment, Inc.

Brady, E. & Hill, S. (1987) Young children and microcomputers. *Young Children*, Vol. 39, pp. 49–61.

Bransford, J., Brown, A. L., & Cocking, R. R. (2000). *How people learn: Brain, mind, experience, and school* (expanded ed.). Washington, DC: National Academies Press.

Bricker, D. & Squires, J. (1999). *Ages & Stages Questionnaires®*, Second Edition (ASQ®-2). Baltimore, MD: Brookes Publishing Co. Brigance, A. H., (2005).

Bridgeland, J. M., DiIulio Jr., J. J. & Morison, K. B. (2006). *The Silent Epidemic: Perspectives of High School Dropouts*. Washington, DC: Civic Enterprises and Peter D. Hart Research Associates.

Brigance, A. H. (2005). *BRIGANCE® Preschool Screen-II. North Billerica*, MA: Curriculum & Associates, Inc.

BRIGANCE® Early Preschool Screen-II. North Billerica, MA:Curriculum & Associates, Inc.

Brizuela, L. E. A. (2010). *Hispanic Preschoolers' School Readiness: A Study Examining the Impact of Cultural, Social-Emotional, and Socio-demographic Factors*. Ph.D. Thesis, Texas A&M University.

Brooker, L., & Woodhead, M. (2008) *Developing Positive Identities*, Milton Keynes, United Kingdom: Child and Youth Studies Group, The Open University.

Brooks-Gunn, J., & Duncan, G. J. (1997). The effects of poverty on children. *The Future of Children*, Vol. 7, No. 2, pp. 55-71.

Brooks-Gunn, J., Han, W. J., & Waldfogel, J. (2002). Maternal employment and child cognitive outcomes in the first three years of life: The NICHD study of early child care. *Child Development*, Vol. 73, No. 4, pp. 1052-1072.

Brooks-Gunn, J., Rouse, C. E., & McLanahan, S. (2007). 'Racial and Ethnic Gaps in School Readiness', Ch. 12 in *School Readiness and the Transition to Kindergarten in the Era of Accountability*, edited by Robert C. Pianta, Martha J. Cox and Kyle L. Snow, Brookes Publishing, Baltimore, Md., pp. 283–306.

Brophy, J. (2006). *Grade repetition*. (pp. 1–33). Paris, France.

Brougère, G., Guénif-Souilamas, N., & Rayna, S. (2008). Ecole maternelle (preschool) in France : A Cross Cultural Perspective, *European Early Childhood Education Research Journal*, Vol. 16, No.3, pp. 371-384.

Bruner, J. S. (1961). The act of discovery. *Harvard Educational Review*, Vol. 31, No. 1, pp. 21–32.

Brusilovsky, P., & Peylo, C. (2003). Adaptive and Intelligent Web-based Educational Systems // *International Journal of Artificial Intelligence in Education*. – Vol. 13, pp. 156-169.

Brusilovsky, P., & Miller, P. (2001) 'Course Delivery Systems for the Virtual University'. In: Della Senta, T., Tschang, T. (eds.): Access to Knowledge: *New*

Information Technologies and the Emergence of the Virtual University, pp. 167-206. Elsevier Science, Amsterdam.

Brusilovsky, A. & Vassileva, J. (eds.): *Adaptive Hypertext and Hypermedia* (pp. 1-43). Dordrecht: Kluwer Academic Publishers.

Brusilovsky, P. (1998). *Methods and techniques of adaptive hypermedia*. In: P.

Brusilovsky, P. (2001). Adaptive hypermedia. *User Modeling and User Adapted Interaction,* Vol. 11, No. 1/2, pp. 87-110, Ten Year Anniversary Issue (Alfred Kobsa, ed.).

Bull J. (2003). *Introduction to computer-assisted assessment*. [ONLINE] Available at: http://asp2.wlv.ac.uk/celt/download.asp?fileid=44&detailsid=200008. [Last Accessed 05.05.2006].

Buckingham, D. (2008) Youth, Identity, and Digital Media, Cambridge: The MIT Press.

Buntaine, R. & Costenbader, V. (1997). The effectiveness of a transitional prekindergarten program on later academic achievement. *Psychology in the Schools*, Vol. 34, No. 1, pp. 41-49.

Burstein, J., Leacock, C., & Swartz, R. (2001). *Automated Evaluation of Essays and Short Answers*. [ONLINE] Available at: http://caaconference.co.uk/pastConferences/2001/proceedings/a.pdf.

Butler, M., Retzlaff, P., & Vanderploeg, R. (1991). Neuropsychological test usage. *Professional Psychology: Research and Practice*, Vol. 22, pp. 510–512.

Campbell, E., Schellinger, T., & Beer, J. (1991). Perceptual and Motor Skills, Vol. 73, No. 3, Part 1, pp. 859-862.

Canadian Task Force on the Periodic Health Examination (1994). The Canadian Guide to Clinical Preventive Health Care. Ottawa: Minister of Supply and Services Canada. Chapter 26 "Preschool Screening for Developmental Problems".

Carlton, M. P., & Winsler, A. (1999). School readiness: The need for a paradigm shift. *School Psychology Review*, Vol. 28, No. 3, pp. 338-352.

Carlton, M. P. (1999). Motivation and school readiness in kindergarten children. *Dissertation Abstracts International*, Vol. 60, No. 11-A, 3899A.

Carvalho, M., & others. (2011). "Validating a Brazilian version of the ASQ-3." Draft report.

Casey, G. & Evans, T. (2011). Designing for learning: online social networks as a classroom environment, *International review of research in open and distance learning*, Vol. 12, No. 7, pp. 1-26.

Cassidy, D., Mims, S., Rucker, L., & Boone, S. (2003). Emergent curriculum and kindergarten readiness. *Childhood Education,* Vol. 79, No. 4, p. 194.

Castro, F., Vellido, A., Nebot, A., & Mugica, F. (2007). Applying Data Mining Techniques to e-Learning Problems. In: Jain, L.C., Tedman, R. and Tedman, D. (eds.) Evolution of Teaching and Learning Paradigms in Intelligent Environment. Studies in Computational Intelligence, 62, Springer-Verlag,, pp. 183-221.

Chambers, L. (2000) *The Practical Handbook of Genetic Algorithms: Applications*, 2nd Edition. CRC Press.

Chan, K. C., Andrew, G., & Francis A. (1992). Anthony Sanders, B.. The Journal of Finance , Vol. 47, No. 3, Papers and Proceedings of the Fifty-Second Annual Meeting of the American Finance Association, New Orleans, Louisiana January 3-5, 1992. pp. 1209-1227.

Channon, A. D., & Damper, R. I. (2000). Towards the evolutionary emergence of increasingly complex advantageous behaviours, *International Journal of Systems Science*, Vol. 31, No. 7, pp 843-860.

Chapel Hill Training-Outreach Project Inc. - http://www.chtop.org

Chew, A. L. & Morris, J. D. (1989) Predicting later academic achievement from kindergarten scores on the metropolitan readiness tests and lollipop test. *Educational and Psychological Measurement*, Vol. 49, pp. 461-465.

Chih-Fong, T., Ching-Tzu, T., Chia-Sheng, H., & Po-Sen, H. (2011). Data mining techniques for identifying students at risk of failing a computer proficiency test required for graduation. *Australasian Journal of Educational Technology*, Vol. 27, No. 3, pp. 481-498.

Chih-Ming, C., Ying-Ling, H., & Shih-Hsun, H. (2007) Mining learner profile utilizing association rule for web-based learning diagnosis. *Expert Systems with Applications*. Vol. 33, pp. 6–22.

Chinn, C. A. (2011) Educational Psychology: Understanding Students' Thinking, : Rutgers University.

Choi, S. (2007). UNESCO Education Sector, The Division for the Promotion of Basic Education. (2006). Policy review report: early childhood care and education in brazil (N° 13 – 2007). Retrieved from UNESCO Education Sector website: http://unesdoc.unesco.org/images/0015/001512/151271e.pdf

Chong, H., DiGangi, S., Jannasch-Pennell, A., & Kaprolet C. (2010). A Data Mining Approach for Identifying Predictors of Student Retention from sophomore to Junior Year. *Journal of Data Science*, Vol. 8, pp. 307-325.

Cicchetti, D. & Toth, S. L. (1997). Transactional ecological systems in developmental psychopathology. In. Luthar, S. S, Burack, J. A. Cicchetti, D., & Weiss, J. R. (Eds.)

Cicchetti, D., & Valentino, K. (2006). Toward the application of a multiple-levels-of-analysis perspective to research in development and psychopathology. In A. Masten (Ed.), *Minnesota Symposia on Child Psychology*, Vol. 32. Mahwah, NJ: Erlbaum.

Clements, D. H., Nastasi, B. K., & Swaminathan, S. (1993). Young children and computers: Crossroad and direction from research, *Young Children*, Vol. 48, pp. 56-64.

Clements, D. H. & Gullo, D. F. (1984). Effect of computer programming on young children's cognition. *British Journal of Educational Psychology*, Vol. 76, pp. 1051–1058.

Clements, D. H. (1994). The uniqueness of the computer as a learning tool: insights from research and practice. In: Wright, J.L. & Shade, D.D. (Eds.). *Young Children: Active Learners in a Technological Age*, (pp. 31–49). Washington, DC: National Association for the Education of Young Children.

Clements, D. H. (2002). Computers in early childhood mathematics. *Contemporary Issues in Early Childhood*, Vol. 3, pp.160–181.

Cleveland, G. A., & Smith, S. F. (1989) 'Self-optimizing image segmentation system using a genetic algorithm', In J. D. Schaffer, editor, *Proceedings of the Third International Conference on Genetic Algorithms and Their Applications*, San Mateo, CA, pp. 160-169.

Cohen, E. & Gumpel, T. (2000) "School readiness: Perceptions of the concept and their implications". The N.C.J.W Institute for the Advancement of Research in Education, Jerusalem: The Hebrew University. [Hebrew].

Coley, R. J. (2002). *An uneven start: Indicators of inequality in school readiness*, Available at: http://www.ets.org/Media/Research/pdf/PICUNEVENSTART.pdf (Accessed: April 5, 2009).

Computer adaptive assessment [Electronic resource] / Castle Rock Research Corp., (2005). –http://www.castlerockresearch.com/caa/Default.aspx – 01.10.2008.

Computer aided assessment-the pros and cons [Electronic resource] (2000). / The Learning Technology Development Unit, Learning and Information Services,– http://www.herts.ac.uk/ltdu/learning/caa_procon.htm – 10.12.2007.

Computer Assisted Assessment: The future, right here, right now [Electronic resource] / SQA, 2004. http://www.sqa.org.uklfiles_ccc/Computer_Assisted_Assessment_article.pdf 03.10.2008

Computer-assisted assessment. (2004). Using computers to design and deliver objective tests [Electronic resource] – http://etudeedl.free.fr/annexes/assess.pdf – 03.10.2008.

Condron, D. J., & Start, A. E. (2008). Skill Grouping and Unequal Reading Gains in the Elementary Years, *The Sociological Quarterly*, Vol. 49, pp. 363-394.

Connell, C. M. (2001). The relationship between parental behaviors, academic readiness and social skills development in at-risk kindergarten students. *Dissertation Abstracts International*, Vol. 62, No. 2, 1072B. (UMI No. 3006016)

Cordes, C., & Miller, E. (Eds) (2000). *Fool's Gold: A Critical Look at Computers in Childhood*. College Park. MD: Alliance for Childhood.

Cost, Quality, & Child Outcomes Study Team. (1995). *Cost, quality, and child outcomes in child care centers, public report* (2nd ed.). Denver: Economics Department, University of Colorado at Denver.

The Council of Economic Advisers (2014) The War on Poverty 50 Years Later: A Progress Report, Available at: http://www.whitehouse.gov/sites/default/files/docs/50th_anniversary_cea_report_-_final_post_embargo.pdf.

Cramer, N. L. (1985) A representation for the adaptive generation of simple sequential programs ', In J. D. Schaffer, editor, *Proceedings of the First International Conference on Genetic Algorithms and Their Applications*. Erlbaum.

Crespo, P. (2013). *Social networks exploration for educational data mining*. Tecnico Lisboa.

Crick, N., & Dodge, K. A. (1994). A review and reformulation of social-information processing mechanisms in children's social adjustment. *Psychological Bulletin*, Vol. 115, pp. 74-101.

Crnic, K., & Lamberty, G. (1994). Reconsidering school readiness: Conceptual and applied perspectives. *Early Education and Development*. Vol. 5, No. 2, pp. 91–105;

Csikszentmihalyi, M. (1990). *Flow: The psychology of optical experience*. New York: Harper Perrennial.

CURRICULUM ASSOCIATES®, Incorporated - http://www.curriculumassociates.com

Currie, J., & Thomas, D. (1996). Does Head Start help Hispanic children? Labor and population program, working paper series 96-17 (Report No. DRU-1528-RC). Bethesda, MD: National Institute of Child Health and Human Development. (ERIC Document Reproduction Service No. 404008).

D'Mello, S., Picard, R., & Graesser, A. (2007). Toward an affect-sensitive AutoTutor // *IEEE Intelligent Systems*.- Vol. 22, No. 4, pp.53-61.

Darwin, C. (1859). *The Origin of Species*, John Murray, London.

David, H. (1999). *Adaptive Learning by Genetic Algorithms: Analytical Results and Applications to Economic Models*, Springer Verlag.

David, W. (2002). *Wechsler Preschool and Primary Scale of Intelligence™ - Third Edition (WPPSI™–III)*. San Antonio, Texas: The Psychological Corporation.

Davis, M. (1983). Measuring individual differences in empathy: Evidence for a multidimensional approach. *Journal of Personality and Social Psychology*, Vol. 44, pp. 113–126.

Dede, C. (2005). Planning for Neomillennial Learning Styles. *EDUCAUSE Quarterly* 28, No. 1, pp. 7–12.

De Jong, K. A. (1975) *An Analysis of the Behavior of a Class of Genetic Adaptive Systems*. Ph.D. dissertation, University of Michigan.

De Jong, K. A. (1988) Learning with genetic algorithms: an overview. *Machine Learning*, Vol. 3, No. (2/3), pp. 121-138.

Dekker, G., Pechenizkiy, M. & Vleeshouwers, J. (2009). Predicting Students Drop Out: A Case Study. *Educational Data Mining*.

Dempster, A., Laird, N., & Rubin, D. (1977). Maximum likelihood from incomplete data via the EM algorithm. *Journal of the Royal Statistical Society*, Vol. 39, No. 1, pp. 1–38.

Denham, S. (2005). Assessing social-emotional competences in children from a longitudinal perspective. Prepared for the *National Children's Study*, Contract no. 282-98-0019.

Denham, S. (2006). Social-emotional competence as a support for school readiness: what is it and how to assess it? *Early Education Development*, Vol. 17, No. 1, pp. 57-89.

Dennebaum, J., Kulberg, M., & Janet M. (1994). Kindergarten retention and transition classrooms: Their relationship to achievement. In *Psychology in the Schools*. Vol. 31, Issue 1, pp. 5–12

Denver Developmental Materials, Incorporated - http://www.denverii.com

Department for Education and Skills (2004). A National Conversation about Personalised Learning [online]. (Available: www.standards.dfes.gov.uk/personalisedlearning)

Department for Education and Skills (2006). 2020 Vision: The Report of the Teaching and Learning in 2020 Review Group. [The Gilbert Report] [online] (Available: http://webarchive.nationalarchives.gov.uk/20130401151715/https://www.education.gov.uk/publications/eOrderingDownload/6856-DfES-Teaching%20and%20Learning.pdf)

Department of Education, Department of Social Development, Department of Health & UNICEF. (2005). National Integrated Plan for Early Childhood Development in South Africa: 2005-2010 (Draft Document). Pretoria: Government of South Africa.

Designing Test Questions [Electronic resource] (1998). The University of Tennessee at Chattanooga. – http://www.utc.edu/Administration/WalkerTeachingResourceCenter/FacultyDevelopment/

Desmarais, M., & Baker, R. (2012). A review of recent advances in learner and skill modeling in intelligent learning environments. *User Modeling and User-Adapted Interaction*, Vo. 22, No. 1-2, pp. 9-38.

Developmental psychopathology: *Perspectives on adjustment, risk and disorder* (pp. 317-349), New York. Cambridge University Press.

Devereux Early Childhood Initiative – http://www.devereuxearlychildhood.org

DiCerbo, K., & Behrens, J. (2012). Implications of the Digital Ocean on Current and Future Assessment. In Computers and Their Impact on State Assessment: Recent History and Predictions for the Future, ed. R. Lissitz and H. Jiao, pp. 273–306. Charlotte, NC: Information Age Publishing.

Dodge, K., Laird, R., Lochman, J., Zelli, A. & Conduct Problems Prevention Research Group, (2002). Multidimensional latent-construct analysis of children's social information processing patters: Correlations with aggressive behavior problems. *Psychological Assessment*, Vol. 14, pp. 60-73.

Donald, A., & Stenner, A. (2005). Assessment Issues in the Testing of Children at School Entry, *The Future of Children*, Vol. 15, No. 1, pp. 15-34.

Donker, A., & Reitsma, P. (2007). Young children's ability to use a computer mouse. Computers and Education. Vol. 48, No. 4, pp. 602–617

Dorigo, M., & Schnepf, U. (1993). Genetics-based Machine Learning and Behaviour Based Robotics: A New Synthesis, *IEEE Transactions on Systems, Man and Cybernetics,* Vol.23, No.1, pp. 141-154.

Duncan, G. J., et al., (2007). School readiness and later achievement, *Developmental Psychology*, Vol. 43, No. 6, pp. 1428-1446.

Duncan, G. J., & Magnuson, K. A. (2005). Can family socioeconomic resources account for racial and ethnic test score gaps? *The Future of Children*, Vol. 15, No. 1, pp. 35-54.

Dyer-Witheford, N., & de Peuter, G. (2009) Games of Empire Global Capitalism and Video Games , Minneapolis: University of Minnesota Press.

Early, D., Maxwell, K. L., Burchinal, M., Bender, R. H., Ebanks, C., Henry, G. T., Howes, C., Iriondo-Perez, J., Jeon, H.J., Mashburn, A.J., Peisner-Feinberg, E., Pianta, R.C., Vandergrift, N., & Zill, N. (2007). Teachers' education, classroom quality, and young children's academic skills: Results from seven studies of preschool programs. *Child Development*, Vol. 78, No. 2, pp. 558-580

Edgar, P. & Edgar, D. (2008) *The New Child in search of smarter grown-ups*, Melbourne: Wilkinson Publishing Pty Ltd.

Elizabeth Love Inner East Community Health Service. (2003). School readiness and early literacy. *Love and Reilly*, Vol. 7, pp. 1-7.

Elkind, D. (1987) The child, yesterday, today and tomorrow. *Young Children*, Vol. 42, pp. 6–11.

Ellingsen, K., M., Burch-Lewis, A., & Pham, A. (2012). Learning and Applying Knowledge (d, ICF-CY) In Annette Majnemer (Ed.) Measures of outcomes and their determinants for children and youth with developmental disabilities.

Erfan, A. S. Z., & Hakeem, B. M. H. (2014) 'Effect of using the Kinetic Computerized Story with Sign Language on Social Interaction and Some of the Basic Kinetic Skills of Deaf and Dumb Students', *Science, Movement and Health*, Vol. 14, No. 1, pp. 5-13.

Escobedo, T. H., & Bharoava, A. (1991). A study of children's computer-generated graphics. *Journal of Computing in Childhood Education*, Vol. 3, No. 1, pp. 15-30.

Eshel, I., & Bensky, M. (1995). Test readiness and teacher assessment of the achievements and forecasters estimate a school teacher: what the child's success in predicting the grade? Trends, thirty-six (4), pp. 464-451. [Hebrew]

Evans, G. (1977). Pronouns, Quantifiers, and Relative Clauses (I) , *Canadian Journal of Philosophy*, Vol. 7, No. 3, p. 46.

Evans, D. & Kosec, K. (2012) Early Child Education: Making Programs Work for Brazil's Most Important Generation, Washington: World Bank Publications.

Falakmasir, M., H. & Habibi, J. (2010). *Using Educational Data Mining Methods to Study the Impact of Virtual Classroom in E-Learning*.

Falmagne, J. C., Cosyn, E., Doignon, J. P., & Thiery, N. (2003). The assessment of knowledge, in theory and in practice. In R. Missaoui & J. Schmid (Eds.), ICFCA, Vol. 3874 of *Lecture Notes in Computer Science*, pp. 61–79. Springer.

Faour, B. (2003). *Early childhood teachers in Lebanon: Beliefs and practices*. Unpublished doctorate thesis. University of Leicester, England.

Faour, B., Hajjar, Y., Bibi, G., Chehab, M., & Zaazaa, R. (2006) Comparative, regional analysis of ECCE in four Arab countries (Lebanon, Jordan, Syria, and Sudan),Available at:http://www.mawared.org/sites/default/files/comparative_regional_analysis_of_ecce_in_four_arab_countries.pdf.

Faria, A. M. (2009). *Peer Interactions and School Readiness in Head Start Children: Physical Aggression, Relational Aggression, and Pro-social Behavior*. Ph.D. Thesis. University of Miami.

Farkas, G., & Hibel, J. (2008). Being unready for school: Factors affecting risk and resilience In A. Booth & A. Crouter (Eds.), Disparities in School Readiness: How families contribute to transitions into school (pp. 3-28). New York: Lawrence Erlbaum Associates.

Farran, D. C. (2000). Another decade of intervention for children who are low income or disabled: what do we know now? In J. Shonkoff & S. Meisels (Eds.), Handbook of early intervention, second edition (pp. 510–548). Cambridge, England: Cambridge University Press.

Farran, D. C., & Son-Yarbroug, W. (2001). Title I funded preschools as a developmental context for children's play and verbal behaviors. *Early Childhood Research Quarterly*, Vol. 16 , pp. 245–262.

Farver, J. A. M., Xu, Y., Eppe, S., & Lonigan, C. J. (2006). Home environments and young Latino children's school readiness. *Early Childhood Research Quarterly*, Vol. 21, No. 2, pp. 196-212.

Fayyad, U., Piatetsky-shapiro G., & Smyth. P. (1996). From Data Mining to Knowledge Discovery in Databases. *American Association for Artificial Intelligence*, Vol. 17, pp. 37-54.

Feinstein, L. (2003). Inequality in the Early Cognitive Development of British Children in the 1970 Cohort, *Economica*, Vol. 70, No. 277, pp. 73-97.

Fernald, L., Kariger, P., Engle, P., & Raikes, A. (2009). *Examining Early Child Development in Low-Income Countries: A Toolkit for the Assessment of Children in the First Five Years of Life*. Washington DC: The World Bank.

Feurstein, R. et al. (2003). *The Dynamic Assessment of Cognitive Modifiability*, Jerusalem: ICELP Press.

Feurstein, R., Rand, Y., Hoffman, M., & Miller, R. (1980). *Instrumental Enrichment: An Intervention Program for Cognitive Modifiability*, Baltimore, MD: University Park Press.

Fewell, R. R., & Kaminski, R. (1988). Play skills development and instruction for young children with handicaps. In S. L. Odom & M. B. Karnes (Eds.), Early intervention for infants and children with handicaps (pp. 145-158). Baltimore: Paul H. Brookes.

Fink, B. R. (1976). *Evolution of laryngeal folding. In Origins and Evolution Of Language and Speech* (ed. H.Steklis, S.Harnad & J.Lancaster). Annals Of the New York Academy of Sciences (in the Press).

Finnish National Board of Education (2004a) PISA –survey, Finnish schools, teacher training and math. education, Available at: http://www.oph.fi/english/page.asp?path=447,488,42774 (Accessed: 2 August, 2005).

Finnish National Board of Education (2004b) National Core Curriculum for Basic Education, Available at:http://www.oph.fi/download/47674_core_curricula_basic_education_5.pdf

Finnish National Board of Education (2012) Basic education, Available at:http://www.oph.fi/english/curricula_and_qualifications/basic_education.

Finnish Ministry of Education (2006) Education and Science in Finland , Available at:http://www.minedu.fi/export/sites/default/OPM/Julkaisut/2006/liitteet/eng_opm15.pdf?lang=fi.

Fogel, D.B. (2000). *Evolutionary Computation: Towards a New Philosophy of Machine Intelligence*, IEEE Press.

Fogel, L. J., Owens, A. J., & Walsh, M. J. (1966) *Artificial Intelligence Through Simulated Evolution*, New York: John Wiley & Sons.

Fowler, M., & Cross, A. (1986). Preschool risk factors as predictors of early school performance. Journal of Developmental and Behavioral Pediatrics, Vol. 7, No. 4, pp. 237-241.

Frankenburg, W. K., Dodds, J., Archer, P., Shapiro, H., & Bresnick, B. (2005). *Denver Developmental Screening Test, Second Edition* (DDST-R). Denver, CO: Denver Developmental Materials, Inc.

French, G. (2007) *Children's early learning and development: A research paper*, Dublin: NCCA.

Frezzo, D. C., Behrens, J. T., & Mislevy, R. J. (2009). Design patterns for learning and assessment: facilitating the introduction of a complex simulation-based learning environment into a community of instructors. *The Journal of Science Education and Technology*. Springer Open Access http://www.springerlink.com/content/566p6g4307405346/Friedman, T. (2005).

The World Is Flat: A Brief History of the Globalized World in the Twenty-First Century. London: Allen Lane.

Fujiki, C. & Dickinson, J. (1987) Using the genetic algorithm to generate Lisp source code to solve the Prisoner's dilemma', In J. J. Grefenstette, ed, *Proceedings of the First International Conference on Genetic Algorithms and Their Applications*. Erlbaum.

Furstenberg, F., & Hughes, M. (1997) The influence of neighbourhoods on children's development: a theoretical perspective and a research agenda. In J Brooks-Gunn, G Duncan and J Aber (eds.) Neighbourhood Poverty Volume 2: Policy Implications in Studying Neighbourhoods.New York:Russell Sage Foundation.

Gage, N. L., & Berliner, D. C. (1998). *Educational psychology*. Boston: Houghton Mifflin Company.

García, E., Romero, C., Ventura, S., & Castro, C. (2009). An architecture for making recommendations to courseware authors using association rule mining and collaborative filtering. *Journal for User Model and User Adapted Interaction*, Vol. 19, No. 1-2, pp. 99-132.

Gatenio-Gabel, Shirley, K., & Sheila B. (2007). Early Childhood Education and Care in the United States: An Overview of the Current Policy Picture *International Journal of Child Care and Education Policy*, Vol. 1, No.1, pp. 23-34.

Geary, D. C. (2006*). Development of mathematical understanding*. In D. Kuhl & R. S. Siegler (Vol. Eds.), Cognition, perception, and language, Vol 2 (pp. 777-810). W. Damon (Gen. Ed.), Handbook of child psychology (6th Ed.). New York: John Wiley & Sons.

Geary, D. C. (Ed.) (2006). Evolutionary developmental psychology. *Developmental Review*, Vol. 26 (special issue, pp. 113-276).

Gee, J. & Shaffer, D. (2010). *looking where the light is bad: video games and the future of assessment,* Madison: university of wisconsin-Madison. Available at: http://epistemicgames.org/eg/looking-where-the-light-is-bad [Accessed June 23, 2010].

Gee, J. P. (2003). *What video games have to teach us about learning and literacy*. New York: Palgrave Macmillan.

Gee, J. P., Hull, G. A., & Lankshear, C. (1996). *The New Work Order: Behind the Language of the New Capitalism*. St Leonards, Australia: Allen and Unwin.

General CAA topics [Electronic resource] (2002). /Web-based assessment (CAA) Centre – http://www. caacentre.ac.uk – 01.10.2008.

Georgouli, K. (2008). Adapting Assessment Goals to the Child's Profile [Electronic resource] / T.E.I. of Athens. – http://www.emis.de/journals/AUA/acta7/Georgouli.pdf – 03.10.2008.

Gergely, G. & Watson, J. S. (1996). The social biofeedback theory of parental affect-mirroring: The development of emotional self awareness and self-control in infancy. *International Journal of Psycho-analysis*, Vol. 77, pp. 1181-1212.

Gesell, A., & Ilg, F. (1966). *The Child from Five to Ten*. (From the Former Clinic of Child Development School of Medicine at Yale University. H. Hamilton.

Ginsburg, H. P. & Baroody, A. J. (2003). *Test of Early Mathematics Ability*, 3rd Ed. (TEMA-3). Lutz, FL: Psychological Assessment Resources, Inc.

Glascoe, F. P. et al. (1992). "Accuracy of the Denver-II in Developmental Screening". *Pediatrics*, Vol. 89, pp. 1221–1225.

Glass, N. (1999) Sure Start: The Development of an Early Intervention Programme for Young Children in the United Kingdom. *In Children & Society*, Vol. 13, pp. 257-264.

Goals Panel, Goal 1. (1995). Technical Planning Group. Washington, DC: Government Printing Office.

Goldberg, D. E. (2002). *Design of Innovation: Lessons From and For Competent Genetic Algorithms*, Kluwer, Boston, MA.

Goldberg, D. E. (1989). *Genetic Algorithms in Search, Optimization and Machine Learning, Reissue*, Addison-Wesley Publishing Company.

Goldberg, D. E., & Richardson, J. (1987). "Genetic Algorithms with Sharing for Multimodal Function Optimization: Genetic Algorithms and Their Applications", Proceedings of the Second *International Conference on Genetic Algorithms* , pp. 41-49, Cambridge, MA.

Goodwin, L. D., Goodwin, W. L. & Garel, M. B. (1986). Use of microcomputers with preschoolers: a review of literature. *Early Childhood Research Quarterly*, Vol. 1, pp. 269–286.

Goodwin, L. D., Goodwin, W. L., Nansel, A., & Helm, C. P. (1986). Cognitive and affective effects of various types of microcomputer use by preschoolers. *American Educational Research Journal*, Vol. 23, pp. 348–356.

Gouli, E., Gogoulou, A., Papanikolaou, K., & Grigoriadou, M. (2004). COMPASS: an adaptive web-based concept map assessment tool / Proceedings of the First International Conference on Concept Mapping – Pamplona, 2004.

Grantham-McGregor. S., et al. (2007). 'Developmental Potential in the First 5 Years for Children in Developing Countries', *The Lancet*, Vol. 369, No. 9555, 6–12 January 2007, pp. 60–70.

Green, C. & Bavelier, D. (2003). Action video game modifies visual selective attention. Nature, Vol. 423, pp. 534–537.

Greenspan, S. I. (1985). *First feelings*. New York:Viking.

Grefenstette, J. J. (1988) Credit assignment in rule discovery systems based on genetic algorithms, *Machine Learning*. Vol. 3, No. (2/3), pp. 225-245.

Grefenstettte, J. J., Gopal, R., Rosmaita, B. J., & Gucht, D. V. (1985) Genetic algorithm for the traveling salesman problem. In J. J. Grefenstette, editor, *Proceeding of the First International Conference on Genetic Algorithms and Their Applications*, pp. 160-168, Hillsdale, NJ. Lawrence Erlbaum Associates.

Grover, S. C. (1986). A field of the use of cognitive-developmental principles in microcomputer design for young children. *The Journal of Educational Research*, Vol. 79, pp. 325–332.

Grubbs, K. R. (1965) The Philosophy behind the Economic Opportunity Act of 1964, Louisiana: NACTA.

Guardian (2009) TSocial policy in the noughties: 10 years of change and controversy,Available at: http://www.theguardian.com/world/2009/dec/16/public-services-policy-review-decade (Accessed: 16 December 2009).

Guhn, M., & Forer, B. (2006).Translating school readiness assessment into community actions and policy planning—The Early Development Instrument Project, Symposium conducted at the annual meeting of the American Educational Research Association, San Fran., CA.

Gullo, D. F., & Burton, C. B. (1992). Age of Entry, Preschool Experience, and Sex as Antecedents of Academic Readiness in Kindergarten. *Early Childhood Research Quarterly*, Vol. 7, pp.175-186.

Gullo, D. F., & Clements, D .H. (1984). Differences in achievement patterns for boys and girls in kindergarten and first grade: A longitudinal study. *Psychological Reports*, Vol. 54, pp. 23-27.

Guo, Q., & Zhang, M. (2009). Implement web learning environment based on data mining. *Elsevier Knowledge Based Systems*, Vol. 22, No. 6, pp. 439-442.

Guthrie, J. (2006). *Engagement and expertise in reading: students' needs and classroom practices*.

Gütl, C., Dreher, H., & Williams, R. (2005). E-TESTER: a Computer-based Tool for Auto-generated Question and Answer Assessment // Proceedings of ELEARN 2005. – Vancouver, 2005. – P.2929-2936.

Habgood, M. P. J., Ainsworth, S. E., & Benford, S. (2005) 'Endogenous fantasy and learning in digital games', *Simulation and Gaming*, Vol. 36, No. 4, pp. 483-498.

Hagen, D. (1984). *Microcomputer Resources Book for Special Education*. Reston Publishing Inc Reston Virginia.

Hagen, M. T., Demuth, H. B., & Beale, M. (1996). *Neural Network Design*, PWS Publishing Co. Boston.

Hair, E., Halle, T., Terry-Humen, E., Lavelle, B. & Calkins, J. (2006). Children's school readiness in the ECLS-K: Predictions to academic, health, and social outcomes in first grade. *Early Childhood Research Quarterly*, Vol. 21, pp. 431–454.

Halász, V., & Cunnington, R. (2012) 'Unconscious Effects of Action on Perception', *Brain Science*, Vol. 2, pp. 130-146.

Hale, J. B., & Catherine, A. F. (2004). *School Neuropsychology: A Practitioner's Handbook*. Guilford. p. 36.

Han, J., & Kamber, M. (2006). *Data Mining: Concepts and Techniques*, Morgan Kaufmann Publishers.

Harp, S. A., Samad, T., & Guha, A. (1989) Towards the genetic syndissertation of neural networks. In J. D. Schaffer, editor, *Proceedings of the Third International Conference on Genetic Algorithms and Their Applicatins*, pp. 360-369, San Mateo, CA. Morgan Kaufmann.

Harrison, P., Kaufman, A., Kaufman, N., Bruininks, R., Rynders, J., Ilmer, S., Sparrow, S., & Cicchetti, D. (1990). *Early Screening Profiles (ESP)*. Circle Mines, MN: AGS Publishing.

Hart, B., & Risley, T. (1995). *Meaningful differences in the everyday experiences of young American children*. Baltimore, MD: Brookes Publishing.

Hartley, D., & Mitrovic, A. (2002). Supporting learning by opening the child model // Proceeding of the 6th International Conference on *Intelligent Tutoring Systems ITS* 2002. – Biarritz, pp. 453-462.

Haugland, S. W. & Wright, J. L. (1997). *Young Children and Technology: A World of Discovery*. Boston, MA: Allyn and Bacon.

Haugland, S. W. (1992). The effect of computer software on preschool children's developmental gains. *Journal of Computing in Childhood Education*, Vol. 3, pp. 15–30.

Haugland, S. W. (2000). What role should technology play in young children's learning? Part 2- Early childhood classrooms in the 21st century: using computers to maximize learning. *Young Children*, Vol. 55, No. 1, pp. 12-18.

Health Nexus Sante (2011) *Learning to Play and Playing to Learn: Getting Ready for School*, Ontario: Best Start.

High/Scope Educational Research Foundation, Available at: http://www.highscope.org.

Hill, P. W. & Rowe, K. J. (1996). Multilevel Modeling in School Effectiveness Research. *School Effectiveness and School Improvement*, Vol. 7, No. 1, pp. 1-34.

Hirumi, A., Appelman, R., Rieber, L., & Van Eck, R. (1998). Four perspectives on preparing instructional designers to optimize game-based learning. Tech Trends, AECT.

Hitz, R., & Richter, S. (1993). School readiness: A flawed concept. *Principal*. Vol. 72, No. 5, pp. 10–12.

Holland, J. H. (1975). *Adaptation in Natural and Artificial Systems*, Ann Arbor: The University of Michigan Press.

Hoot, J. (1986) *Computer in Early Childhood Education Issues and Practices*. Englewood Cliffs, N.J.: Prentice-Hall.

Hoppe, H. U. (2006). Technology Facilitated Integration of Learning Processes in Classrooms and Virtual Communities. In: Redondo, M.A., Bravo, C. & Ortega, M. (Eds.), Diseño de la Interacción Persona Ordenador: Tendencias y Desafíos (pp. 5-8). Puertollano – Ciudad Real.

Howard, J. R., Eatson, J.A., Brinkley, V. M. & Ingels-Young, G. (1994) Comprehension monitoring, stylistic differences, pre-math knowledge, and transfer: a comprehensive pre-math/spatial development computer-assisted instruction (CAI) and Logo curriculum designed to test their effects. *Journal of Educational Computing Research*, Vol. 11, pp. 91–105.

Howell, R. D., Scott, P. B. & Diamond, J. (1987). The effects of "instant" LOGO computing language on the cognitive development of very young children. *Journal of Educational Computing Research*, Vol. 3, pp. 249–260.

Hughes, K. (1990). "*You took my talk": Aboriginal literacy and empowerment*. Ottawa: House of Commons, Standing Committee on Aboriginal Affairs

Hunt, J. M. (1965). Intrinsic motivation and its role in psychological development. *Nebraska symposium on motivation*. Vol. 13, pp. 189-282.

Hunt, N., & Kirk, S. (2005). The Education For All Handicapped Children Act (PL 94-142) 1975. Houghton Mifflin College Division . http://college.hmco.com/education/resources/res_prof/students/spec_ed/legislation/pl_94-142.html

IBGE. 2004. *Síntese de Indicadores Sociais*. Brasília, IBGE.

Ionescu, T., & Benga, O. (2007). Reconceptualizing Early Education on Scientific Grounds: School Readiness in Focus. *Cognition, Brain, Behavior*, Vol. 11, No. 1, pp. 49-66.

Ito, M., Baumer, S., Bittanti, D., Boyd, R., Cody, B., Herr-Stephenson, H. A., Horst, P. G., Lange, D., Mahendran, K. Martinez, C. J., Pascoe, D., Perkel, L., Robinson, C., & Tripp, L. (2010). *Hanging Out, Messing Around, and Geeking Out: Kids Living and Learning with New Media*. Cambridge, MA: MIT Press.

Izard, C. E., Fine, S., Schultz, D., Mostow, A., Ackerman, B., & Youngstrom, E. (2001). Emotions knowledge as a predictor of social behavior and academic competence in children at risk. *Psychological Science*, Vol. 12, pp. 18-23.

Jaber, S. G. (2010). *A Preschool Program Based on Multiple Intelligences*. Submitted to the Lebanese American University In partial fulfillment of the equirements for the degree of Master's of Arts in Education.

Jadrić, M., Garača Ž & Ćukušić, M. (2010). Student Dropout Analysis With Application of Data Mining Methods. *Management*, Vol. 15, No. 1, pp. 31-46.

Janus, M., & Offord, D., (2007). Development and psychometric properties of the Early Development Instrument (EDI): A measure of children's school readiness, Canadian *Journal of Behavioral Science*, Vol. 39, pp. 1–22.

Jerónimo, C. & Gabriel & Sturm, C. (2006). Edumóvil: Una Alternativa para la Educación Primaria en México. In: Redondo, M.A., Bravo, C. & Ortega, M. (Eds.), Diseño de la Interacción Persona Ordenador: Tendencias y Desafíos (pp. 537-546). Puertollano – Ciudad Real.

Johnson, J. (1986). *Improves Self-Esteem and Motivation: an Overview*. In Hope, The Magic of Micro. The Council for Educational Technology.

Johnson, J. E. (1985). Characteristics of preschoolers interested in microcomputers. *Journal of Educational Research*, Vol. 78, pp. 299-305.

Johnson, J. E., Christie, J. F., & Yawkey, T. D. (1999). *Play and early childhood development*. New York: Addison Wesley Longmans, Inc.

Johnson, S., & D'Souza, R. (2013). *Brief Announcement Brokerage and Closure in a Strategic for Social Capital*.

Kabakchieva, D. (2013). Predicting Student Performance by Using Data Mining Methods for Classification. *Cybernetics And Information Technologies*. Vol. 13, No 1.

Kagan, S. L., Evelyn, M., & Sue, B., (1995). *Reconsidering children's early development and learning: Toward common views and vocabulary*. In Report of the National Education Goals Panel, Goal 1 Technical Planning Group. Washington, DC: Government Printing Office.

Kagan, S., & Stewart, V. (2005). Education in a global era [Special issue]. *Phi Delta Kappan*, Vol. 87, No. 3.

Kagan, S. L. (2000). Readiness: Rethinking rhetoric and responsibility. *Phi Delta Kappan* Vol. 1, pp. 272–79.

Kamerman, S. B. (2002) *Early Childhood Care and Education and Other Family Policies and Programs in South-East Asia*, Paris: United Nations Educational, Scientific and Cultural Organization.

Kamerman, S., & Kahn, S. (1995). *Starting right: How American neglects its youngest children and what we can do about it* . New York: Oxford University Press.

Kaplan Early Learning Company, Available at: http://www.kaplanco.com.

Kapoor, A., & Picard, R.W. (2005). Multimodal affect recognition in learning environments // Proceedings of the 13th *Annual ACM International Conference on Multimedia.* – Singapore. – pp. 677-682.

Karr, C. L. (1991) Design of an adaptive fuzzy logic controller using a genetic algorithm. In R. K. Belew and L. B. Booker, editors, *Proceedings of the Fourth International Conference on Genetic Algorithms and Their Applications*, pp. 450-457, San Mateo, CA, Morgan Kaufmann.

Kasparian, C. (2003). *L'entrée des Jeunes Libanais dans la Vie Active et L'émigration*. Université Saint Joseph.

Kaufman, A. S., & Kaufman, N. L. (1993). *The Kaufman Survey of Early Academic and Language Skills (K-SEALS)*. Circle Mines, MN: AGS Publishing.

Kay, J., Kummerfeld, B., & Lauder, P. (2003). Managing private user models and shared personas in Proceedings of Workshop on User Modelling for Ubiquitous Computing, User Modelling.

Kellaghan, T., & Madaus, G. F. (1991). National Testing: Lessons for America from Europe. *Educational Leadership,* Vol. 49, No. 3, pp. 87–93.

Kemp, C. (2002). High-tech tots: experts debate value of exposing preschoolers to computers. *American Academy of Pediatric News*, Vol. 21, pp. 1-172.

Kernan, M. (2007) *Play as a context for Early Learning and Development: A research paper*, Dublin: NCCA.

Kinshuk, C. (2008). Application of Adaptivity in Quiz Systems [Electronic resource] / http://www.col. org/pcf3/Papers/PDFs/Cheng_Kinshuk.pdf – 01.10.2008.

Klein, P., & Yaacov Y. (2008) *From Research to Practice in Early Childhood Education*, Jerusalem: The Israel Academy of Sciences and Humanities, pp. 1-2.

Kliebard, H. (1987). *The Struggle for the American Curriculum*, pp. 1893–1958. New York: Routledge and Kegan Paul.

Kobsa, A., & Wahlster, W. editors. (1989). *User Models in Dialog Systems*. Springer Verlag, London.

Kochenderfer, B. J., & Ladd, G. W. (1996). Peer victimization: Cause or consequence of school maladjustment? *Child Development*, Vol. 67, pp. 1305-1317.

Koedinger, K., Cunningham, K., Skogsholm, A., & Leber, B. (2008). An open repository and analysis tools for fine-grained, longitudinal learner data. In *1st International Conference on Educational Data Mining*, Montreal, pp. 157-166.

Kolucki, B., & Lemish, D. (2011) *Communicating with Children, Principles and Practices to Nurture, Inspire, Excite, Educate and Heal*, New York: UNICEF.

Kopp, C. (1989). Regulation of distress and negative emotions: A developmental perspective. *Developmental Psychology*, vol. 25, pp. 343-354.

Korkman, M., Kirk, U., & Kemp, S. (1997). NEPSY®. San Antonio, Texas: The Psychological Corporation.

Kotsiantis, S. (2009). "Educational data mining: A case study for predicting dropout—prone students," *Int. J. Know. Eng. Soft Data Paradigms*, Vol. 1, No. 2, pp. 101–111.

Kotsiantis, S., Patriarcheas, K., & Xenos, M. (2010). "A combinational incremental ensemble of classifiers as a technique for predicting students' performance in distance education", *Knowledge. Based Syst*., Vol. 23, No. 6, pp. 529–535.

Kovačić, Z. J., & Green, J. S. (2010) *Predictive working tool for early identification of 'at risk' students*. An Ako Aotearoa publication.

Kovacic, Z. J. (2009). Predicting student success by mining enrolment data. Research in *Higher Education Journal*.

Koza, J. R. (1994) *Genetic Programming II: Automatic Discovery of Reusable Programs*. MIT Press.

Koza, J. R. (1992) *Genetic Programming: On the Programming of Computers by Means of Natural Selection*. MIT Press.

Krause, A. (2010). *Advanced Topics in Machine Learning, Nonparametric learning and Gaussian processes*.

Krebs, V. (2002). Mapping Networks of Terrorist Cells. *Connections*. Vol. 24, No. 3, pp. 43-52.

Kristinsson, K. & Dumont, G. A. (1992) System identification and control using genetic algorithms. *IEEE Transactions on System, Man, and Cybernetics*, Vol. 22, No. 5, pp. 1033-1046.

Labidi, S., & Sergio, N. (2000). Child modelling and semi-automatic domain ontology construction for Shiecc // Proceedings of the 30th ASEE/IEEE Frontiers in Education Conference. – P.F1B/14 - F1B/18.

Ladd, G. W. (1990). Having friends, Keeping friends, making friends, and being liked by peers in the classroom: Predictors of children's early school adjustment? *Child Development*, Vol. 61, pp. 1081-1100.

Lambert, G. (2004). What is computer aided assessment and how can I use it in my teaching? [Electronic resource] / Canterbury Christ Church university college, – http://www.canterbury.ac.uk/support/staff-development/brochure/computer-aided-assessment.asp – 01.10.2008.

Lazarinis, F. & Retalis, S. (2007). Analyze Me: Open Learner Model in an Adaptive Web Testing System //*International Journal of Artificial Intelligence in Education*. Vol.17, pp.255-271.

Leacock, C., & Chodorow, M. (2003). C-rater: scoring of short-answer questions, *Computers and the Humanities*, Vol. 37, No. 4, pp. 389-405.

Lebanese Association for Educational Studies, (2006). National Education Strategy in Lebanon.

Lee, V., Loeb, S., & Lubeck, S. (1998). Contextual effects of prekindergarten classrooms for disadvantaged children on cognitive development: the case of Chapter 1. *Child Development*, Vol. 69, pp. 479–494.

Legal Information Institute (2012) National Education Goals, Available at: http://www.law.cornell.edu/uscode/text/20/5812

Lehrer, R., Harckham, L. D., Archer, P., & Pruzek, R. M. (1986). Microcomputer-based instruction in special education. *Journal of Educational Computing Research*, Vol. 2, pp. 237–355.

Lemerise, E. A., & Arsenio, W. F. (2000). An integrated model of emotion processes and cognition in social information processing. *Child Development*, Vol. 71, pp. 107-118.

Lenhart, A., Kahne, J., Middaugh, E., Macgill, A. R., Evans, C., & Vitak. J. (2008). Teens' Gaming Experiences Are Diverse and Include Significant SocialInteraction and Civic Engagement. Washington, DC: Pew Internet and American Life Project.

Levine, M. (1966). Residential change and school adjustment. *Mental Health Journal*, Vol. 2, pp. 61-69.

Lillard, A. S. (2013) 'Playful Learning and Montessori Education ', *American Journal of Play*, 5(2), pp. 157-186.

Linder, T. W. (1990). *Transdisciplinary play-based assessment: A functional approach to working with young children* .Baltimore: Brookes.

Linder, T. W. (1993a). *Transdisciplinary play-based assessment: A functional approach to working with young children* (2nd ed). Baltimore: Brookes.

Linder, T. W. (1993b). *Transdisciplinary play-based intervention: Guidelines for developing a meaningful curriculum for young children*. Baltimore: Brookes.

Lipinski, J., Nida, R., Shade, D., & Watson, J. (1986). The effect of microcomputers on young children: An examination of free play choices, sex differences, and social interactions. *Journal of Educational Computing Research*, Vol. 2, No. 2, pp. 147-68.

Liu, M. (1996). An exploratory study of how pre-kindergarten children use the interactive multimedia technology: Implications for multimedia software design. *Journal of Computing in Childhood Education*, Vol. 7, No. 2, pp. 71-92.

Lukashenko, R., & Anohina, A. (2003). Architecture and Application of Knowledge Assessment Systems: An Overview. Proceedings of the *29th Annual Conference of the International. Association for Educational Assessment*. – Midland, Vol. 15, p. 13.

Lukashenko, R., Vilkelis M., & Anohina, A. (2008). Deciding on the Architecture of the Concept Map Based Knowledge Assessment System // Proceedings of the *International Conference on Computer Systems and Technologies* (CompSysTech'08). – Gabrovo. – P.V.3-1-V.3-6.

Lykourentzou, I., Giannoukos, I., Nikolopoulos, V., Mpardis, G., & Loumos, V. (2009). "Dropout prediction in e-learning courses through the combination of machine learning techniques," Comput. Educ., Vol. 53, No. 3, pp. 950–965.

MacQueen, J. (1967). Some methods for classification and analysis of multivariate observations. In Proceedings of the *Fifth Berkeley Symposium on Mathematical Statistics and Probability*, Berkeley, CA, pp. 281–297.

Madaus, G., & O'Dwyer, L. (1999). A Short History of Performance Assessment. *Phi Delta Kappan*, Vol. 80, No. 9, pp. 688–695.

Madhyastha, T., & Hunt, E. (2009). Mining diagnostic assessment data for concept similarity. *Journal of Educational Data Mining*, Vol. 1, No. 1, pp. 1-19.

Maimon, O., & Rokach, L (2010) *Data Mining and Knowledge Discovery Handbook*, Second Edition, Springer: New York .

Majsteberg, J. D., & Wilson, R. (1989). Computer Assisted Instruction for Students With Learning Disabilities: Consideration for Practitioners, Learning Disabilities Focus, *The Journal of Special Education*, Vol. 5, No. 1, pp. 18-27.

Malinen, B. (2010) *The Nature, Origins, and Consequences of Finnish Shame-Proneness: A Grounded Theory Study*, Helsinki: Helsinki University Print.

Malone, T. W., & Lepper, M. R. (1987). *Making learning fun: a taxonomy of intrinsic motivations for learning*. Snow, R.E. & Farr, M.J. (Eds.), Aptitude, learning and instruction III: Cognitive and affective process analysis, Hillsdale, NJ: Lawrence Erlbaum Associates.

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, Vol. 5, No. 4, pp. 333-369.

Marie, B., Mingyu, F., & Barbara, M. (2012). *Enhancing Teaching and Learning Through Educational Data Mining and Learning Analytics: An Issue Brief*. U.S. Department of Education Office of Educational Technology, Center for Technology in Learning SRI International.

Marinagi, C. C., Kaburlasos, V. G., & Tsoukalas, V. T. (2007). An architecture for an adaptive assessment tool //Proceeding of the *37th ASEE/IEEE Frontiers in Education Conference*. – Milwaukee, – P.T3D-11-T3D-16.

Marks, A. K., & Coll, C. G. (2007). Psychological and demographic correlates of early academic skill development among American Indian and Alaska Native Youth: A growth modeling study. *Developmental Psychology*, Vol. 43, No. 3, pp. 663-674.

Márquez-Vera, C., Morales, C. R., & Soto, S. V. (2013). Predicting School Failure and Dropout by Using Data Mining Techniques. *IEEE Journal of Latin-American Learning Technologies*, Vol. 8, No. 1.

Márquez-Vera, C., Romero, C., & Ventura, S. (2011). Predicting School Failure Using Data Mining. *Expert Systems With Applications*, Vol. 38, No. 12, pp. 15020-15031.

Masui, T. (1992). *Graphic Object Layout with Interactive Genetic Algorithms*. Proc. IEEE Visual Languages '92.

May, D. & Kundert, D. (1997). School readiness practices and children at-risk: Examining the issues. *Psychology in the Schools*, Vol. 34, pp. 1-12.

McCollister, T. S., Burts, D. C., Wright, V. L. & Hildreth, G. J. (1986) Effects of computer- assisted instruction and teacher-assisted instruction on arithmetic task achievement scores of kindergarten children. *The Journal of Educational Research*, Vol. 80, pp. 121–125.

McLoyd, V. C. (1998). Socioeconomic disadvantage and child development. *American Psychologist*, Vol. 53, No. 2, pp. 185-204.

McWayne, C. M., Fantuzzo, J. W., & McDermott, P. A. (2004). Preschool competency in context: An investigation of the unique contribution of child competencies to early academic success. *Developmental Psychology*, Vol. 40, pp. 633-645.

Meisels, S. J., Wiske, M. S., & Henderson, L. W. (1997). *Early Screening Inventory-Preschool* (ESI-P). New York, NY: Pearson Early Learning.

Meisels, S. J., (1999). *Assessing readiness*. In R.C. Pianta & M.J. Cox (Eds.). The transition to kindergarten, Baltimore, P. H. Brooks Publishing Company.

Mello, L. & Hoppe, M. (2005). *Educational Attainment in Brazil: The experience of Brazil*. Paris: OECD.

Miclea, Mircea, Mihalca, & Loredana. (2007). A Computerized Platform for Assessment of School Readiness. *Cognition, Brain, Behavior,* Vol. 11, No. 1, pp. 83 – 90.

Milani, A., (2004). Online genetic algorithms. *International Journal of Information Theories and Applications*, Vol. 11, pp. 20-28.

Miller, G. G., Todd, P. M., & Hegde, S. U. (1989) Designing neural networks using genetic algorithms. In J. D. Schaffer, editor, *Proceedings of the Third International Conference on Genetic Algorithms and Their Applications*, pp. 379-384, San Mateo, CA, Morgan Kaufmann.

Miller, G. E., & Emihovich, C. (1986). The effects of mediated programming instruction on preschool children's self-monitoring. *Journal of Educational Computing Research*, Vol. 2, pp. 283-299.

Miller, L. J. (1993). *FirstSTEP Screening Test for Evaluating Preschoolers*. The Psychological Corporation. Harcourt Brace Jovanovich Inc.

Minaei-Bidgoli, B., Kashy, D. A., Kortemeyer, G., & Punch, W. F. (2003). Predicting student performance: an application of data mining methods with an educational Web-based system Lon-Capa. *Frontiers in Education*, 2003. FIE 2003 33rd Annual, Vol. 1, pp. 13-18.

Ministério da Educação (2007). *The plan for the development of education. Reasons, principles and programs*.

Ministère de l'Éducation Nationale (2012) School Education in France, Available at:http://cache.media.eduscol.education.fr/file/dossiers/07/3/2013_School_Education_in_France_244073.pdf.

Ministry of Education, Culture, Sports, Science and Technology (2004) The Development of Education in Japan, Available at:http://www.ibe.unesco.org/International/ICE47/English/Natreps/reports/japan.pdf.

Mislevy, R. J., Steinberg, L. S., & Almond, R. G. (2003). On the structure of educational assessment. *Measurement: Interdisciplinary Research and Perspective*, Vol. 1, No. 1, pp. 3–62.

Missall, K., Reschly, A., Betts, J., McConnell, S. Heistad, D., Pickart, M., Sheran, C., & Marston, D. (2007). Examination of the predictive validity of preschool early literacy skills. *School Psychology Review*, Vol. 36, No. 3, p. 433-452.

Mitchell, M. (1997) *An Introduction to Genetic Algorithms*. MIT Press.

Module III: Objective and Subjective Tests and Construction of Test Items, Advantages/Disadvantages [Electronic resource] / University of Minnesota, 2008. – http://www.nursing.umn.edu/preceptors/evaluation-in-nursing-education/ModuleIIIObjectiveandSubjectiveTestsandConstructionofTestItems/index.htm – 01.10.2008.

Mogey, N., & Watt, H. (1996). The use of computers in the assessment of child learning [Electronic resource] / Learning Technology Dissemination Initiative, http://www.icbl.hw.ac.uk/ltdi/implementing-it/cont.htm – 01.10.2008.

Moss, P. (2004) *A new era for universal childcare? Childcare and Early Years Services in 2004*. Setting the Scene: A Vision of Universal Children's Spaces. London: Daycare Trust.

Mostow, J., & Beck., J. (2006). Some useful tactics to modify, map and mine data from intelligent tutors. In *Journal Natural Language Engineering*, Vol. 12 , No. 2, pp. 195-208.

Muñoz-Sandoval, A. F., Cummins, J., Alvarado, C. G., & Ruef, M. L. (2006). *Bilingual Verbal Ability Tests, Normative Update BVAT®-NU*. Itasca, IL: Riverside Publishing Co.

Mustard, F. (2002) "Early child Development and the Brain – the Base for Health, Learning and Behavior Throughout Life" in M. Young (Ed.) From *Early Child*

Development to Human Development. Washington D.C.: The World Bank, pp. 23-61.

Muter, V., Hulme, C., & Snowling, M. (1997). *Phonological Abilities Test*. London: Psychological Corporation.

Nachum, B. (2010), "The Education System – an inside look", State of the Nation Report 2009, *Taub Center for Social Policy Studies in Israel*, pp. 137 – 182.

Nachum, B. (2011), "Developments in Israel's Education System State of the Nation Report 2010, *Taub Center for Social Policy Studies in Israel*, pp. 203 – 246.

Nagarajan, P., & Wiselin Jiji, G. (2010) 'Online Educational System (e- learning) ', *International Journal of u- International Journal of u- and e- Service, Science and Technology*, Vol. 3(No. 4), pp. 37-48.

Nash, J. (1997). Fertile minds. *Time*, Vol. 149, pp. 48-56.

National Association for the Education of Young Children (2012) *Technology and Interactive Media as Tools in Early Childhood Programs Serving Children from Birth through Age 8*, Latrobe, PA: Fred Rogers Center for Early Learning and Chidren's Media.

National Association for the Education of Young Children (NAEYC). (1996). Technology and Young Children-Ages 3 through 8 (NAEYC Position Statement). Washington, DC: NAEYC.

National Association for the Education of Young Children. NAEYC position statement on school readiness. *Young Children* (November 1990), Vol. 1, pp.21–23.

National Center for Education Statistics (2001). U.S. Department of Education, ECLS-K Base Year Data Files and Electronic Codebook. Retrieved June 4, 2008, from http://nces.ed.gov/ecls/kindergarten.asp

NESS Impact Study (2005), *Early Impacts of Sure Start Loca. Programmes on Children and Families*, Birbeck:University of London.

Newborg, J. (2004). *Battelle Developmental Inventory, Second Edition* (BDI®-2). Itasca, IL: Riverside Publishing Co.

Newsweek (2010) Finland is the 'World's Best Country', Available at:http://www.goodnewsfinland.com/archive/news/finland-is-the-worlds-best-country/(Accessed: 18 August, 2010).

Niemeyer, J., & Scott-Little, C. (2002). *Assessing kindergarten children: A compendium of assessment instruments*. Online: http://www.serve.org/uploads/publications/assesskindergarteninstruments.pdf

Nkambou, R. (2006). Towards affective intelligent tutoring system // Proceedings of the Workshop on Motivational and Affective Issues on ITS at the *8th International Conference on Intelligent Tutoring Systems*. – Taiwan, pp.5-12.

Noftle, E. E., & Robins, R. W. (2007). Personality Predictors of Academic Outcomes: Big Five Correlates of GPA and SAT Scores. *Journal of Personality and Social Psychology*, Vol. 93, pp. 116–130.

Nord, C. W., Zill, N., Prince, C., et al. (1994). Developing an index of educational risk from health and social characteristics known at birth. Bulletin of the New York *Academy of Medicine*, Vol. 7, No. 2, pp. 167–87.

Novak, J. (2005). *Game development essentials: An introduction*. New York: Thomson Delmar Learning.

O'Connor, M. (Eds 1992) *Future Assessments: Changing Views of Aptitude, Achievement and Instruction*, Boston MA, Kluwer.

O'Connor, M., & Paunonen, S. (2007). Big Five Personality Predictors of Post-secondary Academic Performance. *Personality and Individual Differences*, Vol. 43, pp. 971–990.

Ochanomizu University Center for Women's Education and Development. (2006)., *The History of Japan's Preschool Education and Care*, 2006.3

Ochanomizu University Research Center for Child and Adolescent Development and Education (2004). , *Early Childhood Education Handbook.*

OECD (2004) Early Childhood Education and Care Policy in The Federal Republic of Germany, Available at: http://www.oecd.org/education/school/33978768.pdf (Accessed: 26 November 2004) , p.58.

OECD (2006). *Starting Strong II. Early Childhood Education and Care*, available at: www.oecd.org.

OECD (2009), OECD Reviews of Tertiary Education: Finland 2009, OECD Publishing, Paris, doi: 10.1787/9789264049048-en.

OECD (2010) PISA 2009 Results: Executive Summary - Comparing countries' and Economies' performance, Available at: http://www.oecd.org/pisa/46643496.pdf.

OECD (2012) *The Protection of Children Online, Recommendation of the OECD Council , Report on Risks Faced by Children Online and Policies To Protect Them*, OECD.

OECD (2013) Education Policy Outlook: Finland, Paris: OECD Publishing.

Ofsted (2014) Ofsted Early Years Annual Report 2012/13, Available at:http://www.ofsted.gov.uk/sites/default/files/documents/annual-reports/o/Ofsted%20Early%20Years%20Annual%20Report%20201213.pdf

Oiarzabal, P. J., & Reips, U. D. (Eds.) (2012). Migration and the Internet: Social networking and diasporas [Special issue]. *Journal of Ethnic and Migration Studies* (JEMS). Vol 38, No. 9.

Okolo, C. M. (1992). The Effect of Computer – Based Attribution Retaining on the Attribution, Persistence, and Mathematics Computation of Students with Learning Disabilities. *Journal of Learning Disabilities*. Vol. 25, No. 5, pp. 327-334.

Orey, M. (2010) *Emerging Perspectives on Learning, Teaching, and Technology*, Zurich, Switzerland: Jacobs Foundation.

Oxman, S., & Wong, W. (2014). *White paper: Adaptive Learning Systems*. A white paper from DVX/ DeVry Education Group and Integrated Education Solutions

Packard, N. H. (1990) A genetic learning algorithm for the analysis of complex data *Complex Systems*, Vol. 4, No. 5, pp. 543-572

Panter, J. E., & Bracken, B. A. (2009), Validity of the Bracken School Readiness Assessment for predicting first grade readiness. *Psychology in the Schools*, Vol. 46, pp. 397–409.

Papert, S. (1980). *The Gears of My Childhood. Mindstorms: Children, Computers, and Powerful Ideas* (Basic Books).

Park, H. (2012) 'Relationship between Motivation and Student's Activity on Educational Game', *International Journal of Grid and Distributed Computing*, Vol. 5, No. 1, pp. 101-114.

Parker, A. (1999). "A study of variables that predict dropout from distance education," *International Journal Education Technology*, Vol. 1, No. 2, pp. 1–11.

Pascal, C., & Bertram, A. D. (ED) (1997) *Effective Early Learning: Case Studies of Improvement*, Hodder and Stoughton, London.

Pascal, C., & Bertram, A. D. (1998) *Accounting Early for Life Long Learning*, in Abbott L and Moylett H (eds) Early Education in the Millennium, Falmer Press, London.

Pascal, C., & Bertram, A. D. (1999) *Research to Inform the Evaluation of the Early Excellence Centre Pilot Programme*, DfEE, London.

Pascal, C., & Bertram, A. D. (2001). *Evaluating Early Excellence Year One Report*, DfES, London.

Pascal, C., & Bertram, A. D (2002) *Assessing Young Children's Learning: What Counts*? in Fisher J. (Ed) Building Foundations for Learning, Paul Chapman, London.

Pascal, C., & Bertram, A. D. (2004) *Enhancing the Participation of Black and Minority Ethic Communities in Childcare* , DfES, London.

Paul, H. Brookes™ Publishing Company, Incorporated – Available at: http://www.brookespublishing.com

Pavlik, P., Cen, H., & Koedinger, K. (2009). Learning factors transfer analysis: Using learning curve analysis to automatically generate domain models. Paper presented at the *2nd International Conference on Educational Data Mining* (EDM'09), Cordoba, Spain.

Pearson Early Learning - Available at: http://www.pearsonearlylearning.com

Pechenizkiy, M., Trčka, N., Vasilyeva, E., Aalst, W., & De Bra, P. (2009). Process mining online assessment data. Paper presented at the *2nd International Conference on Educational Data Mining* (EDM'09), Cordoba, Spain.

Pellegrino, J. W. (2006). Rethinking and Redesigning Curriculum, Instruction and Assessment. A paper commissioned by the National Center on Education and the Economy for the New Commission on the skills of the American Workforce. From *early child development to human development* (pp. 1–14). Chicago: The University of Illinois.

Peñalver, J. G., & Merelo, J. J. (1998). *Optimizing web page layout using an annealed genetic algorithm as client-side script*. In Proceedings PPSN, Parallel Problem Solving from Nature V,Lecture Notes in Computer Science. Springer-Verlag.

Pérez, D., Alfonseca, E., & Rodríguez, P. (2004). Application of the BLEU method for evaluating free-text answers in an e-learning environment // Proceedings of the *Language Resources and Evaluation Conference* (LREC-2004).- Lisbon.

Perez, S. M., & Martinez, D. (1993). *State of Hispanic America 1993: Toward a Latino anti-poverty agenda*. (UD No. 029424). Washington DC: National Council of La Raza. (ERIC Document Reproduction Service No. ED360465)

Perez-Marin, D., (2007). *Adaptive Computer Assisted Assessment of free-text children' answers: an approach to automatically generate children' conceptual models*, PhD thesis [Electronic resource] / Universidad Autonoma de Madrid, http://orestes.ii.uam.es/dperez/tesisDianaPerezMarin.pdf – 01.10.2008.

Peterson, R. A. (1994). A meta-analysis of Cronbach's coefficient alpha. *Journal of Consumer Research*, Vol. 21, pp. 381–391.

Phillips, D., & Love, J. (1994). Indicators for school readiness, schooling, and child care in early to middle childhood. Draft article presented at Indicators of *Children's Well-Being conference*. Washington, DC, November 17–18.

Pianta, R. C. (2003). Professional development and observations of classroom process. Paper presented at the SEED Symposium on *Early Childhood Professional Development*. Washington, DC.

Poropat, A. E. (2009). A Meta-analysis of the Five-Factor Model of Personality and Academic Performance. *Psychological Bulletin*, Vol. 135, pp. 322–338.

Praag, C. (2002). *The Social and Cultural Report 2002*. The Netherlands Institute for Social Research.

Predicting College Student Retention. Hanover Research. 2011.

Prensky, M. (2001). *Digital game-based learning*. New York: McGraw-Hill.

Proceedings of the *5th International Computer Assisted Assessment Conference*. – Loughborough, 2001. – pp .41-53.

Psychological Assessment Resources, Inc. (PAR™) - Available at: http://www3.parinc.com

Pullen, P., & Justice, L. (2003). Enhancing phonological awareness, print awareness, and oral language skills in preschool children. *Intervention in School and Clinic*. Austin: Vol. 39, No. 2, p. 87.

Quadril, M. N., & Kalyankar, N. V. (2010). "Drop out feature of student data for academic performance using decision tree techniques", *Global Journal. of Computer Science and Technology*, vol. 10, pp. 2–5.

Quellmalz, E. S., Timms, M. J., Buckley B. C., Silberglitt, M., & Brenner, D. (2012). *SimScientists: Measurement in Simulation-Based Science Assessments*. Unpublished manuscript.

Quinlan, J. R., (1986). Induction to decision trees. *Machine Learning*, Vol. 1, No, 1, pp. 81–106.

Quinn, C. (2005). *Engaging learning: Designing e-learning simulation games*. San Francisco: Pfeiffer.

Rabbany, R., Takaffoli, M., & Zaiane, O. (2011). Analyzing Participation of Students in Online Courses Using Social Network Analysis Techniques. In: Proceedings of the *4th International Conference on Educational Data Mining*. pp. 21-30.

Ramanathan, L., Dhanda, S., & Kumar, D. S. (2013). Predicting Students' Performance using Modified ID3 Algorithm. *International Journal of Engineering and Technology* (IJET). Vol 5, No 3.

Raskind, M., & Higgens, L. (1995) Reflection on Ethic, Technology and Learning Disabilities: Avoiding the Consequences of Ill- considered Action . *Journal of learning Disabilities*, Vol. 28, No. 7, pp. 425-438.

Raudenbush, S. W., & Bryk, A. S. (2002). *Hierarchical linear models: Applications and data analysis methods*, 2nd edition. Newbury Park, CA: Sage Publications.

Raver, C. C., & Knitzer, J. (2002). *Ready to enter: What research tells policymakers about strategies to promote social and emotional school readiness among three- and four years-old*. New York: National Center for Children in Poverty.

Rebecca, S. N., & Moncrieff, C. (2007). *Early childhood education* [four volumes] (pp 1081-1084). Washington DC : Greenwood Publishing Group, Inc. 2007.

Reid, D. K., Wayne, D. K., Hresko, P., Donald, D., & Hammill, D. D. (2002). *Test of Early Reading Ability*, ThirdEd. (TERA-3). Lutz, FL: Psychological Assessment Resources, Inc.

Reiter, M. K., & Rubin, A. D. (1998). Crowds: anonymity for Web transactions, *ACM Transactions on Information and System Security*, Vol.1, No.1, pp.66-92.

Rendell, L., Boyd, R., Cownden, D., Enquist, M., Eriksson, K., Feldman, M. W., Fogarty, L., Ghirlanda, S., Lillicrap, T., & Laland, K. N. (2010). Why copy others? Insights from the social learning strategies tournament. *Science*, Vol. 328, No. 5975, pp. 208–213.

Reynolds, D., & Packer, A. (1992). *School effectiveness and school improvement in the 1990s*. In D. Reynolds & P. Cuttance (Eds.), School Effectiveness: Research Policy and Practice. (pp. 171–196). London: Cassell.

Rieber, L. (1996). *Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games*.

Riverside Publishing Company - Available: http://www.riverpub.com

Roberta, F., Garber, R. F., Timko, G., L. Bunkley, S., Lumpkins, D., & Duckens, C. (2007). *School Readiness Assessment: A Review of the Literature*. Community Research Partners.

Roberts, H. (2000) What is Sure Start? *Arch Dis Child,* Vol. 82, pp. 435-437.

Robins, L. N., & Rutter, M. (1990). *Straight and devious pathways from childhood to adulthood*. Cambridge, England: Cambridge University Press.

Rock, D. A., & Stenner, A. J. (2005). Assessment issues in the testing of children at school entry. *The Future of Children*, Vol. 15, No. 1, pp. 15-34.

Rodriguez, E. T. (2008). The home literacy environment: Predictors of trajectories across the first five years and relations to children's school readiness at prekindergarten. *Dissertation Abstracts International*, Vol. 69, No. 3, 1988B. (UMI No. 3308289)

Roe, K. V., & Bronstein, R. (1988). Maternal education and cognitive processing at three months as shown by the infants' vocal response to mother vs. stranger. *International Journal of Behavioral Development*, Vol. 11, No. 3, pp. 389-393.

Roid, G. H. (2005). *Stanford-Binet Intelligence Scales for Early Childhood* (Early SB5). Itasca, IL: Riverside Publishing Co.

Romero, C., & Ventura, S. (2010). Educational Data Mining: A Review of the State of *the Art. IEEE Transactions on Systems, Man, and Cybernetics*, Part C: Applications and Reviews, Vol. 40, No. 6, pp. 601-618.

Romero, C., & Ventura, S. (2007). "Educational data mining: A survey from 1995 to 2005", *Expert Systems with Applications*, Vol. 33, No. 1, pp. 135–146.

Romero, C., Ventura, S., Zafra, A., & de Bra, P. (2009). Applying Web usage mining for personalizing hyperlinks in Web-based adaptive educational systems. Paper presented at *Computers & Education*, Vol. 53, pp. 828–840.

Romero, C., Ventura, S., Espejo, P., & Hervas, C. (2008). Data mining algorithms to classify students. Paper presented at *1st International Conference on Educational Data Mining* (EDM'08), Montreal, Canada.

Rooke, J., & Lawrence, P. (2012) *Transforming Writing: Interim Evaluation Report*, London: National Literacy Trust.

Rosasco L., De Vito E., Caponnetto A., Piana M., & Verri A. (2003). Are Loss Functions All the Same? *Neural Computation*, Vol. 16, pp.: 1063–1076, (2004).

Rouse, C., Brooks-Gunn, J., & McLanahan, S. (2005). Introducing the Issue. *The Future of Children*, Vol. 15, No. 1, pp. 5-14.

Rudin, C., Dunson, D., Irizarry, R., Ji, H., Laber, E., Leek, J., McCormick, T., Rose, S., Schafer, C., Van der Laan, M., Wasserman, L., & Xue, L. (2014) *Discovery with Data: Leveraging Statistics with Computer Science to Transform Science and Society*, American Statistical Association.

Ryokai, K., Farzin, F., Kaltman, E., & Niemeyer, G. (2013) 'Assessing multiple object tracking in young children using a game', *Educational Technology Research and Developmen*t, Vol. 61, pp. 153-170.

Salen, K., & Zimmerman, E. (2004). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.

Sameroff, A. J. (1998). Management of clinical problems and emotional care: environmental risk factors in infancy. *Pediatrics*, Vol. 102, No. 5, pp. 1287-1292.

Sanders, T. (1997). Semantic and pragmatic sources of coherence: On the categorization of coherence relations in context. *Discourse Processes*, Vol. 24, pp. 119-147.

Sargent, C., Houghton, E., & O'Donnell, S. (2012) INCA Comparative Tables, Available at: http://webarchive.nationalarchives.gov.uk/20130220111733/http://inca.org.uk/documents/INCAcomparativetablesOctober2012final.pdf(Accessed: 05-Nov-2012).

Sarwar, K., Chowdhury, L., & Nimmy, F. N. (2012). New Dropout Prediction for Intelligent System. *International Journal of Computer Applications* (0975 – 8887, Vol. 42, No.16,

Sawyer, B. & Smith, P. (2008). Serious Games taxonomy. Available at: www.seriousgames.org/presentations/serious-games-taxonomy-2008_web.pdf.

Schetz, K. F., & Stremmel, A .J. (1994) Teacher-assisted computer implementation: a Vygotskian perspective. *Early Education and Review*, Vol. 5, No. 1, pp. 18–26.

Schetz, K. F. (1994). An examination of software used with enhancement for preschool discourse skill improvement. *Journal of Educational Computing Research*, Vol. 11, pp. 51–71.

Schiffman, G. (1982). Microcomputers Instruction for the Learning Disabled. *Journal of Learning Disabilities*, Vol. 15, pp. 557-559.

Schmidt, R. (2004) OECD Early Childhood Policy Review 2002 – 2004 Hintergrundbericht Deutschland, Available at:http://www.oecd.org/edu/school/34484643.pdf (Accessed: 26 November 2004). p. 55.

Schrank, F. A. (2006). *Specification of the cognitive processes involved in performance on the Woodcock-Johnson III* (Assessment service Bulletin No. 7). Itasca, IL: Riverside Publishing.

Scoter, J. V., Ellis, D., & Railsback, J. (2001). *Technology in Early Childhood Education: Finding the Balance*. Portland, OR: Northwest Regional Educational Laboratory.

Scott, R., & Seifert, K. (1975). Family size and learning readiness profiles of socioeconomically disadvantaged preschool whites. *Journal of Psychology: Interdisciplinary and Applied*, Vol. 89, No. 1, pp. 3-7.

Scott-Little, C., Kagan, S. L., & Frelow, V. S. (2003). Creating the conditions for success with early learning standards: Results from a national study of a state-level standards for children's learning prior to kindergarten. *Early Childhood Research & Practice*, Vol. 5, No. 2.

Scott-Little, C., Kagan, S. L., & Frelow, V. S., (2006). Conceptualization of readiness and the content of early learning standards: The integration of policy and research?, *Early Childhood Research Quarterly*, Vol. 21, pp. 153-173.

Seale, J. (2002). Using CAA to support child learning, Learning Technology and Support Network, Available at: http://www.alt.ac.uk/docs/eln004.pdf – 01.10.2008 [Electronic resource].

Sembiring, S., Zarlis, M., Hartam, D., Ramliana, S., & Wani, E. (2011). Prediction of Student Academic Performance by an Application of Data Mining Techniques. *International Conference on Management and Artificial Intelligence*. IPEDR vol.6 IACSIT Press, Bali, Indonesia.

Semel, E., Wiig, E. H., & Secord, W. A. (2004). *Clinical Evaluation of Language Fundamentals®-(CELF®-2.)* San Antonio, Texas: The Psychological Corporation.

Semrud-Clikeman, M., & Phyllis, A. T. E. (2009). *Child Neuropsychology: Assessment and Interventions for Neurodevelopmental Disorders*. Springer. p. 119.

Shade, D., & Watson, J. (1987). Microcoworlds, mother teaching behavior and concept formation in the very young child. *Early child development and care* , Vol. 28, pp. 97-113.

Shade, D., Nida, R., Lipinski, J., & Watson, J. (1986). Microcomputers and preschoolers: Working together in a classroom setting. *Computers in the Schools*, Vol. 3, No. 2, pp. 53-61.

Shapiro, D. (In 1977). Individual approach to the question of school readiness, echo park, MB, 26 -36. [Hebrew]

Shekhar, A. (2012) Psychology for IAS: Thinking and problem solving. [Online]. Available at: *http://numerons.files.wordpress.com/2012/04/thinking-and-problem-solving.pdf*.

Shepard, L. A. (1991). Will National Tests Improve Student Learning? Phi Delta Kappan 72:232–238. Available at: http://www.cse.ucla.edu/products/Reports/TECH342.pdf.

Sherwin, A,S. (1983). Fighting Against Convergent Thinking. *Childhood Education*, March-April, pp. 255-258

Shute, V. J. (2011). Stealth assessment in computer-based games to support learning. In S. Tobias, & J. D. Fletcher (Eds.), *Computer games and instruction* (pp. 503-524). Charlotte, NC: Information Age Publishers.

Shute, R., & Miksad, J. (1997). Computer assisted instruction and cognitive development in preschoolers. *Child Study Journal*, Vol. 27, pp. 237–253.

Shute, V. J., & Towle, B. (2003). Adaptive e-learning. *Educational Psychologist*, Vol. 38, No. 2, pp. 105–114.

Shute, V. J., & Zapata-Rivera, D. (2008). Adaptive technologies. In J. M. Spector, D. Merrill, J. van Merrinboer, & M. Driscoll (Eds.), *Handbook of Research on Educational Communications and Technology* (3rd Edition) (pp. 277–294). New York: Lawrence Erlbaum Associates, Taylor & Francis Group.

Shute, V. J. (2007). Tensions, Trends, Tools, and Technologies: Time for an Educational Sea Change. In The Future of Assessment: Shaping Teaching and Learning, ed. C. A. Dwyer, pp. 139–187. New York: Erlbaum.

Shute, V. J. (2008). Focus on formative feedback. *Review of Educational Research*, Vol. 78, No. 1, pp. 153–189.

Shute, V. J. (2009). Simply Assessment. *International Journal of Learning and Media*, Vol. 1, No. 2, pp. 1–11.

Shute, V. J., & F. Ke. (2012). *Games, Learning, and Assessment. In Assessment in Game-Based Learning: Foundations, Innovations, and Perspectives*, ed. D. Ifenthaler, D. Eseryel, and X. Ge, pp. 43–58. New York: Springer.

Shute, V. J., & Torres. R. (2012). *Where Streams Converge: Using Evidence-Centered Design to Assess Quest to Learn. In Technology-Based Assessments for Twenty-First-Century Skills: Theoretical and Practical Implications from Modern Research*, ed. M. Mayrath, J. Clarke-Midura, and D. H. Robinson, pp. 91–124. Charlotte, NC: Information Age Publishing.

Shute, V. J., & Kim, Y. J. (2011). Does playing the World of Goo facilitate learning? In D. Y. Dai (Ed.), Design research on learning and thinking in educational settings: Enhancing intellectual growth and functioning (pp. 359-387). New York, NY: Routledge Books.

Shute, V. J., & Torres, R. (2011). Where streams converge: Using evidence-centered design to assess Quest to Learn. In M. Mayrath, J. Clarke-Midura, & D. H. Robinson (Eds.). Technology-based assessments for 21st Century skills: Theoretical and practical implications from modern research (pp. 91-124). Charlotte, NC: Information Age Publishing.

Shute, V. J., Hansen, E. G., & Almond, R. G. (2008). You can't fatten a hog by weighing it—Or can you? Evaluating an assessment for learning system called ACED. *International Journal of Artificial Intelligence and Education*, Vol. 18, No. 4, pp. 289–316.

Shute, V. J., Ventura, M., Bauer, M. I., & Zapata-Rivera, D. (2009). *Melding the power of serious games and embedded assessment to monitor and foster learning: Flow and grow*. In U. Ritterfeld, M. Cody, & P. Vorderer (Eds.), Serious games: Mechanisms and effects (pp. 295–321). Mahwah, NJ: Routledge, Taylor and Francis.

Sivin-Kachala, J., & Bialo, E. R. (1994). *Report on the Effectiveness of Technology in Schools, 1990–1994*. Washington, DC: Software Publishers Association.

Snow, C. E., & Susan, B. (editors) Van Hemel. *Early Childhood Assessment: Why, What, and How*. Washington, DC: The National Academies Press, 2008

Sottilare, Brawner, Goldberg, & Holden. (2012). *The Generalized Intelligent Framework for Tutoring* (GIFT).

Sparks, S. D. (2011). *Schools Find Uses for Predictive Data Techniques*. Education Week.

Spears, W. M., De Jong, K. A., Bäck, T., Fogel, D. B., & de Garis, H. (1993). An Overview of Evolutionary Computation, Machine Learning: ECML-93, European *Conference on Machine Learning*, Lecture Notes in Artificial Intelligence, No. 667, Ed. Brazdil, P.B., pp. 442-459.

Squire, K. (2006). From content to context: Videogames as designed experience. *Educational Researcher*, Vol. 35, No. 8, pp. 19–29.

Squire, K., (2005). Changing the game: what happens when video games enter the classroom. innovate, J*ournal of online education*, Vol. 1, No. 6.

Squires, J., Bricker, D., & Twombly, E. (2002). *Ages & Stages Questionnaires®: Social Emotional (ASQ®:SE).* Baltimore, MD: Brookes Publishing Co.

Stelzner, M. A. (2008). *Learn all about white papers*. WhitePaperSource Publishing.

Sternberg, R. J. (2006). The Nature of Creativity. *Creativity Research Journal,* Vol. 18, No. 1, pp. 87–98.

Stevenson, H. W., & Newman, R. S. (1986). Long-term prediction of achievement and attitudes in mathematics and reading. *Child Development*, Vol. 57, pp. 646-659.

Stone, B. (2008). *Human Factors Guidelines for interactive 3D and Games-based training Systems Design*. Available at: www.eece.bham.ac.uk/Default.aspx?tabid=154 [Accessed April 14, 2010].

Subedi, B. R., & Howard, M. (2013). Predicting High School Graduation and Dropout for At-Risk Students: A Multilevel Approach to Measure School Effectiveness. *Advances In Education*. Vol.2, No.1, ISSN 2165 - 946X.

Sukkarieh, J. Z., Pulman, S. G., & Raikes, N. Auto-marking: using computational linguistics to score short, free text responses // Proceedings of the *29th Annual Conference of the International*.

Suleiman, I., Salman, T., Gao, S., Polat, F., Arslan, M., Alhajj, R., & Ridley, M., (2010). The Power of Genetic Algorithm in Automated Assessment of School Readiness , *IEEE IRI 2010*, August 4-6, 2010, Las Vegas, Nevada, USA 978-1-4244-8099-9

Surjeet, K. Y., Brijesh, B., & Saurabh, P. (2012). Mining Education Data to Predict Student's Retention: A comparative Study. *(IJCSIS) International Journal of Computer Science and Information Security*, Vol. 10, No. 2.

Surjeet, K. Y., & Saurabh P. (2012) Data Mining: A Prediction for Performance Improvement of Engineering Students using Classification. *World of Computer Science and Information Technology Journal* (WCSIT), Vol. 2, No. 2, pp. 51-56.

Swick, K. J. (1987). *Readings on multicultural learning in early childhood education* . Little Rock, AR: Southern Early Childhood Association.

Syswerda, G. & Palmucci, J. (1991) The application of genetic algorithms to resource scheduling. In R. K. Belew and L. B. Booker, editors, *Proceedings of the Fourth International Conference on Genetic Algorithms and Their Applications*, pp. 502-508, San Mateo, CA. Morgan Kaufmann

Takagi, H. (2001). Interactive evolutionary computation: fusion of the capabilities of EC optimization and human evaluation in Proceedings of the IEEE01, IEEE Press, 2001.

Tanner, T., & Toivonen, H. Predicting and preventing student failure – using the k-nearest neighbour method to predict student performance in an online course environment.

Teaching Strategies, Incorporated - Available at: http://www.teachingstrategies.com

Thai, A., Lowenstein, D., Ching, D., & Rejeski, D. (2009). Game changer: Investing in digital play to advance children's learning and health. New York: The Joan Ganz Cooney Center at Sesame Workshop.

The Psychological Corporation - Available at: http://harcourtassessment.com

Thévenin, D., & Coutaz, J. (1999). Adaptation and plasticity of user interfaces // Proceedings of the *Workshop on Adaptive Design of Interactive Multimedia* Presentations for Mobile Users. – Barcelona.

Tobias, S., & Fletcher, J. D. (2007). What research has to say about designing computer games for learning. *Educational Technology*, Vol. 47, No. 5, pp. 20–29.

Tobias, S., & Fletcher, J. D. eds. (2011). *Computer Games and Instruction*. Charlotte, NC: Information Age Publishers.

Tobias, S., Fletcher, J. D., Dai, D. Y., & Wind, A. P. (2011). Review of Research on Computer Games. In Computer Games and Instruction, ed. S. Tobias and J. D. Fletcher, pp. 127–222. Charlotte, NC: Information Age.

Tout, K., Starr, R., Soli, M., Moodie, S., Kirby, G., & Boller, K. (2010). . *The Child Care Quality Rating System (QRS) Assessment: Compendium of Quality Rating Systems and Evaluations*. Washington DC: Office of Planning, Research and Evaluation, Administration for Children and Families, Department of Health and Human Services.

Tramontana, M. G., Hooper, S. R., & Selzer, S.C. (1988). Research on the preschool prediction of later academic achievement. *Developmental Review*, Vol. 8, pp. 89–147.

Trapmann, S., Hell, B., Hirn, J. W., & Schuler, H. (2007). Meta-analysis of the Relationship between the Big Five and Academic Success at University. *Journal of Psychology,* Vol. 215, pp. 132–151.

Trilling, B., & Fadel, C. (2009). *Twenty-First-Century Skills: Learning for Life in Our Times*. San Francisco: Jossey-Bass.

UK Department for Education (2014) The national curriculum for England, Available at:https://www.gov.uk/government/collections/national-curriculum (Accessed: 16 July 2014).

UNESCO. (2003). *Education for All in Latin America: A goal within our reach*. Regional EFA Monitoring Report. Paris, UNESCO.

UNESCO EFA. (1998). *Wasted Opportunities: When Schools Fail Wasted Opportunities--Education for All, Status and Trends* (pp. 1–51). Paris, France.

UNESCO EFA. (2011a). *State of Education in Brazil: Ensuring Quality Education for All.* (pp. 4–6).

UNESCO EFA. (2011b). *Regional overview: Latin America and the Caribbean.* (pp. 1–20).

UNESCO Institute for Statistics (2012). *Regional and Country Profiles,* Available at:*http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=198&IF_Language=eng.*

UNESCO Institute for Statistics (2013) Pre-Primary education (ISCED 0) Gross enrolment ratio, Available at: http://data.un.org/Data.aspx?d=UNESCO&f=series%3AGER_0.

UNICEF. (2011). *Basic Education Department in the Republic of South Africa and social development Department in the Republic of South Africa*. Tracking public expenditure and assessing

UNESCO/OECD. (2007). *Early Childhood and Family Policy Series. Policy Review Report: Early Childhood Care and Education in Brazil.* (pp. 10–16). Paris, France.

UNESCO (2007) *EFA Global Monitoring Report 2007: Strong foundations – Early childhood care and education*, Paris: UNESCO.

UNICEF. (2006a). *Guidelines for Early Childhood Development Services*. South Africa.

UNICEF. (2006b). *Lebanon - Early Childhood Care and Education (ECCE) programmes, Compiled by: UNESCO International Bureau of Education (IBE)*, Geneva, (Switzerland).

service quality in Early Childhood Development in South Africa 2011.

Valimaki, A., & Lindberg, P. (2004) National Curriculum Guidelines on Early Childhood and Care in Finland, Helsinki: Stakes. Available at: http://www.thl.fi/thl-client/pdfs/267671cb-0ec0-4039-b97b-7ac6ce6b9c10.

Vialle, W. (1997). In Australia: Multiple intelligences in multiple settings. Educational *Leadership*, Vol. 18, No. 4, pp. 30-38.

Vogler, P., Crivello, G., & Woodhead, M. (2008) Early childhood transitions research: A review of concepts, theory, and practice. Working Paper No. 48. The Hague, The Netherlands: Bernard van Leer Foundation

Vygotsky, L. S. (1987). *The collected works of L. S.* Vygotsky. New York: Plenum.

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental processes*. Cambridge, MA: Harvard University Press.

Wachs, T. D., & Camli, O. (1991). Do ecological or individual characteristics mediate the influence of the physical environment upon maternal behavior? *Developmental Psychology*, Vol. 11, No. 3, pp. 249-264.

Walberg, H. J., & Stariha, W. E. (1992). Productive Human Capital: Learning, Creativity, and Eminence. *Creativity Research Journal,* Vol. 5, pp. 323–340.

Wayne, C. M., Fantuzzo, J. W., & McDermott, P. A., (2004). Preschool competences in context: an investigation of the unique contribution of the child competences to early academic success. *Developmental Psychology*, Vol. 40, No. 4, pp. 633-645.

Weigel, D., & Martin, S. (2006). Identifying key early literacy and school readiness issues: Exploring a strategy for assessing community needs. *Early Childhood Research & Practice,* Vol. 8, No. 2. Retrieved from http://www.questia.com/read/5017885745?title=Identifying%20Key%20Early%20Literacy%20and%20School%20Readiness%20Issues%3a%20Exploring%20a%20Strategy%20for%20Assessing%20Community%20Needs

Wen, D., Graf, S., Lan, C. H., Anderson, T., Kinshuk, C., & Dickson, K. (2007). //Adaptive Assessment in Web-Based Learning / Proceedings of the IEEE *International Conference Multimedia and Expo* 2007. –Beijing, 2007. – P.1846-1849.

What is Computer Assisted Assessment? (1999). [Electronic resource] / University of Leicester. – http://www2.le.ac.uk/Members/rjm1/talent/book/c3p2.html – 01.10.2008.

Whitley, D. (2001). An overview of evolutionary algorithms: practical issues and common pitfalls. *Information and Software Technology*, Vol. 43, pp. 817-831.

Williams, R.A. (1984). Preschoolers and the computer. *Arithmetic Teacher*, Vol. 4, No. 31, pp. 39–42.

Willms, J. D. (2002). *Standards of care: Investments to improve children's educational outcomes in Latin America*. In M. E.Young (Ed.), From early child development to human development (pp. 81–122). Washington, DC: The World Bank.

Willms, J. D., & Somers, M. A. (2001). Family, classroom and school effects on children's educational outcomes in Latin America. *International Journal of School Effectiveness and Improvement*, Vol. 12, No. 4, pp. 409-445.

Wilson, K. A., Bedwell, W., Lazzara, E. H., Salas, E., Burke, C. S., Estock, J., & Conkey, C. (2009). Relationships between Game Attributes and Learning Outcomes: Review and Research Proposals. *Simulation and Gaming*, Vol. 40, No. 2, pp. 217–266.

Winter, S., & Kelley, M. (2008). Forty years of school readiness research: What have we learned? *Childhood Education*, Vol. 84, No. 5, p. 260.

Witten, I. H., & Frank, E. (2005). *Data Mining: Practical Machine Learning Tools and Techniques*, Morgan Kaufman, San Francisco, CA.

Wolf, A. (2004) *England: New Governments' New Policies in Balancing Change and Tradition in Global Education Reform.*

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *The Woodcock-Johnson® III (WJ-III®) Tests of Achievement*. Itasca, IL: Riverside Publishing Co.

Woodcock, R. W., McGrew, K. S., & Mather, N. (2001). *The Woodcock-Johnson® III (WJ-III®) Tests of Cognitive Abilities*. Itasca, IL: Riverside Publishing Co.

Woodcock, R. W., Muñoz-Sandoval, A. F., McGrew, K. S., & Mather, N. (2005). *Batería III Woodcock-Muñoz™*. Itasca, IL: Riverside Publishing Co.

Woodcock, R. W.; Kevin S., McGrew, K. S., & Schenk, F. A. (2007). *Woodcock–Johnson III Normative Update Technical Manual*. Itasca: Riverside.

Woodcock, R. W.; Mather, N., & McGrew, K. S. (2001). *Woodcock–Johnson III Tests of Cognitive Abilities Examiner's Manual*. Itasca: Riverside.

Woodcock, R., W., Schrank, F., McGrew, K., Ruef, M., Alvarado, C., & Muñoz-Sandoval, A. (2005). *Batería III Woodcock-Muñoz™ - Assessment Service Bulletin Number 1, Overview and Technical Supplement*. Riverside Publishing Company.

Woodcock-Johnson III Normative Update (NU) Tests of Cognitive Abilities. Riverside Publishing. Retrieved 29 January 2013.

World Bank. (2012). *World Development Indicators & Global Development Finance*.

Xiaoming, L., Melissa, S., & Atkins, B. S. (2006). Effects of Home and School Computer Use on School Readiness and Cognitive Development Among Head Start Children: A Randomized Controlled Pilot Trial. *Merrill-Palmer Quarterly*, Vol. 52, No. 2, pp. 239-263.

Ye, P., & Baldwin, T. (2005). Semantic role labeling of prepositional phrases. In The Second *International Joint Conference on Natural Language Processing*, Jeju Island, Korea, pp. 779–791.

Yelle, L. E. (1979). *The Learning Curve- Historical Review and Comprehensive Survey*. University of Lowell.

Zafra, A., & Ventura, S. (2009). Predicting Student Grades in Learning Management Systems with Multiple Instance Genetic Programming. *Educational Data Mining*, pp. 309-318.

Zalles, D., Haertel, G., & Mislevy, R. (2010). *Using Evidence-Centered Design to Support Assessment, Design and Validation of Learning Progressions (Large-Scale Assessment Technical Report 10)*. SRI International, Menlo Park, CA.

Zapata-Gonzalez, A., Menendez, V. H., Prieto-Méndez, M. E., & Romero, C. (2009). Using data mining in a recommender system to search for learning objects in repositories. This research has been partially supported by the Regional Government of Andalucia, Spain, excellence project, JCCM, Spain and PLINIO project, JCCM, Spain; The National Council of Science and Technology (CONACYT, México) and the Council of Science and Technology of Yucatán State (CONCyTEY, México).

Zelazo, P. D., Muller, U., Frye, D., & Marcovitch, S. (2003). The development of executive function in early childhood. *Monographs of the Society for Research in Child Development*. Serial No. 274, Vol. 68, No. 3.

Zhang, Y. (1998). Japanese ECEC from the Eyes of a Chinese Researcher, Research Bulletin of ECEC vol.16, Institute for ECEC Research, , (translated into Japanese).

Zhang, Y., Oussena, S., Clark, T., & Kim, H. (2009). Use Data Mining To Improve Student Retention In Higher Education – A Case Study. In: ICEIS - 12th *International Conerence on Enterprise Information Systems*, 2010., 8-12 June, Portugal.

Ziajka, A. (1983). Microcomputers in early childhood education? a first look. *Young Children*, Vol. 38, pp. 61–67.

Zill, N., & et al. (1995). School readiness and children's developmental status. Urbana, IL: ERIC Clearinghouse on Elementary and Early Childhood Education. Report: EDO PS. (ERIC Document Reproduction Service Report No. ED389475).

Arabic Resources

بشور, نجلاء وآخرون (2002). "رياض الاطفال في لبنان". بيروت: الهيئة اللبنانية للعلوم التربوية

(In English: Bachur, Nagla and others (2002). “Kindergartens in Lebanon”. Beirut: The Lebanese Association for Educational Studies)

بشور, نجلاء (2002). "واقع رياض الاطفال في لبنان". بيروت: الهيئة اللبنانية للعلوم التربوية. ص ص 189-186.

(In English: Bachur, Nagla (2002a). “The reality of Kindergartens in Lebanon”. Beirut: The Lebanese Association for Educational Studies. pp 186-189)

بشور, نجلاء (2002). " رياض الاطفال في لبنان: واقع وتحديات". بيروت: الهيئة اللبنانية للعلوم التربوية. ص 429.

(In English: Bachur, Nagla (2002b). “The Kindergartens in Lebanon: Reality and Challenges”. Beirut: The Lebanese Association for Educational Studies. p 429)

حطيط, فادية (1999). "نظرة في منهج رياض الاطفال في لبنان", في: رياض الاطفال في لبنان. بيروت: الهيئة العامة للعلوم التربوية.

(In English: Hatit, Fadia (1999). “Look into the curriculum of kindergartens in Lebanon”. “The Kindergartens in Lebanon”, Beirut: The Lebanese Association for Educational Studies)

سليم, مريم (2002). "المنهج الرسمي لرياض الاطفال في لبنان", في: رياض الاطفال في لبنان. بيروت: الهيئة العامة للعلوم التربوية, ص, 213.

(In English: Saleem, Mariam (2002). “The official curriculum for kindergarten in Lebanon”. “The Kindergartens in Lebanon”, Beirut: The Lebanese Association for Educational Studies, p.213)

مقلد, سمر (2002). "التقييم والعلاقة مع الاهل في مرحلة الروضة". في: رياض الاطفال في لبنان. بيروت: الهيئة العامة للعلوم التربوية, ص. 321.

(In English: Mukalid, Samar (2002). “Evaluation and relationship with parents in kindergarten”. “The Kindergartens in Lebanon”, Beirut: The Lebanese Association for Educational Studies, p.321)

APPENDICES

Appendix 1: Early childhood Curricula in 10 Countries

Country	Curriculum based upon below areas of learning
Brazil	Child development, including motor skills, cognitive skills, and social skills
Finland	Mathematics, Science, History, Aesthetics, Ethics, Religious
France	Behavior towards learning, Handwriting and drawing, Physical activities and music, Nature and science, Early literacy, French language arts, Mathematics, Time and space concepts, English language, Art
Germany	Linguistic education and promotion, Mathematics, Natural science and technical education, Musical education and child raising, Aesthetic, Visual and cultural education and child-raising, Promotion of movement and sport, Health and child-raising
Israel	Literacy, Mathematical thinking, Arts, Life skills
Japan	Health, language, Expression, Human relationships, and Environment.
Lebanon	Cognitive development, Language development and communication, Social and emotional development, Physical and motor development, Creative expression
South Africa	Literacy: Listening, Speaking, Reading and viewing, Writing, Thinking and reasoning and Language structure and use. Numeracy: Numbers, operations, and relationship, Patterns, functions, and algebra, Space and shape (Geometry), Measurement, Data handling. Life skills: Historical interpretation, Creating, interpreting, and presenting, Health promotion
UK	Personal, social and emotional development, Communication, language and literacy, Mathematical development, Knowledge and understanding of the world, Physical development, Creative development.
USA	*Kentucky Curriculum*: Cognition and communication, Social and emotional development, Physical development. *Massachusetts Curriculum*: Mathematics, Science and technology, Social sciences/social studies including USA and world history, geography, economics, civics and government English language, World languages, Arts including dance, music, theatre and the visual arts, Health including health education, physical education and family and consumer science education.

Appendix 2: Early Childhood - OECD Perspective 2013
(Source: Education Today 2013. The OECD Perspective. (2013). OECD Publishing)

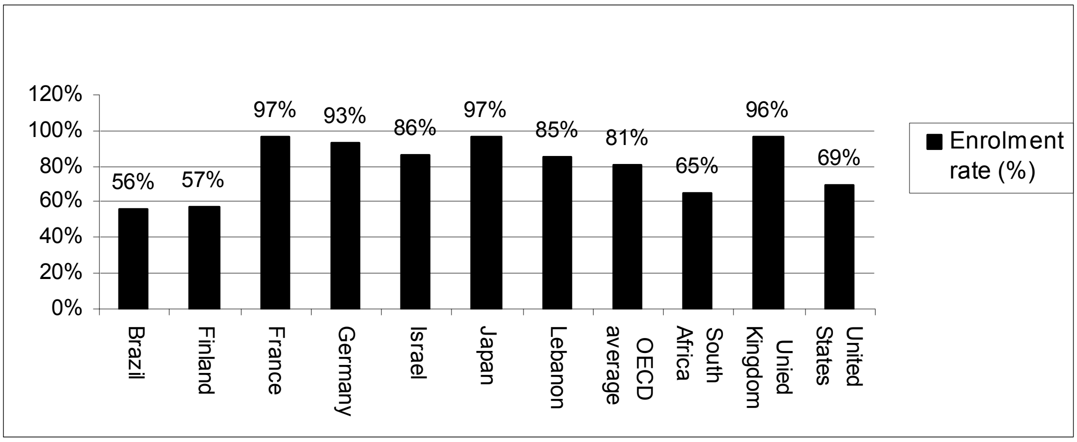


Figure 25- Enrolment rate

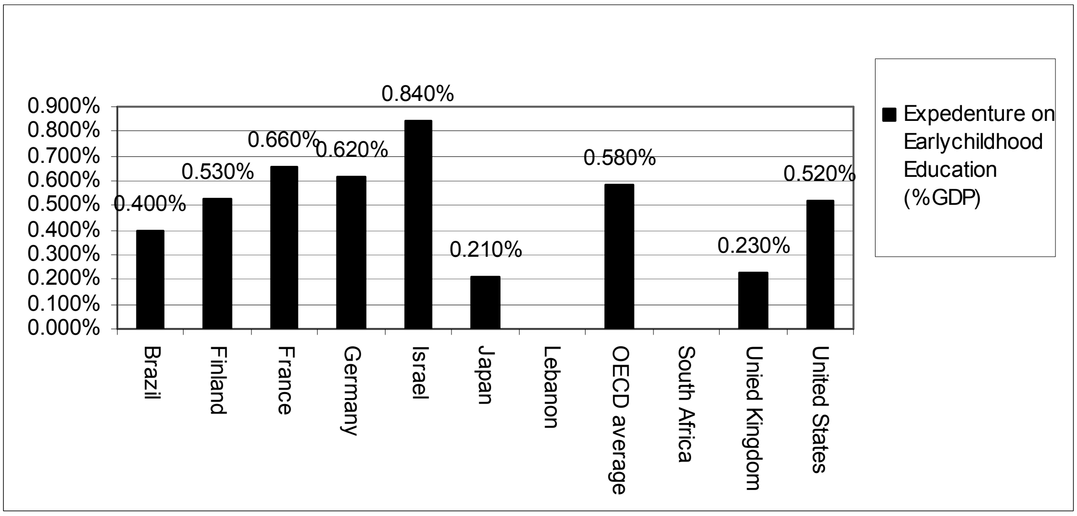


Figure 26- Expedenture on Earlychildhood Education (%GDP)

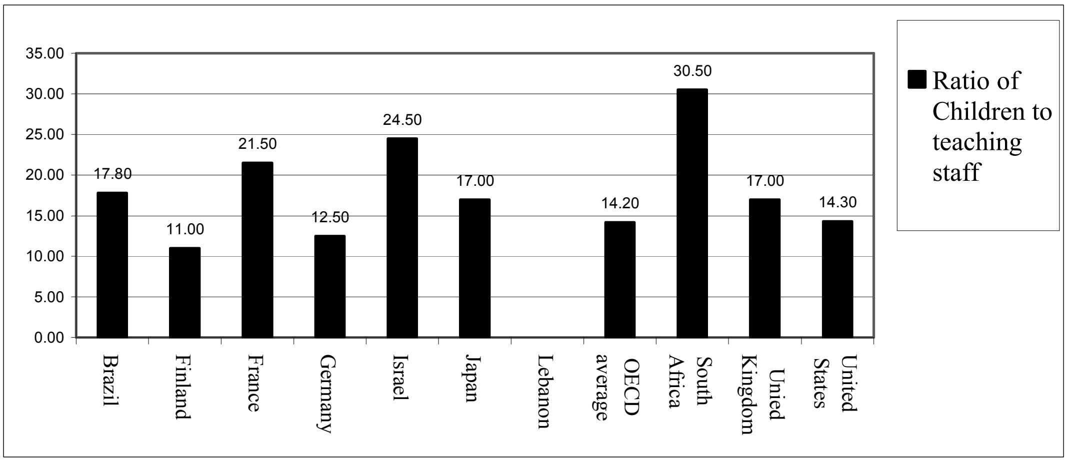


Figure 27- Ratio of Children to teaching staff

Appendix 3: Tools that Examine Developmental/Cognitive/Mental Function

3.1 Ages and Stages Questionnaires: Social Emotional (ASQ-SE)

Publisher	Brookes Publishing Company
Date	2002
Domains/Areas Assessed	- **General areas screened:** Personal-social (self-regulation, compliance, communication, adaptive functioning, autonomy, affect, and interaction with people) - There are 8 questionnaires (corresponding to 8 designated age intervals); each includes 22 - 36 developmental items
Uses or purpose of instrument	- The **ASQ: SE** is a series of 8 questionnaires designed to be completed by parents to address the emotional & social competence of young children. - Created in response to feedback from Ages & Stages
Age Range	6–60 months
Administration Time	Each questionnaire takes 10–15 minutes to complete and approximately 3 minutes to score
Examiner	Professionals, paraprofessionals and non-professionals;
Scores	- Professionals converted parents' responses of ***most of the time, sometimes***, and ***rarely*** or ***never*** to 10, 5, and 0, & the total score, respectively — in just 2-3 minutes — to color coded scoring sheets, enabling them to quickly determine a child's progress in each developmental area and total.
Language(s)	Questionnaires in English and Spanish
Type (norm-/criterion-referenced)	Norm-referenced questionnaires (by age intervals)
Periodic vs. Ongoing	Ongoing (when used for monitoring purposes - which is often)
Validity	- Validity was studied by comparing the classification of questionnaires completed by parents with the classification of standardized assessments by trained examiners. Comparisons were made with the following instruments: the Child Behavior Checklist (1991, 1992); the Vineland Social-Emotional Early Childhood Scale (1998) - Concurrent validity between the **ASQ:SE** & concurrent measures ranged from 81% to 95% with overall agreement of 93%; - Sensitivity (ability to detect delayed development) ranged from 71% to 85% with 78% overall sensitivity. - Specificity (ability to screen correctly those children without delayed development) ranged from 90% to 98% with 95% overall specificity - supporting the usefulness of the **ASQ:SE**
Reliability	Investigated with over 3,000 children across the age intervals and their families. Test-retest reliability was 94%
Uses Manipulative Materials	Mostly those in natural environment
Adaptations for Special Needs	N/A

3.2 Bateria III Woodcock-Muñoz™

Publisher	The Riverside Publishing Company
Date	2005
Domains/Areas Assessed	The Cognitive battery offers 6 major scales that yield a General Intellectual Ability (GIA) Score: □ Brief Scale □ Standard Scale □ Extended Scale □ Early Development Scale □ Bilingual scale (w/ Diagnostic Supplement) □ Low verbal scale (w/ Diagnostic Supplement)
Uses or purpose of instrument	Provides a comprehensive system for measuring general intellectual ability (including bilingual and low verbal), specific cognitive abilities, scholastic aptitude, oral language, and academic achievement.
Age Range	2.0 to 90.0+ years
Administration Time	Varies, approximately 5-10 minutes per test
Examiner	Professionals (commonly used by bilingual school psychologists in school settings) ● Training required ● Practice sessions are recommended prior to "real" Administration
Scores	**WJ III® Compuscore® and Profiles Program** allows to score and report quickly and easily, Provides a brief summary report in both English and Spanish
Language(s)	Spanish
Type (norm-/criterion-referenced)	Norm-referenced - The norms are from the WJ III® - year 2000, which allows comparisons between an individual performance on the Batería III and the WJ III; includes co-normed cognitive and achievement batteries.
Periodic vs. Ongoing	Periodic
Validity	N/A
Reliability	N/A
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.3 Battelle Developmental Inventory 2nd Edition (BDI-2)

Publisher	The Riverside Publishing Company
Date	2004
Domains/Areas Assessed	● Five (5) Domains: ● Personal-Social, Adaptive, Motor, Communication & Cognitive Twenty-two (22) Subtests including, but not limited to the Expression of feelings, peer interaction, attention, personal responsibility, body coordination, fine motor, perceptual motor communication (receptive/expressive), perceptual discrimination, memory, conceptual development, reasoning & academic skills.
Uses or purpose of instrument	● To assess and identify pre-k children w/disabilities

	● To evaluate groups of pre-k children w/disabilities ● To assess the typically developing pre-k child ● To assess or screen for school readiness ● To use for program evaluation & accountability purposes ● The screening test consists of 96 of the 341 total items & identifies if there is a need for further examination ● The full BDI-2 provides useful information for eligibility or placement decisions ● Useful for Head Start mandates ● Matches all areas as required by IDEA
Age Range	Birth to 7 years/11 months
Administration Time	● Complete BDI-2: 1 - 2 hours; ● Screening Test: 10 - 30 minutes
Examiner	● Can be administered by a team of professionals or by an experienced individual service provider
Scores	● Hand scored or scored w/optional scoring software: the BDI-2 ScoringPro software. Examiners can also use the BDI-2S Personal Digital Assistant (PDA) application - Palm® Solution - which includes both English and Spanish versions ● Data is collected on electronic record forms. ● Examiners then hotsynch data to their local desktop & can use the scoring software ● Flexible web-based scoring options for use by team of professionals or single examiner ● Wide range of computerized reports to choose ● Scoring procedure for BDI-2 Screening are similar to those of the full BDI-2, but cut-off scores are provided to help identify children who need additional follow-up
Language(s)	● English & Spanish
Type (norm-/criterion-referenced)	● Norm-referenced ● Normative data gathered nationally from over 2500 children between the ages of birth to 7 years 11 months - for the 2nd edition of instrument ● Sample closely matched the 2000 U.S. Census ● (The earlier version of the BDI-2 (BDI, 1985) was standardized nationally on approx. 800+/- subjects)
Periodic vs. Ongoing	Periodic
Validity	Correlations are in the .79 to .94 range when compared to similar instruments - according to publishers &/or the related literature on the topic
Reliability	Test-Retest Reliability for the BDI Total was in the .90 to .99 range according to publishers &/or related literature
Uses Manipulative Materials	Yes
Adaptations for Special Needs	Yes

3.4 Behavior Assessment System for Children - Second Edition (BASC-2)

Publisher	AGS Publishing
Date	2005

Domains/Areas Assessed	A comprehensive set of rating scales and forms including the *Teacher Rating Scales (TRS)*, *Parent Rating Scales (PRS)*, *Self-Report of Personality (SRP), Student Observation System (SOS),* and *Structured Developmental History (SDH).* ● By analyzing the child's behavior from three perspectives—Self, Teacher, and Parent—one gets a more complete and balanced picture, as follows: □ **Self Perspective -** ○ ***Self-Report of Personality (SRP):*** provides insight into a child's or adult's thoughts and feelings. ○ Each form—child (ages 8 to 11), adolescent (ages 12 to 21), college (ages 18 to 25)—includes validity scales for helping judge the quality of completed forms. ▪ A Spanish version is available for the child and adolescent forms. ○ The BASC-2 version includes an SRP-Interview (SRP-I) form for children 6-7 in which children provide simple yes-or-no responses to questions asked by examiner; responses are then recorded on a checklist – takes 20 minutes to complete. □ **Teacher Perspectives -** ○ ***Teacher Rating Scales (TRS):*** used to measure adaptive and problem behaviors in the preschool or school setting. ○ The forms describe specific behaviors that are rated on a four-point scale of frequency, ranging from "Never" to "Almost Always"; the TRS contains 100-139 items. ○ ***Student Observation System (SOS):*** used to code and record direct observations of a child's behavior utilizing momentary time sampling—during 3-second intervals spaced 30 seconds apart for 15 minutes. ▪ SOS assesses both adaptive and maladaptive behaviors, from positive peer interaction to repetitive motor movements ○ The SOS can also be used for the direct observation portion of a FBA (Functional Behavioral Assessment). Assessment Tools 38 ○ You can use the SOS on its own, or with other BASC-2 components. □ **Parent Perspectives -** ○ ***Parent Rating Scales (PRS):*** used to measure both adaptive and problem behaviors in the community and home setting. ○ The PRS contains 134-160 items and uses a fourchoice response format. ○ ***Structured Developmental History (SDH):*** a 12-page history and background survey, helps when gathering crucial information for the diagnostic and treatment process. The SDH provides a thorough review of social, psychological, developmental, educational, and medical Information about a child.

	○ You can use the SDH on its own, or with other BASC-2 Components. □ Activities of Daily Living, Adaptability, Aggression, Anxiety, Attention Problems, Atypicability, Conduct Problems, Depression, Functional Communication, Hyperactivity, Leadership, Learning Problems, Social Skills, Somatization, Study Skills, Withdrawal ● This revision of the BASC includes new scales: ***Functional Communication (TRS/PRS), Activities of Daily Living (PRS), Attention Problems (SRP),*** and ***Hyperactivity (SRP)***
Uses or purpose of instrument	The BASC-2 is a multi-method, multi-dimensional system to evaluate the behavior and self-perceptions of children young adults - it is multi-dimensional in that it has five components, which may be used individually, or in any combination, and that it measures numerous aspects of and personality, including positive (adaptive) as well as (clinical) dimensions ● BASC-2 is a well-established system for measuring behavior and emotions - together the comprehensive set of rating scales and forms will help you help understand the behaviors and emotions of children and adolescents. ● These scales measure areas important for both IDEA and DSM-IV classifications. In addition, the instrument is respected for its developmental sensitivity and provides the most extensive view of adaptive and maladaptive behavior. ● The uses of the basic BASC-2 tools are the following: □ **To assess behavior patterns** - Teacher Rating Scales (TRS); Parent Rating Scales (PRS); Student Observation System (SOS) □ **To assess emotions and feelings** - Self-Report of Personality (SRP) □ **To gather background information** - Structured Assessment Tools 39 Developmental History (SDH) ● A great benefit of the BASC-2 if that it **differentiates between hyperactivity and attention problems**
Age Range	2-0 through 21-11
Administration Time	Complete forms in about 10–20 minutes for each of the three age levels — preschool (ages 2 to 5), child (ages 6 to 11), and adolescent (ages 12 to 21)
Examiner	Professionals - test users/examiners should have a Ph.D. in Psychology or be certified in School Psychology (applicable for administration of TRS, PRS, and SRP) ● Paraprofessionals with training and supervision - (applicable for administration of SOS and SDH)
Scores	○ T scores and percentiles, for a general population and clinical populations **Parent Feedback Report:**

	○ Survey results are presented to parents by means of the Parent Feedback Report - the reports work with all age levels of the TRS, PRS, and SRP ○ Parents receive test results, interpretative information, definitions of behavior problems, an explanation of treatment approaches, and next steps ○ Includes a resource list
Language(s)	English and Spanish
Type (norm-/criterion-referenced)	Norm-referenced - Normed based on current U.S. Census population characteristics
Periodic vs. Ongoing	Periodic
Validity	● **Concurrent:** Groups of children with preexisting clinical diagnoses tend to have distinct BASC-2 profiles. Assessment Tools 40 ● **Predictive:** none ● **Content:** Item content came from teachers, parents, children, and psychologists, as well as from reference sources such as the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV-TR; American Psychiatric Association, 2000) and other instruments.
Reliability	● Internal consistency: **TRS -** Preschool (age 2 -3) within the range of .87-.96 for Composites; and .75-.92 for the Scales. Preschool (age 4 -5) within the range of .91-.96 for Composites; and .81-.93 for the Scales. **PRS -** Preschool (age 2 -3) within the range of .85-.93 for Composites; and .77-.88 for the Scales. Preschool (age 4 -5) within the range of .87-.93 for Composites; and (.70-.87) for the Scales. ● Test-retest: **TRS -** Preschool (age 2 -5) within the range of .84-.87 for Composites; and .72-.87 for the Scales. **PRS -** Preschool (age 2 -5) within the range of .81-.86 for Composites; and .72-.85 for the Scales.
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.5 Bilingual Verbal Ability Tests- Normative Update (BVAT-NU)

Publisher	The Riverside Publishing Company
Date	2006
Domains/Areas Assessed	The Bilingual Verbal Ability Tests are comprised of three subtests from the *Woodcock-Johnson-Revised Test of Cognitive Ability; Picture Vocabulary; Oral Vocabulary*, and *Verbal Analogies.* ● These three subtests have been translated into eighteen languages, plus English
Uses or purpose of instrument	● Provides a measure of overall verbal ability for bilingual individuals, or the unique combination of cognitive/academic language abilities possessed by bilingual individuals in English and another language. □ The need for this test is based in the reality that

	bilingual persons know some things in one language, some things in the other language, and some things in both languages - traditional procedures only allow the person's ability to be tested in the dominant language. ● The BVAT-NU can be used for a variety of purposes in bilingual education and clinical assessment; it can be used for entry and exit criteria for bilingual programs. It can be used to assess the academic potential of bilingual students through a comparison of his or her current level of English language proficiency to his or her bilingual verbal ability. ● The BVAT-NU can also be used in place of Tests 1 an 31 the WJ® III Tests of Cognitive Abilities to provide a general intellectual ability-bilingual (GIA-Bil) score.
Age Range	5.0 to Adult
Administration Time	An estimate is approximately 30 minutes
Examiner	● It may be administered either by one examiner who is fluent in the individual's two languages, or, alternatively, by a primary and ancillary examiner team when a bilingual examiner is not available.
Scores	Scores that can be generated by using the BVAT include: SS, PR, AE, GE, RPI, Instructional Ranges, CALP levels ● The BVAT-NU provides an overall score (BVA) which can be used to determine an individual's overall level of verbal ability. ● For comparative purposes, the BVAT-NU also provides a measure of English language proficiency. ● The BVAT yields an aptitude measure that can be used in conjunction with the WJ-R Tests of Achievement. ● A Scoring and Reporting Program is included with each test kit. This software program automates scoring procedures and provides a narrative report of the individual's bilingual verbal ability, English language proficiency, and language use and exposure. When used with the WJ-R Tests of Achievement, the achievement test results are scored and aptitude/achievement discrepancies are calculated and interpreted. The program determines and explains whether any identified discrepancy is related to limitations of English language proficiency.
Language(s)	The languages available in BVAT -NU are: Arabic; Chinese Simplified; Chinese Traditional; French; German; Haitian-Creole; Hindi; Hmong; Italian; Japanese; Korean; Navajo; Polish; Portuguese; Russian; Spanish; Turkish; Vietnamese - plus English
Type (norm-/criterion-referenced)	Norm-referenced
Periodic vs. Ongoing	Periodic

Validity	The construct validity of the BVA score was validated by comparing estimates of bilingual verbal ability obtained by two parallel, but independent, testing procedures. No further details were available, per results of search
Reliability	According to the publishers, alternative form procedures reliabilities are provided for the BVA score. No further details were available, per results of search
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.6 Bracken Basic Concept Scale: Expressive (BBCS:E) and (BBCS–3:R)

Publisher	The Psychological Corporation
Date	2006
Domains/Areas Assessed	The BBCS-3:R is a revision of a test (including updated norms and new items) meant to complement the Expressive Bracken instrument: The Bracken Basic Concept Scale: Expressive (BBCS:E) detailed separately. The BBCS-3:R assesses important educational concepts such as: ● color, letter/sounds, numbers/counting, size, shapes, direction/position, self-/ social-awareness, texture/material, quality, time/sequence
Uses or purpose of instrument	● The BBCS-3:R is a developmentally sensitive measure of children's basic concept knowledge - includes the ability to evaluate a child's (receptive) understanding of basic concepts. ● The purpose of the BBCS-3:R is to evaluate the acquisition of basic concepts of a child, and to determine cognitive and (receptive) language development for childhood academic achievement. ● Assists in developing appropriate IEP goals that relate to the educational curriculum ● Follows the early childhood education curriculum outlined through Head Start and No Child left Behind Act
Age Range	3:0 through 6:11 years
Administration Time	30 to 45 minutes
Examiner	Professional and paraprofessional
Scores	● Standard scores and concept age equivalents ● Scoring Assistant software which quickly and accurately score test results, maintain demographic information, store raw scores, and create comprehensive graphical and narrative reports for both the BBCS–3:R and BBCS:E
Language(s)	English and Spanish
Type (norm-/criterion-referenced)	Norm-referenced
Periodic vs. Ongoing	Periodic to monitor progress
Validity	None described yet
Reliability	None described yet
Uses Manipulative Materials	None described

Adaptations for Special Needs	N/A

3.7 Brigance K & 1 Screen II

Publisher	Curriculum Associates®, Inc.
Date	2005
Domains/Areas Assessed	● The broad areas screened are the following: □ general knowledge & comprehension □ speech & language □ fine-motor & gross-motor skills □ pre-academic/academic □ social-emotional & self-help scales □ reading skills & manuscript writing ● Specific areas sampled include: □ personal data (response & in print) □ color recognition □ visual discrimination, visual motor & gross motor □ rote counting, number readiness, numerals in sequence □ body parts & draws-a-person □ syntax & fluency □ reads upper or lower case letters, recites alphabet □ auditory discrimination & listening vocabulary □ phonemic awareness, decoding & word recognition □ computation □ work/help skills & feeding/eating skills □ toileting skills □ play skills & behaviors □ gets along with others ● Supplemental assessments include uppercase letters dictated, lowercase letters dictated, verbal concepts, substitutes initial consonant sounds
Uses or purpose of instrument	To screen key developmental & early academic skills before entering kindergarten & first grade ● To assist teachers with classroom planning & mandated screening compliance, as well as to indicate developmental problems - language, learning, or cognitive delays - & to identify children with academic talent or intellectual giftedness ● At-risk guidelines for use in prevention programs is included to identify children in need of prompt referral ● K & 1 Screen II correlates to Head Start Child Outcomes Framework; Parent questionnaires add valuable information to the screening process. ● Meets IDEA requirements & provides consistent results that support early childhood educators' observations & judgments ● Used by school districts nation-wide
Age Range	children 4.9 through the end of the first grade
Administration Time	10 - 15 minutes per child
Examiner	● Widely used in educational settings & often administered by paraprofessionals in addition to professionals
Scores	● Cut-off, age-equivalents, percentiles, & quotients in

	motor, language, and readiness, as well as overall scores, are generated ● In addition, there are cut-offs indicating potential giftedness and/or any psychological risk ● Growth indicator scores plot progress over time. ● Sensitivity & Specificity to giftedness & to developmental & academic problems are 70% to 82% across ages.
Language(s)	English, Spanish, Laotian, Vietnamese, Cambodian, and Tagalog
Type (norm-/criterion-referenced)	Depending on the information being sought, the Brigance® screens are both criterion-referenced & normed
Periodic vs. Ongoing	Periodic
Validity	● There is abundant support for the content validity of the Brigance screens & for the applicability of the screens in educational settings, according to publishers
Reliability	● Test-retest reliability in the lower grades was in the .85 range, and the inter-rater reliability (.97), alternative forms reliability, & internal consistency measures were also uniformly high (.80 - .97+/-).
Uses Manipulative Materials	No
Adaptations for Special Needs	No

3.8 Child Observation Record Second Edition (COR-2)

Publisher	High/Scope Educational Research Foundation
Date	2002
Domains/Areas Assessed	● The broad categories (or domains) assessed of eight items each are as follows: □ Initiative, Social Relations □ Creative Representation, Movement & Music □ Language & Literacy □ Mathematics & Science ● Assesses thirty-two dimensions of learning within above categories
Uses or purpose of instrument	● Designed to measure children's progress in early childhood programs including, but not limited to, those using the Highscope educational approach. ● The COR-2 is an observational assessment tool that charts children's development & progress over time ● Tool which enables teachers to construct a profile on each child that is directly connected to major educational goals ● Information is gathered by those who know the child best - the caregiver & the parent
Age Range	2.6 to 6.0 years
Administration Time	Ongoing
Examiner	● Teachers & other caregivers
Scores	● Scored the same way by different observers ● Score of 1 to 5 on 32 behaviors and skills with subscale scores for four broad categories ● Assessment log, portfolio, child observation, child

	interview ● Computerized version of COR-2, the Preschool COR CD-Rom Kit is available through High/Scope ● COR-Headstart Outcomes Reporter CD-Rom translates results into statistics, charts, & graphs that meets Headstart Outcomes reporting requirements
Language(s)	English & Spanish
Type (norm-/criterion-referenced)	● Criterion-referenced ● Highscope philosophy advocates avoiding comparisons between children - as one would with norm-referenced instruments
Periodic vs. Ongoing	Ongoing
Validity	● The COR-2 is valid, correlating as expected with concurrent measures of children's development & future measures of school success ● Moderate correlations with the Cognitive Skills Assessment Battery (CSAB), specially in language & literacy ● External validity was supported by expected correlation between COR-2 Total & CSBA (.46 - .62) & between COR-2 Total and children's ages (.31) with no significant association with gender ● Validity findings formed the rationale for re-grouping initial categories from six to four
Reliability	● According to publishers, reliability findings on ten pairs of teachers and assistant teachers rating the same children were as follows: □ .73 Total COR-2 □ .69 Initiative, Social Relations □ .70 Creative Representation, Movement & Music □ .79 Language & Literacy □ .73 Mathematics & Science
Uses Manipulative Materials	Yes
Adaptations for Special Needs	Yes

3.9 CELF® Preschool, Second Edition (CELF® Preschool-2)

Publisher	The Psychological Corporation
Date	2004
Domains/Areas Assessed	● The language assessment specifically designed for preschool aged children who are bound for the classroom: ● The CELF® Preschool-2 contains three composite scales (Receptive Language, Expressive Language, and Total Language), with the Receptive and Expressive Language scales each being comprised of three subtests. □ The Second Edition includes a variety of subtests that provide in-depth assessment of a child's language skills. □ It includes a pre-literacy scale and phonological awareness subtest. □ A pragmatics profile helps to describe the child's language use at school or at home. ● **Total Language Scale** is the total of the standard

	scores for all basic 6 subtests (i.e., the sum of the Receptive and Expressive Language scales). In addition, a **Quick-Test** can be administered as a screener to determine the need for further testing. ● **Receptive Language**: This scale contains the Linguistic Concepts, Sentence Structure, and Basic Concepts subtests. □ The ***Linguistic Concepts*** subtest assesses understanding of concepts such as the use of conjunctions (e.g., and, or), positive versus negative and location in space or time. □ The ***Sentence Structure*** subtest taps understanding of early acquired sentence formation rules, such as the ability to identify key attributes of items from an example of those items. □ The ***Basic Concepts*** scale involves the child's ability to understand modifiers, such as relative amount or size as well as basic concepts such as same versus different, and inside and outside. ● **Expressive Language**: The Expressive Language scale is comprised of the Recalling Sentences in Context, Formulating Labels, and Word Structure subtests. □ The ***Recalling Sentences in Context*** subtest measures the child's ability to recall and repeat a sentence that is read to him/her in the context of a story. □ The ***Formulating Labels*** subtest focuses on the child's ability to give verbal labels to nouns and verbs depicted in illustrations. □ The ***Word Structure*** subtest measures the child's understanding of morphological rules, through tapping his/her ability to provide word forms such as past tense, irregular verbs, and pronoun assignment. ● **Total Language**: The Total Language score is derived by summing scores for all six subtests included within the **Expressive** and **Receptive Language** scales. ● **Quick -Test**: The Quick-Test may be used as an initial step in assessment and consists of only the Linguistic Concepts and Recalling Sentences in Context subtests. A score of seven or below on the Quick -Test indicates that the remainder of the battery should be given to address specific language deficits. ● CELF® Preschool-2 is an individually administered test that assesses receptive and expressive language ability and an is used as a tool for identifying, diagnosing and performing follow-up evaluations of language deficits in preschool children
Uses or purpose of instrument	● CELF® Preschool-2 includes a **Behavioral Observation Checklist** to be used during or after the assessment to record specific child behaviors that occur in the testing session (makes note of physical activity level,

	attention to task, response latency, fatigue/boredom/ frustration, and level of interaction) ○ It is unclear whether there is a standardized way to include the Behavioral Observation Checklist in CELF® Preschool-2 scoring
Age Range	3.0 through 6.0
Administration Time	Un-timed, takes approximately 30 to 45 minutes ● The Quick-Test administration times are approximately half that of the full test.
Examiner	Professionals involved in preschool education, including speech language pathologists, child psychologists, educational diagnosticians, and special educators
Scores	● Total Language Score, Receptive Language Composite, Expressive Language Composite and additional index scores ● Standard Scores, Percentile Ranks, and Age Equivalents ● *CELF® Preschool-2 Scoring Assistant* - software that scores test results, maintains demographic information, stores raw scores and produces comprehensive graphical and narrative reports; all reports comply with IDEA mandates.
Language(s)	English
Type (norm-/criterion-referenced)	Norm-referenced - More than 1,500 children participated in standardization, reliability, and validity studies.
Periodic vs. Ongoing	Periodic
Validity	N/A
Reliability	N/A
Uses Manipulative Materials	N/A
Adaptations for Special Needs	N/A

3.10 Denver Developmental Screening Test II (DDST-R)

Publisher	Denver Developmental Materials Inc
Date	2005
Domains/Areas Assessed	● Broad categories of children's development in four areas of functioning: □ fine motor-adaptive □ gross motor □ personal-social □ language skills
Uses or purpose of instrument	● To determine if a child's development is within the normal range ● To identify changes in development rates or patterns over time ● (Utilized by pediatricians to test a child's use of movement, vision, hand skills & other general areas of development)
Age Range	Birth to 6.0
Administration Time	20 minutes
Examiner	Professionals
Scores	● Diagnostic scores are treated as categories: □ Normal

	□ Abnormal □ Questionable □ Untestable ● Sources of scoring are parent report, child observation & structured performance task
Language(s)	English & Spanish versions
Type (norm-/criterion-referenced)	Norm-referenced
Periodic vs. Ongoing	Periodic
Validity	● Yes, according to developers ● Other studies cite psychometric deficiencies of the DDST-R, such as poor sensitivity & specificity; however, if used with clinical judgment it may be a valuable tool for re-screening, parent-guidance, further evaluation or referral
Reliability	● Yes; according to developers, acceptable item test-retest and high inter-rater reliability (.90) ● Other studies cite low sensitivity in predicting later developmental status & school readiness ● Despite the psychometric deficiencies cited in studies, if used with clinical judgment, the DDST-R may be a valuable tool for re-screening, parent-guidance, further evaluation or referral
Uses Manipulative Materials	Yes
Adaptations for Special Needs	No

3.11 FirstSTEp: Screening Test for Evaluating Preschoolers

Publisher	Psychological Corporation
Date	1993
Domains/Areas Assessed	● A standardized screening tool - designed to identify young children who may have mild to severe school-related problems; meant only as a ***first step*** in the process of evaluating children with special needs/developmental delays ● Five domains: cognitive, communication, motor (fine & motor), social-emotional, and adaptive-behavior checklist □ The social-emotional assessment occurs by observing behaviors during the ***first step*** assessment. ○ Social-emotional areas evaluated include: task confidence; cooperative mood, temperance & emotionality, uncooperative antisocial behavior, attention communication difficulties. ● Each test consists of 12 subtests in the form of games designed to test each specific function
Uses or purpose of instrument	● Screening instrument which is: a) sensitive enough to detect even mild developmental delays b) used to assist the teacher in planning a developmental program which is appropriate for individual student needs & c) used to identify the children who need more complete, in-depth, diagnostic evaluations. ● Also designed as short companion to the ***Miller Assessment for Preschoolers (MAP) -*** a test of

	nonverbal, cognitive, verbal, neuromaturational and integrated abilities ● The main purpose is to screen for the presence of developmental delays in each of the 5 domains mandated by IDEA Amendments of 1991: cognition, communication, motor, social-emotional, and adaptive functioning
Age Range	2.9 to 6.2 years old
Administration Time	15 - 20 minutes
Examiner	● Professionals and paraprofessionals (teachers and aides, school nurse, special education specialist, speech pathologist, and the occupational and/or physical therapist - OT/PT)
Scores	● Age groupings; norm tables convert raw scores to scaled scores stratified by age for 5 domains and 1 composite ● A score is produced for each domain graded as ***acceptable limits, caution***, or ***at risk***; the total score can be directly compared with age-peer scores. ● Children demonstrating signs of developmental delay have been shown through validation studies to score 1.5 to 2 SD below the mean of normal children on this test. ● Correlates well with full developmental assessments, such as the Wechsler Preschool and Primary Scale of Intelligence-Revised (WPPSI-R)
Language(s)	English
Type (norm-/criterion-referenced)	Norm-referenced in 6-month designated age intervals;
Periodic vs. Ongoing	Periodic, but can be ongoing, if needed
Validity	● Both sensitivity and specificity are above 80% (8 out of 10 children will be correctly identified; and 8 out of 10 children will also be correctly identified, as such, and will not be referred for further evaluation or screening) ● Correlates well with full developmental assessments, such as the WPPSI-R.
Reliability	Did not find relevant information on this topic
Uses Manipulative Materials	Yes
Adaptations for Special Needs	Did not find relevant information on this topic

3.12 Kaufman Survey of Early Academic and Language Skills (K-SEALS)

Publisher	AGS Publishing
Date	1993
Domains/Areas Assessed	*K-SEALS* is an expanded and enhanced version of the Cognitive/Language Profile in the AGS Early Screening Profiles. This means you receive a more reliable and balanced evaluation in the subtest, scale, and composite content areas. *K-SEALS* features three separate domains for a well-rounded profile: ● Vocabulary Subtest—the child identifies, by gesture or name, pictures of objects or actions and points to or names objects based on verbal descriptions of their

	attributes ● Numbers, Letters & Words—the child selects or names numbers, letters, or words; counts; indicates knowledge of number concepts ("smallest," "half"); and solves number problems ● Articulation Survey—the child pronounces the names of common objects or actions and is assessed for correctness of pronunciation ● The test names are: Vocabulary; Numbers, Letters, & Words; and Articulation Survey
Uses or purpose of instrument	*K-SEALS* is an easy-to-administer measure of young children's language skills (expressive and receptive vocabulary), numerical skills, and articulation. ● *K-SEALS* is valuable in a variety of situations—testing school readiness, identifying gifted children, evaluating program effectiveness, and researching children's early development
Age Range	3.0 to 6.11 years
Administration Time	Approximately 15-25 minutes
Examiner	Professional and paraprofessional (training & supervision required) ● Appropriate for preschool, kindergarten, and elementary teachers. Used in speech and language clinics, and medical agencies
Scores	● Age-based standard scores (mean = 100, standard deviation = 15) are available on the subtests, scales, and composite. ● Percentile ranks, descriptive categories, and age equivalents are also provided. Performance on the Articulation Survey subtest can be interpreted using descriptive categories (Normal, Below Average, Mild Difficulty, or Moderate to Severe Difficulty) and item error analysis procedures.
Language(s)	English
Type (norm-/criterion-referenced)	Norm-referenced -Based on U.S. census data in the year 1990 and estimates for education attainment and region from 1985 estimates (from machine-readable data file).
Periodic vs. Ongoing	Periodic to monitor progress
Validity	Intercorrelations: ● Correlations between Vocabulary and Numbers, Letters and Words: Mean is .59 ● Correlations between Expressive Skills and Receptive Skills: Mean is .86 ● Correlations between Number Skills and Letter and Word Skills: Mean is .77 Content: The three *K-SEALS* subtests, Vocabulary; Numbers, Letters and Words; and Articulation Survey were designed to measure children's expressive and receptive language skills, pre-academic skills, and articulation. Construct: ● A test for young children should demonstrate age differentiation if it is designed to measure constructs such as language and academic skills that are related

	to development and learning and are purported to increase with chronological age. Mean raw scores for each *K-SEALS* subtest and scale increased steadily with increasing age. Concurrent: ● With tests of intelligence and achievement: The *K-SEALS* composite correlated substantially with standard scores on individually administered tests, correlating in the low .80s with K-ABC Achievement, SB-IV Verbal Reasoning, and SB-IV Test Composite; and about .55 to .65 with most other K-ABC and SB-IV scales. ● Coefficients with the group-administered Metropolitan tests were lower, typically ranging from the low .30s to the low .50s. ● With language and screening tests: Correlations of the PPVT-R and BBCS standard scores with the *K-SEALS* language and composite scales range from .66 to .73 ● The correlations between the *K-SEALS* and the Battelle and the DIAL-R are generally lower than this, but this is accountable in terms of these measures having less overlap of content with the *K-SEALS.* Predictive: ● With intelligence, language, and achievement tests: □ The Early Academic & Language Skills Composite correlated. 80 with the K-ABC Achievement Scale, and .76 with the Assessment Tools 82 PPVT-R standard score. Correlation with the SAT Total Battery and Otis-Lennon standard scores were .60 and .57 respectively. ● With Teacher's Ratings as criteria: □ Vocabulary (.47); Numbers, Letters & Words (.57); Receptive Skills (.58); Expressive Skills (.57); Number Skills (.49); Letter & Word Skills (.53); and Early Academic & Language Skills Composite.
Reliability	Internal consistency: ● Median reliability the Subtests is .88 to .94 ● Median reliability for the Scales is .81 to .94 ● Median reliability for the Composite is .94 Test - Retest: ● Median test-retest reliability the Subtests is .87 to .92 ● Median test-retest reliability for the Scales is .88 to .93 ● Median test-retest reliability for the Composite is .94
Uses Manipulative Materials	No
Adaptations for Special Needs	Children with identified delays or handicaps were not systematically sampled during standardization, however they were not excluded as subjects unless they had visual, hearing, or physical problems that

	prevented them from responding to test items.

3.13 Stanford-Binet Intelligence Scales for Early Childhood (Early SB5)

Publisher	The Riverside Publishing Company
Date	2005
Domains/Areas Assessed	● Measures: Fluid Reasoning, Knowledge, Quantitative Reasoning Visual-Spatial Processing, Working Memory ● The Early SB5, like the SB5, has 10 subtests. Two routing subtests (Nonverbal Fluid Reasoning and Verbal Knowledge) cover the age range 2.0 through 7.3, while the remaining eight subtests offer scores in the preschool range from 2.0 - 5.11. As with the SB5, testing begins in Item Book 1 with the two routing subtests, which are retained in their entirety. However, all remaining subtests into which the 1st two subtests route are contained in Item Book 2, with only the most difficult levels of items dropping across those subtests. Dropping these more difficult items will generally have no impact on the scores of the young children typically assessed with the Early SB5. However, because of the changes, assessment for intellectual giftedness would require use of only the two routing subtests or, better yet, the complete SB5.
Uses or purpose of instrument	Purpose: Individually administered assessment of intelligence and cognitive abilities
Age Range	2 to 7-3 years (2 to 5-11 years for full battery; 6 to 7-3 years for abbreviated battery)
Administration Time	Full Battery: 30-50 minutes; Abbreviated Battery: 15-20 minutes
Examiner	Professional
Scores	Scores that can be generated by the Early SB5 include: Full Scale IQ, Nonverbal IQ, Verbal IQ, Abbreviated Battery IQ, Standard Scores, Percentile Ranks, Change-Sensitive Scores, and Extended IQ. The SB5 can be hand-scored or scored with optional scoring software. ● All scored available for the SB5 are also available for the Early SB5. ● These include 10 subtest scores (scales scores have a mean of 10, SD=3, score range 1-19), broad ability (factor index) and IQ composite scores (mean of 100, SD=15, range 40-160), percentile, change-sensitive scores (CSSs), and age-equivalents. ● CSSs, because they reference absolute levels of ability rather than age-referenced norms, may be especially useful in the stuffy of the rapid growth of abilities in earliest childhood. In distinction to the complete SB5, users should be aware that determination of Extended IQ (EXIQ) scores from instructions in the Interpretive Manual should be limited to scores under 40, which may be of interest in the study of severe developmental delays.

	● The newly developed Test Observation Checklist identifies a range of behaviors that may serve as “flags” for behavioral or cognitive difficulties ● The Early SB5 may be hand-scored or scored with the optional SB5 ScoringPro™ software
Language(s)	English
Type (norm-/criterion-referenced)	Norm-referenced - A normative sample of 1,800 individuals was used in the age range addressed by the Early SB5 (ages 20. through 7). The normative sample closely matches the 2000 U.S. Census (education level based on 1999 data).
Periodic vs. Ongoing	Periodic
Validity	Concurrent and criterion validity data were obtained using the SB IV, SM L-M, WJIII®, UNIT™, Bender®-Gestalt II, WPPSI-R®, WAIT®-II, and WISC-III®.
Reliability	Reliabilities for the Early SB5 are very high for scores across its age range: FSIQ (.97-.98), NVIQ and VIQ (.94.96), factor indexes (.90-.92), and subtests (.81-.92).
Uses Manipulative Materials	Yes
Adaptations for Special Needs	N/A

3.14 Test of Mathematics Ability - Third Edition (TEMA-3)

Publisher	Psychological Assessment Resources, Inc
Date	2003
Domains/Areas Assessed	The test measures informal and formal (school-taught) concepts and skills in the following domains: ● numbering skills, number-comparison facility, numeral literacy, mastery of number facts, calculation skills, and understanding of concepts. ● It has two parallel forms, each containing 72 items.
Uses or purpose of instrument	● The TEMA-3 measures the mathematics performance of young children and is also useful with older children who have learning problems in mathematics. ● It can be used as a norm-referenced measure or as a diagnostic instrument to determine specific strengths and weaknesses. ● Thus, the test can be used to measure progress, evaluate programs, screen for readiness, discover the basis for poor school performance in mathematics, identify gifted students, and guide instruction and remediation. ● The two forms of the TEMA-3 allows you to study a child's mathematics progress over time.
Age Range	3.0 to 8.11 years
Administration Time	Approximately 40 minutes
Examiner	Professionals and paraprofessionals (training & supervision required) ● The TEMA-3 can be used in a variety of settings, including preschools, elementary schools, and clinics
Scores	● Test results are reported as standard scores, percentile ranks, and age and grade equivalents.

	● Reportedly, one of the test authors (Herbert Ginsburg) is currently working on software that can guide teachers' mathematics assessment and organize their observations
Language(s)	English
Type (norm-/criterion-referenced)	Norm-referenced - The all new standardization sample is composed of 1,219 children. The characteristics of the sample approximate those in the 2001 U.S. Census
Periodic vs. Ongoing	Periodic to monitor progress
Validity	Many validity studies are described in the Examiner's Manual
Reliability	Internal consistency reliabilities are all above .92; immediate and delayed alternative form reliabilities are in the .80s and .90s
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.15 Test of Early Reading Ability - Third Edition (TERA-3)

Publisher	Psychological Assessment Resources, Inc
Date	2002
Domains/Areas Assessed	This new edition of the *TERA-3* has been redesigned to provide the examiner with three subtests. The cognitive elements supported: Three subtests: □ Construction of meaning - knowledge of environmental □ Alphabet knowledge - letter naming and oral reading □ Conventions - book handling, punctuation, proofreading ● Examiners no longer have to prepare their own items that require the use of company logos and labels because these items are now standardized and provided as part of the test kit. □ Logos and labels from such national companies as McDonald's, and Kraft, Libby's, are used to make the TERA3 ● Categorical vocabulary in this assessment consists of identifying what word "goes with" a set of words. ● Part of the alphabet knowledge subtest score is determined by oral reading accuracy. ● Two forms of the test are available for test-retest applications.
Uses or purpose of instrument	● *TERA-3* is a unique, direct measure of the reading ability of young children. Rather than assessing children's "readiness" for reading, the *TERA-3* assesses their mastery of early developing reading skills. ● The *TERA-3* has many uses: □ (a) to identify those children who are significantly below their peers in reading development and may be candidates for early intervention;

	□ (b) to identify strengths and weaknesses of individual children; □ (c) to document a child's progress as a consequence of early reading intervention programs; □ (d) to serve as a measure in research studying reading development in young children; and to other assessments. □ (e) to serve as an adjunct
Age Range	Ages 3.6 through 8.6 (Pre-K, K, 1, 2, 3, and higher)
Administration Time	Approximately 15 to 30 minutes
Examiner	Professional or paraprofessional (training & supervision required) Commonly used by teachers and/or reading specialists in classroom settings
Scores	● Raw scores can be converted into standard scores, percentiles, and NCEs - age and grade equivalents provided. ● An overall Reading Quotient is computed using all three subtest scores. ● Software for scoring is available for PC or Apple II systems
Language(s)	English
Type (norm-/criterion-referenced)	Norm-referenced - this assessment tool was normed on national sample of 1,454 children in 15 states. ● All new normative data were collected during 1999 and 2000
Periodic vs. Ongoing	Ongoing
Validity	● Validity measures, assessed using the Basic School Skills Inventory, were found to be in the .55 range. ● New validity studies have been conducted; special attention has been devoted to showing that the test is valid for a wide variety of subgroups as well as for a general population.
Reliability	Reliability measures are in the .90 range: ● Reliability coefficients have been computed for subgroups of the normative sample (e.g., African Americans, Hispanic Americans, females) as well as for the entire normative sample. Reliability is consistently high across all three types of reliability studied. All but 2 of the 32 coefficients reported approach or exceed .90
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.16 Wechsler Preschool & Primary Scale of Intelligence - Third Edition (WPPSI™-III)

Publisher	The Psychological Corporation
Date	2002
Domains/Areas Assessed	The WPPSI™-III is an individual test that does not require reading or writing. Verbal subtests are oral questions without time limits. Performance subtests are nonverbal (both spatial and fluid reasoning) problems, several of which are timed. The subtests are as follows: ● *Information:* oral, “trivia”-style general information questions. Scoring is pass/fail.

	● *Vocabulary:* giving oral definitions of words. Scoring is 2-1-0, according to the quality of the responses ● *Word Reasoning:* deducing the meaning of a word from one, two, or three clues. Scoring is pass/fail. ● *Comprehension:* oral questions of social and practical understanding. Scoring is 2-1-0, based on quality. ● *Similarities:* explaining how two different things (e.g., horse and cow) or concepts (e.g., hope and fear) could be alike. Scoring is 2-1-0, according to the quality of the responses. ● *Block Design*:* copying small geometric designs with two, three, or four plastic cubes while viewing a constructed model or a picture within a specified time limit. Scoring is 2-1-0 for items 1 through 6 and 2-0 for items 7 to 20. ● *Matrix Reasoning:* completing logical arrangements of designs with missing parts; multiple-choice. Scoring is pass/fail. ● *Picture Concepts:* presented with two or three rows of pictures, choose the one picture from each row based upon a common characteristic. Scoring is pass/fail. ● *Picture Completion*:* identifying missing parts of pictures by either pointing to or naming the missing part. Scoring is pass/fail. ● *Object Assembly*:* assemble, within a specified time limit, puzzles of cut-apart silhouette objects with no outline pieces. Scoring allows for scores from 5 to 0 depending upon the item. ● Symbol Search*: deciding if a target symbol appears in a row of 3 symbols and marking YES or ? accordingly. ● *Coding *:* copying symbols that are paired with simple geometric designs as quickly as possible for 2 minutes ● *Receptive Vocabulary:* point to one of 4 pictures that represents the word spoken by the examiner. Scoring is pass/fail. ● *Picture Naming:* Name pictures shown. Scoring is pass/fail. ■ ***Verbal IQ*** is based on Information, Vocabulary, and Word Reasoning. (Comprehension and Similarities are possible substitutes for the other verbal subtests.) ■ ***Performance (fluid) IQ*** is based on Block Design, Matrix Reasoning, and Picture Concepts. (Picture Completion and Object Assembly are possible substitutes for the other Performance subtests.) ■ ***Processing Speed Quotient,*** or visual-motor, clerical speed and accuracy, includes Coding & Symbol Search. ■ ***General Language Composite*** is based on Receptive Vocabulary and Picture Naming

	■ ***Full Scale IQ*** is based on seven tests: 3 Verbal, 3 Performance (fluid), and 1 Processing Speed test. NOTE: * time limit
Uses or purpose of instrument	● The WPPSI™-III is a revision of the WPPSI-R and extended the age range, updated the norms, added new subtests and composite scores, and claims to have a developmentally appropriate structure based on contemporary intelligence and cognitive development theory. ● The artwork was updated, and some the test material was made more child-friendly and engaging. ● Some modifications in the administration and scoring made the scales easier to use. ● The WPPSI™-III accurately measures intellectual abilities in young children; it is a reliable and valid measure of intelligence that is more age-appropriate and user-friendly than previous editions. ● The WPPSI™-III was updated to reflect both feedback from users of WPPSI–R® and contemporary theories on children's intelligence. providing more clinically useful information for diagnosis and planning.
Age Range	Approximately 2.6 to 7.3 years
Administration Time	● 2.6 to 3.11 years range: 30-45 minutes ● 4.0 to 7.3 years range: 45-60 minutes
Examiner	Professional
Scores	● Scaled Scores by age, intelligence quotients (IQs) ● The WPPSI™-III employs the Deviation IQ (M=100, SD=15) for the Verbal, Performance and Full Scale IQS, and scaled scores (M=100, SD=3) for the subtests ● In addition to traditional hand scoring, WPPSI™–III offers two optional scoring and reporting software programs: *WPPSI–III®—WIAT®–II Scoring Assistant®.* By simply entering raw scores, concise scorereports are generated automatically from any PC.
Language(s)	
Type (norm-/criterion-referenced)	Norm-referenced - The normative sample included 1700 children in nine age groups. The sample was representative of the US population of children aged 2:6 to 7:3 for sex, race/ethnicity, parental education level and geographic region
Periodic vs. Ongoing	Periodic
Validity	● Validity studies with numerous other measures, including the new Wechsler Individual Achievement Test®—Second Edition (WIAT®–II), have been conducted to reflect federal legislation requirements and the use of multiple criteria for identification of children for special services. ● Also being conducted are studies with various special groups, including mental retardation (mild and moderate), developmental delay, Autism, Asperger's

	Syndrome, receptive and expressive language disorders, children at risk, motor impairment, Attention-Deficit/Hyperactivity Disorder, cognitively gifted, and limited English proficiency. ● The scores derived from the WPPSI-R correlate well with the WPPSI, WISC-R, Stanford Binet (4th ed.), and McCarthy Scales (rs between WPPSI-R FSIQs and other test composites range from .74 to .90). ● The correlation between the WPPSI-R FSIQ and the Kaufman-Assessment Battery for Children (K-ABC) Mental Processing Composite is low (.49), but the K-ABC has consistently yielded lower correlations with other intelligence tests as well. ● These results imply good criterion validity for the WPPSI-R. There are also studies showing the discriminant validity of the WPPSI-R with gifted, mentally deficient, learning disabled, and speechlanguage impaired children.
Reliability	● The reliability coefficient of the WPPSI™-III subtests range from .83 to .95. ● The reliability coefficients for the composite scales ranged from .89 to .96. ● Test-retest reliabilities for a mean interval of 26 days for the 2:6 to 3:11 year old group Verbal, Performance, Full and General Language scores were .90, .84, .92 and .92 respectively. ● For the 4 to 7:3 year old group for Verbal, Performance, Processing Speed, Full and General Language werer.92, .87, .93, .92, and .90 respectively.
Uses Manipulative Materials	Yes
Adaptations for Special Needs	N/A

3.17 Woodcock-Johnson® III (WJ-III) Tests of Achievement

Publisher	The Riverside Publishing Company
Date	2001
Domains/Areas Assessed	The WJ® III measures many aspects of academic achievement with a variety of brief tests and it is divided into two batteries – parallel forms (A and B); the Standard and the Extended Battery. ● The Standard Battery includes tests 1 through 12 which provide a broad set of scores. □ Letter-Word Identification; Reading Fluency; Story Recall; Understanding Directions; Calculation; Math Fluency; Spelling; Writing Fluency; ● The Extended Battery includes tests 10 through 22 which provide more in-depth diagnostic information on specific, relative strengths and weaknesses ● Examiners can administer the Standard Battery either alone or with the Extended Battery ● In addition, the tests are grouped into clusters, which parallel the IDEA areas & provide sound procedures for determining discrepancies between a student's abilities and achievement in each area.

	□ Oral Expression; Listening Comprehension; Written Expression; Basic Reading Skills; Reading Comprehension; Math Calculation Skills; Math Reasoning
Uses or purpose of instrument	● Although the WJ® III Tests of Achievement are measures of academic achievement, they can be used with the WJ® III Tests of Cognitive Abilities to assess a student's abilities on many specific McGrew, Flanagan, and Ortiz Integrated Cattell-Horn-Carroll Gf-Gc (CHC) "cognitive factors". ● This instrument was built upon the idea of selective testing. The examiner is advised to consult the Selective Testing Table in the manual to make sure to administer all of the tests necessary to obtain the desired cluster score - depending on the goal of testing. ● An additional new feature of this edition is that it is computerscored, thus decreasing errors from manual scoring
Age Range	2 to 90+ years
Administration Time	Approximately (5) minutes per test; (35 - 45) minutes per Standard Battery; (90 - 115) minutes per Extended Battery (Individual users may have different experiences)
Examiner	Professionals (commonly used by school psychologists in school settings) ● Training required ● Practice sessions are recommended prior to "real" administration
Scores	● Grade or Age Equivalent (GE or AE); Instructional Ranges; Relative Proficiency Indexes (RPIs); Standard Scores (Deviation Quotients); and Percentile Ranks available for each test and cluster ● The Compuscore for the WJ® III has an additional column that allows for the addition of one of the following scores: NCE, T-Score, z-score, age or grade equivalent, Stanines, or CALP level (for certain tests).
Language(s)	English
Type (norm-/criterion-referenced)	● Norm-referenced - Normative data were gathered from 8,818 subjects in over 100 geographically diverse communities in the U.S. ● The sample consisted of 1,143 preschool subjects; 4,784 kindergarten to twelfth-grade subjects; 1,165 college and university subjects; and 1,843 adult subjects.
Periodic vs. Ongoing	Periodic
Validity	● The WJ® III uses continuous-year norms to yield normative data at 10 points in each grade; it provides age-based norms by month from ages 24 months to 19 years and by year from ages 2 to 90+ years; and it provides grade-based norms for kindergarten through 12th grade, 2-year college, and 4-year college,

	including graduate school. ● It is a highly accurate and valid diagnostic system because the two batteries were co-normed, which means that the normative data are based on a single sample. When tests are co-normed, examiners get actual discrepancies and avoid errors typically associated with estimated discrepancies
Reliability	● Most of the WJ® III tests show strong reliabilities of .80 or higher; several are .90 or higher. ● The WJ® III interpretive plan is based on cluster interpretation -and these show strong reliabilities, most at .90 or higher. ● The reliability characteristics of the WJ® III meet or exceed basic standards for both individual placement and programming decisions.
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.18 Woodcock-Johnson® III (WJ-III) Tests of Cognitive Abilities

Publisher	The Riverside Publishing Company
Date	2001
Domains/Areas Assessed	● The Standard Battery consists of tests 1 through 10, and the Extended Battery includes tests 11 through 20. ● The list of Broad Cognitive Factors and the Name of Tests, both Standard and Extended, is as follows: □ **COMPREHENSION-KNOWLEDGE (Gc)** ■ Verbal Comprehension (Std) ■ General Information* (Ext) □ **LONG TERM RETRIEVAL (Glr)** ■ Visual-Auditory Learning (Std) ■ Retrieval Fluency* (Ext) ■ *Visual-Auditory Learning-Delayed* □ **VISUAL-SPATIAL THINKING (Gv)** ■ Spatial Relations (Std) ■ Picture Recognition (Ext) ■ *Planning (Gv/Gf)* □ **AUDITORY PROCESSING (Ga)** ■ Sound Blending (Std) ■ Auditory Attention (Ext) ■ *Incomplete Words* □ **FLUID REASONING (Gf)** ■ Concept Formation (Std) ■ Analysis-Synthesis (Ext) ■ *Planning** (Gv/Gf) □ **PROCESSING SPEED (Gs)** ■ Visual Matching (Std) ■ Decision Speed* (Ext) ■ Rapid Picture Naming* (Ext) ■ *Pair Cancellation** □ **SHORT-TERM MEMORY (Gsm)** ■ Numbers Reversed (Std) ■ Memory for Words (Ext) ■ *Auditory Working Memory** Note: *New tests in the WJ III; the italicized test names are not part of the factor or cognitive

	performance clusters.
Uses or purpose of instrument	● Depending on the purpose and extent of the assessment, examiners can use the Standard Battery alone or in conjunction with the Extended Battery. ● By design, the WJ® III Tests of Cognitive Abilities were developed to measure a student's abilities on many specific cognitive factors. ● Each of the 7 tests in the Standard Battery is designed to measure one factor. However, the Extended Battery offers 7 more tests - making two tests for each factor; one from the Standard and one from the Extended Battery. ● There are 3 Standard and 3 Extended tests that contribute to additional Clinical Clusters ● Tests can also be combined into a General Intellectual Ability (GIA Std) score of 7 or 14 tests (GIA Ext) and into several cognitive categories. ● Examiners are permitted to select the tests they need to select abilities in which they are interested for a particular student. ● The WJ® III Tests of Cognitive Abilities is based on the Cattell-Horn-Carroll (CHC) theory of cognitive abilities, which combines Cattell and Horn's Gf-Gc theory and Carroll's three-stratum theory. The CHC theory provides the most comprehensive framework available for understanding the structure of human cognitive abilities.
Age Range	2 to 90+ years
Administration Time	Approximately (5) minutes per test; (35 - 45) minutes per Standard Battery; (90 - 115) minutes per Extended Battery (Individual users may have different experiences)
Examiner	Professionals (commonly used by school psychologists in school settings) ● Training required ● Practice sessions are recommended prior to "real" administration
Scores	● Grade or Age Equivalent (GE or AE); Instructional Ranges; Relative Proficiency Indexes (RPIs); Standard Scores (Deviation Quotients); and Percentile Ranks available for each test and cluster ● The Compuscore for the WJ® III has an additional column that allows for the addition of one of the following scores: NCE, T-Score, z-score, age or grade equivalent, Stanines, or CALP level (for certain tests)
Language(s)	English
Type (norm-/criterion-referenced)	● Norm-referenced - Normative data were gathered from 8,818 subjects in over 100 geographically diverse communities in the U.S. ● The sample consisted of 1,143 preschool subjects; 4,784 kindergarten to twelfth-grade subjects; 1,165 college and university subjects; and 1,843 adult subjects.

Periodic vs. Ongoing	Periodic
Validity	● The WJ® III uses continuous-year norms to yield normative data at 10 points in each grade; it provides age-based norms by month from ages 24 months to 19 years and by year from ages 2 to 90+ years; and it provides grade-based norms for kindergarten through 12th grade, 2-year college, and 4-year college, including graduate school. ● It is a highly accurate and valid diagnostic system because the two batteries were co-normed, which means that the normative data are based on a single sample. When tests are co-normed, examiners get actual discrepancies and avoid errors typically associated with estimated discrepancies
Reliability	● Most of the WJ® III tests show strong reliabilities of .80 or higher; several are .90 or higher. ● The WJ® III interpretive plan is based on cluster interpretation -and these show strong reliabilities, most at .90 or higher. ● The reliability characteristics of the WJ® III meet or exceed basic standards for both individual placement and programming decisions.
Uses Manipulative Materials	No
Adaptations for Special Needs	N/A

3.19 Work Sampling System 4th Edition (WSS-4)

Publisher	Pearson Early Learning
Date	2001
Domains/Areas Assessed	● The WSS focuses on seven constructs or domains as follows: **Personal and social development** - the child's feelings about self and interactions with peers and adults **Language and literacy** - acquisition of language and reading (or pre-reading) skills **Mathematical thinking** - patterns, relationships, the search for multiple solutions to problems **Scientific thinking** - investigation through observing, recording describing, questioning, forming explanations and drawing conclusions **Social studies** - ideas of human independence and the relationships between people and the environment **The arts** - how children engage in dance, drama, music, and art, both actively and receptively **Physical development**.- addresses fine motor and gross motor development, control, balance and coordination ● Each construct contains a series of "Functional Components" ● Each Functional Component, in turn, is defined by a series of performance indicators that present the skills, behaviors, attitudes, and accomplishments of the child
Uses or purpose of instrument	● Research-based observational classroom performance assessment that is used to document

	children's skills, knowledge, behavior, acknowledge, behavior, and accomplishments across a wide variety of curriculum areas on multiple occasions in order to enhance teaching and learning ● Teachers observe the children and record the classroom observations in the process note forms included in the teacher's manual; document learning by completing a grade-level Developmental Checklist for each child 3 times p/yr; & report to parents 3 times p/yr; children observed in groups or individually ● Designed to improve instruction and enhance learning from preschool to up to grade 6
Age Range	3.0 to 12.0 years of age (preschool through 6th gra
Administration Time	Ongoing
Examiner	Professional/paraprofessional (if well trained and supervised) Generally administered by teachers. It should be noted that this measurement method was originally created to accompany the High/Scope Curriculum
Scores	WSS does not involve point-in-time assessment scores, but rather, it charts the child's progress over time. Data is collected throughout the year by means of portfolios, developmental guidelines and checklists, and then it is compiled in summary reports. ● Portfolios are used to track a child's efforts, achievements & progress: a) by collecting student work that reflect "Core Items" and b) "Individualized Items" ● Developmental checklists are provided for each guideline - including a brief description for the "Functional Components" of the construct (or guideline) being addressed and a few examples of how the one-sentence indicator might be met (i.e., "Listens for meaning in discussion & conversations"). ● Indicators are then rated as ***Not Yet; In Progress; or Proficient*** ● A summary report is to be prepared three times per year (replacing the conventional report cards). □ Each "Functional Component" is rated for Performance (Developing as Expected or Needs Developing) □ Also for both checklists and portfolios as well as for Progress (As Expected or Other Than Expected) □ Teachers can add comments to the ratings ● Teachers who maintain records should also interpret results and use them on an ongoing basis to inform instruction ● Using data based on concurrent validity of WSS ratings (below), cut-offs were created to identify **"at-risk"** and **"not at-risk"** scores on both the WJ-R and on WSS Broad Reading and Broad Math
Language(s)	Mainly English, however, some of the WSS materials

	have been translated into Spanish
Type (norm-/criterion-referenced)	Criterion-referenced
Periodic vs. Ongoing	Ongoing observation/periodic reporting
Validity	**Concurrent validity -** sample of 345 children from 17 classroom in Pittsburgh schools divided I to 4 cohorts: kindergarten, first, second and third grade. ● Correlations between specific subscales of the Woodcock Johnson-Revised (1989) WSS Language and Literacy checklist, the WSS mathematical thinking checklist, and summary report `Assessment Tools112 ratings were assessed ● Correlations between the most relevant WJ-R subscales & WSS checklists and Summary Report ratings at two time points (fall and spring) ranged from .36 to .75, with most of the coefficients falling between .50 and .75. ● Correlations tended to increase with age ● Using data based on concurrent validity of WSS ratings, cut-offs were created to identify **"at-risk"** and **"not at-risk"** scores on both the WJ-R and on WSS Broad Reading and Broad Math **Content validity -** No information provided as to how WSS developers identified the behavior for the Functional Components for each age group
Reliability	**Internal consistency & interrater reliability -** none described for the most recent edition. ● Coefficient alphas for an earlier edition of WSS on checklist scales (final 3 waves of testing done) ranged between .87 to .94 ● for an earlier WSS version the reported interrater reliability (for (2 raters reporting on 24 familiar & 26 unfamiliar children) was .88
Uses Manipulative Materials	Yes, those in the natural environment
Adaptations for Special Needs	Reliability and validity for the most recent version of WSS were assessed with a sample of children, 8% of whom were classified as having special needs. No additional information was disclosed

Appendix 4: Teacher Evaluation Questionnaire

First name: Sex: 1-Male 2-Female
Surname: City:
Address:
ID: Phone:
Date of Birth:
Questionnaire date: Teacher:

Section A: You have a number of behaviors and qualities for children in the Preschool. Please assess the status of the child in each and every one of the following items:

	1 No problem	2 Very Small problem	3 Medium problem	4 Serious problem	5 A very big problem
The desire and ability to persevere and communicate					
The desire of the child for an activity					
Perseverance and ability to communicate in completing tasks					
How to listen and focus					
Participate in different activities in the Preschool class					
Corners of creativity					
Reincarnation of characters during play					
Conversation					
In the arena					
Conduct behavioral emotional					
Child's ability to maintain the laws of disposition (conduct) in the Preschool class					
Ability to reject the temptations .as standing role, discipline, etc					
Ability in the face of emotional difficulties (failure, parting					
Reaction to situations of frustration					
Mood					
Contact with members of his generation					
Place among the children of his generation					
Area of language and comprehension					
Skills in thinking (cognitive ability, generalization, classification					
The use of key terms (color, size, shape, number					
Understand the instructions					
Verbal expression					

	1 No problem	2 Very Small problem	3 Medium problem	4 Serious problem	5 A very big problem
Motor area					
Act as severe movement - Gross motor, the use of games arena, .running, jumping, etc					
Act as micro-movement Fine motor skills, copy, write, fill beads, building blocks, etc.					

Section B: Readiness Assessment for first grade
Please evaluate the potential success of the child in each and every one of the following questions.

	1 Possibility For a Very Large success	2 Possibility For a Large success	3 Possibility For a Medium success	4 Possibility For a Low success	5 Possibility For a Very Low success
What are the possibilities of success for learning to read in the first grade					
What are the possibilities of success in arithmetic lessons in the first grade					
What are the possibilities of success in terms of social adjustment					
What are the possibilities of success in terms of behavioral and accept the laws of the system in the first grade					
What are the possibilities for the overall success of learning in the first grade					

Section C: Any educational framework appropriate for the child, in your opinion, in the coming academic year

1. Normal field of education
2. To special education class (Intent not to each class in the regular education classroom, such as preschool, special education class, etc.)
3. To stay an additional year in the preschool class

Appendix 5: Activities of the Computerized Assessment Tool for School Readiness (CATSR)

Before each exercise/activity, the child receives audio instructions suitable for the content of the activity. The child cannot begin to perform before the end of the instructions.
The CATSR is designed to cultivate thinking and learning skills among kindergarten children (4-6) by using a two-part kit:
1. CATSR that detects learning skills.
2. Activity from the CATSR that trains learning skills

The CATSR is expected to help detect personal learning styles, support any learning style and construct appropriate intervention process at learning junctions requiring the involvement and assistance of the kindergarten teacher.

The tasks in both parts of the CATSR relate to the learning base of the early years: visual and auditory perception, auditory and visual memory, development of fine motor skills, creating semantic abilities with verbal and non-verbal intervention, phonemic awareness and arithmetical comprehension.

In addition (and as important), the kindergarten teacher learns to characterize the children's skills, strengths and weaknesses with the help of a sensitive Learning Manager which relates to the child's natural environment. Such combination enables designing methods of mediation, follow-up and support, even in the early years, with no sense of failure, while encouraging the child to learn independently, with correcting feedback that does not arouse learning anxiety.

The tasks' skills

Arithmetical Readiness: The primary conception of the form of geometrical objects. Figures and objects (plain and volumetric). Simple tasks for recognition (to choose the proper object) and comparison (to choose the proper object among the similar. Operations with geometrical figures and objects. Construction of geometrical objects of different materials. Creation of drawings of geometrical objects using the stencil. Constructing the geometrical figures of different parts (geometrical puzzles), This test examines a number of functions, and among them:

- **Count Balloons**: to enumerate set of objects correctly, the child choose the group that contains a specific [number] of balloons.
- **Count Balloon Strings**: Count out a specified number of objects, there are groups of balloons in the screen, the child must press on the balloon strings that hold a specific [number] of balloons.
- **Identify the Number**: There are specific [number] of balloons in the screen, the child must press on the right number.
- **Amount, Digit Matching**: There is a group of numbers and a group of cards in front of the child on the screen. The child must drag each number to the matching card that has the same number of circles.
- **More or Less**: There are two groups of objects/animals/instruments on the screen. The child must choose the group with the least/largest number of objects/animals/instruments.
- **Addition & Subtraction**: There are two groups of objects. If number of the objects move to the other side of the screen, how many objects will be there? Or If [number/all the] the objects on the screen move out of the screen, how many objects will be left?

Cognitive Development

- **Choose the Form**
- **Magic Circle**: Presented slowly to the child, who must identify what appears inside of the circle. This activity (game) checks the ability of the examinee to identify and move an object whose picture is displayed through a small opening. This test examines a number of functions, and among them:
  - Comprehensive and simultaneous comprehension ability;
  - Reference to visual details;
  - Ability to distinguish between the important and the unimportant;
  - The use of long-term memory;
  - perception of relations between a part and its whole;
  - Short-term visual memory, spacial orientation
- **Incomplete Shadow**: In this activity, a shadow appears on the center of the screen and four additional pictures appear on the upper portion of the screen. The child must press the picture which the shade belongs to. The areas that this test examines:
  - Long-term memory;
  - Synthesis;
  - Simultaneous processing;
  - Attention to visual details;
  - Identifying the whole from among its parts;
  - Comparing (Since the child must compare the shadow figure and the figure presented to him).
- **Triangles**: On the center of a screen, a shape appears which is comprised of triangles of two colors, on the left side of the screen, a number of cards appear that include triangles in different numbers and colors. The child must choose the card that contains the number and color of triangles that construct the figure in the center of the screen. This activity examines the following areas:
  - Synthetic analysis;
  - Visual perception;
  - Attention;
  - Drawing conclusions;
  - Abstract stimuli.
- **Analogy**: Two cards appear on the screen, on the top card, two pictures (shapes) appear that are related in some way. Under the top card, a card appears containing only one picture (shape) and the child must complete this card by choosing one of the pictures (shapes) that refer to the same relationship out of the cards appearing on the bottom of the screen- This activity examines:
  - The ability to form conclusions;
  - Knowledge;
  - Abstract thinking
- **Remember the Location**: The child look at the pictures in front of him, after a while the pictures will disappear. He must remember the place of each picture and press on the place where they were.
- **Sequence of Events**: A number of cards appear on the screen describing a certain event, but they are in a random order. The child must place them in the correct order corresponding to the logical sequence of events.
- **Identifying Faces**: In this activity, the child is shown one or two figures, and afterwards the child must identify these figures within a picture containing a number of figures. This test examines the child's abilities in the following areas:
  - Reference to visual details;
  - Ability to distinguish between the important and the unimportant;
  - Use of short-term visual memory;
  - The ability to organize from a visual perspective without the need to make any motions;

- The ability to perceive meaningful stimuli

- **Hand Movements**: The child watch the movements appearing in front of him and. choose the card with the same movements.

The child look at the pictures in front of him, after a while the pictures will disappear. He must remember the place of each picture and press on the place where they were

<u>Language Development</u>:

- **Picture Selection**: There are a number of objects on the screen. The child will be asked to press on a specific object.
- **Picture Recognition**: There are a number of objects on the screen. The child will be asked to press on the object that fits the same sentence.
- **Series of Pictures**: There are a number of pictures on the screen. The child will be asked to press on a specific order of the pictures as he heard before.
- **Series of Numbers**: There are a number of pictures on the screen. The child will be asked to press on a specific order of the pictures as he heard before
- **Backward Digital Series**: The child is going to hear a series of numbers, and will be asked to press on the card that has the same numbers in a backward order.

<u>Phonological Awareness</u>

- **Sound Units**: To press on the number of syllables in a specific word.
- **Identify Rhymes**: Listen to two words, if the words rhyme then click on the tick, and if they don't, click on the X.
- **Match Rhyming Words**: You have three pictures at the bottom of the screen, choose the picture that rhymes with the picture at the top of the screen.
- **Opening Sound**: Listen to the two words. If they begin with the same sound, click on the tick, and if they don't, click on the X. [e.g. House – Horse]
- **Closing Sound**: Listen to the two words. If they end with the same sound, click on the tick, and if they don't, click on the X. [e.g. Cake – Steak]

Appendix 6: Arithmetic Exam
Class A

Date: ______________

Name:____________________

6.1. Count the Number of circles

	O O O O O O O O O O O O	O O O O O
__________	__________	__________

6.2. Complete drawing circles until the number below

O O O O	O O O O	O O O O O
6	**13**	**10**

6.3. Complete the sequence

6	7	8	__	__	__	__	13
12	__	__	__	__	__	18	19
20	30	40	__	__	40	30	90

6.4. Write the numbers

Eleven	______
Eight	______
Five	______
Sixty	______

6.5. Solve the below exercises

3 + 8	= ___	5 + 4	= ___
17 – 13	= ___	10 + 4	= ___
8 – 0	= ___	19 + 0	= ___
11 – 9	= ___	15 - 5	= ___
3 + 14	= ___	20 - 2	= ___
10 – 8 – 2	= ___	5 + 4 + 2	= ___
20 – ___	= 11	10 + ___	= 13

6.6. Put the signal "< "Or" > "Or"=" inside the square

17 - 5		3 + 14
19		14
9		10 - 1

6.7. Arithmetic question-1

Sitting on the bus 15 passengers, came down in the station 9 passengers. How many passengers stayed on the bus?_____

6.8. Arithmetic question-2

Baha has 5 marbles and Sami has 7 marbles. How many marbles with both?

____

6.9. Draw a circle on the even number

5	**7**	**11**	**2**
18	**10**	**6**	**19**

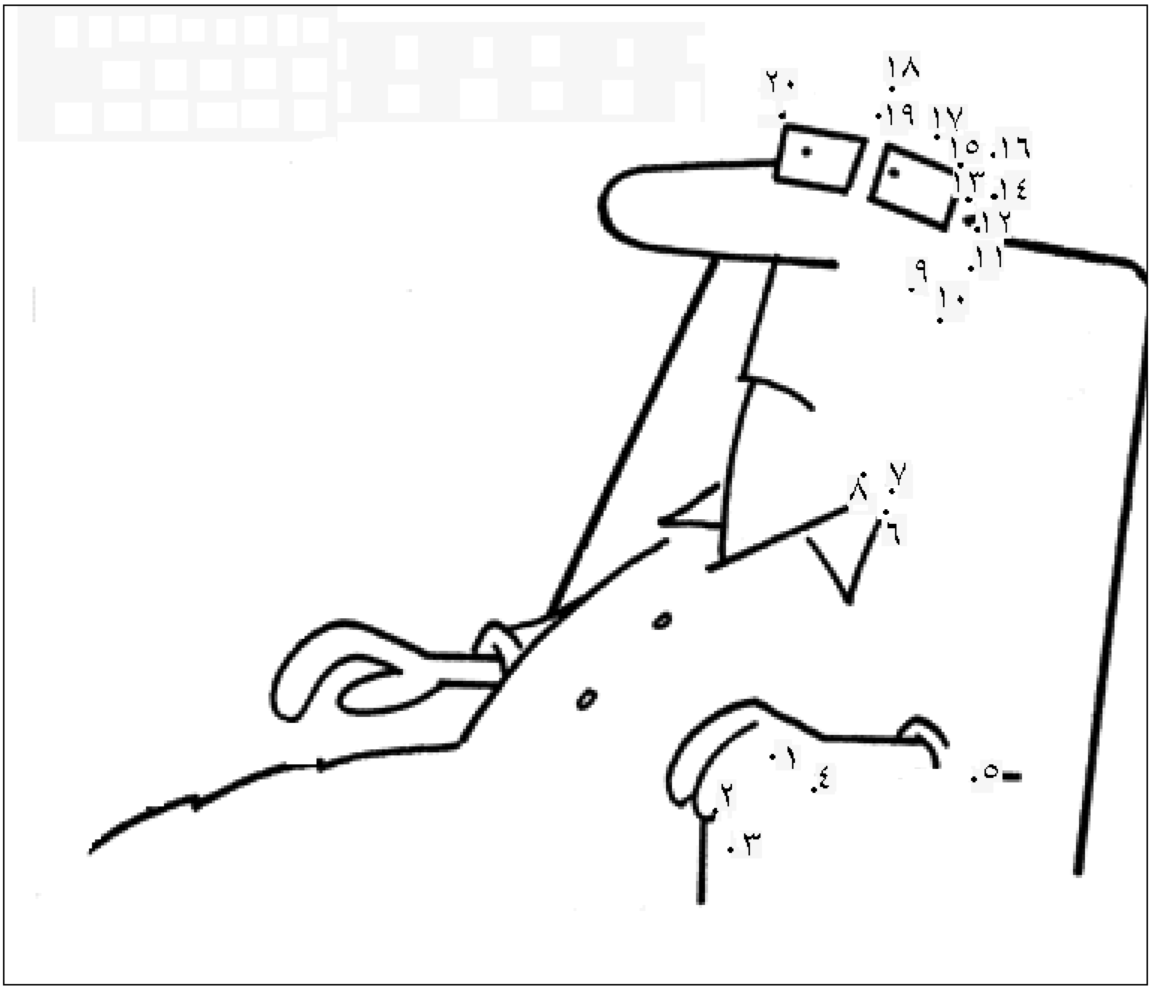
6.10. Analyze to tens and ones?

40 = ______ **Tens**
60 = ______ **Tens**
2 Tens = ______
1 Tens = ______

6.11. Sort the following numbers from smallest to largest

17	**20**	**9**	**14**	**3**	**8**

6.12. Connect the numbers in order, and I get a pretty picture



6.13. Connect between the exercise and the correct answer

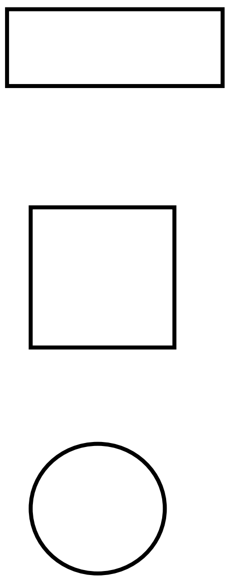
70 – 20 =	70	90 – 60 =	50
80 – 10 =	50	50 + 20 =	30
30 + 40 =	30	20 + 30 =	70

6.14. Complete the straight numbers

0 1 4 5 6

10 11 12 13 15 16 18 20

6.15. Draw a line between form and name



Square

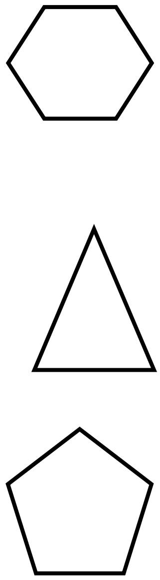
Triangle

Circle

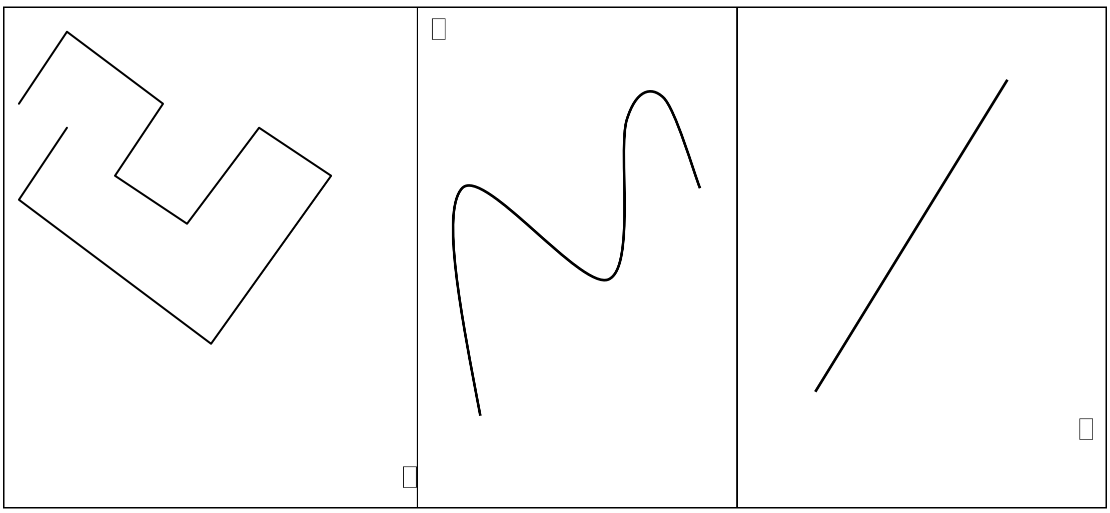
Oblong

Hexagonal

Pentacle



6.16. Put X in the broken line. O on the straight line. □ on the curved line.



Appendix 7: Arabic Exam

Class A

Date:______________

Name:___________________

7.1 Reading comprehension

Samir went on a visit to his uncle's farm. Samir saw many trees. Samir asked his uncle: "Do you irrigate the trees, O my uncle?", His uncle said to him: "We irrigate the tree when it small, and when it grows up the rain will irrigate it"

Complete the sentences of the store words:

1. Samir went to visit _____________ farm.
2. In the Farm, Samir saw _______ trees
3. Samir asked his uncle: “Who is irrigating the ___________”?

(Many, Uncle’s Farm, Trees)

7.2 Answer the following questions:

1. Where Samir did went? __________________________________ .
2. What did he saw in the farm? Samir Saw _________ ___________ .
3. Who is irrigating the trees when it grows up?
   _____ ____ irrigating the trees when it grows up.

7.3 Complete the missing

Plural	Single
Trees	________
_________	Farm
_________	Boy

7.4 Complete the missing

Word	Opposite
Small	________
Asked	__________
Many	__________

(Answered, Little, Big)

7.5 Complete the missing (*)

He	She
Asked	________
__________	Said
Went	__________
__________	Saw

* In Arabic language there a different between the form of he and she.

7.6 Tick (□) or (×)

1. Samir went on a visit to his uncle's farm. _________
2. Samir saw many trees ___________
3. When the trees grows up the rain will irrigate it __________

7.7 Sort words scattered among other useful component

His uncle, Samir, visited .1

____

Samir , His uncle, asked .2

____

7.8 Enter the following words in the useful phrase

Visited _______________________________________

Trees _______________________________________

7.9 Decompose the word:

________	رَ – باب =
________	دَ – جا – جَة =
________	صُنْـ - ـدو – قٌ =
________	تُفـ - فا – ح =
________	شَـ - بَـ - كَـ - تِـ - ـهِ
________	فَـ - رَ – ساً =
________	أثْـ – وابْ =

7.10 Cut the following words

______	______	______	______	______	زَيْتون=
______	______	______	______	______	حَشيش=
______	______	______	______	______	قَصّار=
______	______	______	______	______	ديكْ=
______	______	______	______	______	شيرين=
______	______	______	______	______	بَيْضٌ=
______	______	______	______	______	ألكَلْبُ=
______	______	______	______	______	السَّمَكَةُ=
______	______	______	______	______	ثـَوْراً=

7.11 Decoding words and write down how many characters

دارٌ= ____________ ☐

بَشّار= ____________ ☐

بَقدونِس= ____________ ☐

حِماراً= ____________ ☐

جاءَت= ____________ ☐

ألشَّمْس= ____________ ☐

ألبابُ= ____________ ☐

☐

7.12 Circle the chars

	ليث	لثة	ثعبان	ث
صرخ	فخ	بخيل	خبز	خ
موز	معتز	مزاح	زرافة	ز
راس	لبس	مسح	سامي	س
مرض	غضّ	فضاء	ضوء	ض
	ضغط	عطاف	طابة	ط
جاع	جامع	يعاد	عين	ع
معاق	شَفقَ	عقل	قلم	ق
شبّاك	ديك	بكى	كلب	ك
جمال	عسل	علم	لونا	ل
داري	سامي	عيد	ياسمين	ي

7.13 Read the text and write it:
Hard-working student

I am hard working student. I go to my school every morning. In the class I listen to what my teacher says. In the arena I play with my friends.

7.14 Please read the following characters

ث	ت	ب	أ
د	خ	ح	ج
س	ز	ر	ذ
ط	ض	ص	ش
ف	غ	ع	ظ
م	ل	ك	ق
ي	و	هـ	ن

مقاطع قصيرة

ثَ	تِ	بُ	أَ
دُ	خَ	حِ	جُ
سُ	زَ	رِ	ذُ
طُ	ضَ	صُ	شِ
فِ	غُ	عَ	ظِ
مَ	لِ	كُ	قَ
يُ	وَ	هِـ	نُ

مقاطع طويلة

ثا	تو	بي	آ
دو	خا	حي	جو
سي	زو	را	ذي
طا	ضي	صو	شا
فو	غا	عي	ظو
مي	لو	كا	قي
يي	وو	ها	ني

7.15 Please read the following words:

	وَلَدٌ
	قَفَصاً
	كِتابٍ
	قَصَّ
	الْكِتابُ
	نَجيبْ
	موسى
	فِراءْ
	دُخّانْ
	مَجْروحْ
	جَوادْ
	إِيجارْ
	دوخي
	جاءَ الوَلَدُ
	أَشْعَلْتُ النّارَ

7.16 Spelling of words

جاءَتْ	دَجاجَة	نَجيبْ	نَجّارْ
زَيْتونْ	مُعَلِّمَةٌ	فَرَساً	الوَلَدُ
صِنّارَة	صيصانْ	مَحْبوب	ماءٌ
			الحِصانُ

Appendix 8: Parent's Approval Form

The presence of the student's guardian:

Subject: Participation of your son / daughter in educational research

Greetings to you,

The Preschool children were selected for participation in educational research, the research which will be held under the supervision of the Faculty of Computing, Informatics and Media at the University of Bradford, UK. Research will be conducted by Mr. Iyad Suleiman, under the supervision of Prof. Mick Ridley., Lecturer in the Faculty of Computing, Informatics and Media at the University of Bradford, UK and Prof. Reda Alhajj Lecturer in the Faculty of Computer Science at the University of Calgary, Canada.

Information to be collected is for the research service only. We pledge to maintain the privacy of the individual in all matters relating to the implementation of research, dissemination and processing of information obtained. Participation in research is voluntary and the right of the people of approval or rejection. Preschool Children involved in the research will participate in the research free of charge. Participants in the research will undergo assessment by a computerized program, the examination of the school readiness in the first grade, the program examines the basic skills required for success in school through fun games to give an accurate diagnosis on the absorptive capacities of the child and the readiness to learn in first grade next year.

Please Fill the Annex to this letter and traced back to a Preschool teacher

I agree / disagree on the participation of my son / daughter in the research

Signature ____

Child name ____

Parent name ____

Address ____

Phone ____

For more details please contact IYAD SULEIMAN at -------------

Appendix 9: WEKA Data Mining Results
9.1 The APriori algorithm WEKA results

=== Run information ===
Scheme: weka.associations.Apriori -N 100 -T 0 -C 0.9 -D 0.05 -U 1.0 -M 0.3 -S -1.0 -c -1
Relation: Ready2Learn-weka.filters.unsupervised.attribute.Remove-R1-2,9-11,16-24
Instances: 306
Attributes: 11
Mother_educational_qualification
Father_educational_qualification
Mother_occupation
Father_occupation
Family_size
Child_position
Good_Class_Peers
Weak_Class_Peers
Good_Neighbourhood_Peers
Weak_Neighbourhood_Peers
Ready4School
=== Associator model (full training set) ===

Apriori
=======
Minimum support: 0.4 (122 instances)
Minimum metric <confidence>: 0.9
Number of cycles performed: 12

Generated sets of large itemsets:
Size of set of large itemsets L(1): 14
Size of set of large itemsets L(2): 48
Size of set of large itemsets L(3): 60
Size of set of large itemsets L(4): 28
Size of set of large itemsets L(5): 5

Best rules found:
1. Ready4School=1 273 ==> Father_occupation=1 273 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.89)
2. Mother_occupation=1 Ready4School=1 244 ==> Father_occupation=1 244 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.8)
3. Child_position=1 Ready4School=1 223 ==> Father_occupation=1 223 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.73)
4. Mother_occupation=1 Child_position=1 Ready4School=1 199 ==> Father_occupation=1 199 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.65)
5. Father_educational_qualification=0 Ready4School=1 193 ==> Father_occupation=1 193 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.63)
6. Good_Class_Peers=0 189 ==> Father_occupation=1 189 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.62)
7. Family_size=0 Ready4School=1 178 ==> Father_occupation=1 178 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.58)
8. Mother_educational_qualification=0 Ready4School=1 177 ==> Father_occupation=1 177 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.58)
9. Good_Class_Peers=0 Ready4School=1 172 ==> Father_occupation=1 172 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.56)
10. Mother_occupation=1 Good_Class_Peers=0 169 ==> Father_occupation=1 169 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.55)
11. Father_educational_qualification=0 Mother_occupation=1 Ready4School=1 168 ==> Father_occupation=1 168 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.55)

12. Weak_Neighbourhood_Peers=0 165 ==> Father_occupation=1 165 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.54)
13. Mother_educational_qualification=0 Father_educational_qualification=0 Ready4School=1 164 ==> Father_occupation=1 164 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.54)
14. Good_Neighbourhood_Peers=0 Ready4School=1 157 ==> Father_occupation=1 157 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.51)
15. Mother_occupation=1 Family_size=0 Ready4School=1 156 ==> Father_occupation=1 156 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.51)
16. Father_educational_qualification=0 Child_position=1 Ready4School=1 155 ==> Father_occupation=1 155 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.51)
17. Mother_educational_qualification=0 Mother_occupation=1 Ready4School=1 154 ==> Father_occupation=1 154 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.5)
18. Mother_occupation=1 Good_Class_Peers=0 Ready4School=1 154 ==> Father_occupation=1 154 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.5)
19. Child_position=1 Good_Class_Peers=0 151 ==> Father_occupation=1 151 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.49)
20. Mother_occupation=1 Weak_Neighbourhood_Peers=0 148 ==> Father_occupation=1 148 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.48)
21. Weak_Neighbourhood_Peers=0 Ready4School=1 148 ==> Father_occupation=1 148 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.48)
22. Weak_Class_Peers=0 Ready4School=1 143 ==> Father_occupation=1 143 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.47)
23. Weak_Class_Peers=1 142 ==> Father_occupation=1 142 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.46)
24. Mother_educational_qualification=0 Father_educational_qualification=0 Mother_occupation=1 Ready4School=1 141 ==> Father_occupation=1 141 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.46)
25. Mother_educational_qualification=0 Child_position=1 Ready4School=1 140 ==> Father_occupation=1 140 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.46)
26. Father_educational_qualification=0 Good_Class_Peers=0 138 ==> Father_occupation=1 138 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.45)
27. Mother_occupation=1 Good_Neighbourhood_Peers=0 Ready4School=1 138 ==> Father_occupation=1 138 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.45)
28. Child_position=1 Good_Class_Peers=0 Ready4School=1 136 ==> Father_occupation=1 136 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.44)
29. Child_position=1 Weak_Neighbourhood_Peers=0 135 ==> Father_occupation=1 135 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.44)
30. Father_educational_qualification=0 Mother_occupation=1 Child_position=1 Ready4School=1 135 ==> Father_occupation=1 135 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.44)
31. Mother_occupation=1 Child_position=1 Good_Class_Peers=0 134 ==> Father_occupation=1 134 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.44)
32. Child_position=1 Good_Neighbourhood_Peers=0 Ready4School=1 134 ==> Father_occupation=1 134 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.44)
33. Mother_occupation=1 Weak_Neighbourhood_Peers=0 Ready4School=1 133 ==> Father_occupation=1 133 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.43)
34. Good_Neighbourhood_Peers=1 132 ==> Father_occupation=1 132 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.43)
35. Weak_Class_Peers=1 Ready4School=1 130 ==> Father_occupation=1 130 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.42)
36. Mother_occupation=1 Weak_Class_Peers=0 Ready4School=1 129 ==> Father_occupation=1 129 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.42)
37. Mother_educational_qualification=0 Father_educational_qualification=0 Child_position=1 Ready4School=1 129 ==> Father_occupation=1 129 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.42)
38. Family_size=0 Child_position=1 Ready4School=1 128 ==> Father_occupation=1 128 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.42)
39. Family_size=0 Good_Class_Peers=0 127 ==> Father_occupation=1 127 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.42)
40. Mother_occupation=1 Weak_Class_Peers=1 126 ==> Father_occupation=1 126 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.41)
41. Weak_Neighbourhood_Peers=1 Ready4School=1 125 ==> Father_occupation=1 125 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.41)

42. Father_educational_qualification=0 Family_size=0 Ready4School=1 124 ==> Father_occupation=1 124 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.41)
43. Father_educational_qualification=0 Good_Class_Peers=0 Ready4School=1 123 ==> Father_occupation=1 123 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.4)
44. Mother_educational_qualification=0 Good_Class_Peers=0 122 ==> Father_occupation=1 122 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.4)
45. Mother_educational_qualification=0 Mother_occupation=1 Child_position=1 Ready4School=1 122 ==> Father_occupation=1 122 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.4)
46. Mother_occupation=1 273 ==> Father_occupation=1 272 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.45)
47. Child_position=1 253 ==> Father_occupation=1 252 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.41)
48. Mother_occupation=1 Child_position=1 225 ==> Father_occupation=1 224 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.37)
49. Father_educational_qualification=0 218 ==> Father_occupation=1 217 <conf:(1)> lift:(1) lev:(0) [0] conv:(0.36)
50. Mother_educational_qualification=0 199 ==> Father_occupation=1 198 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.33)
51. Family_size=0 197 ==> Father_occupation=1 196 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.32)
52. Father_educational_qualification=0 Mother_occupation=1 191 ==> Father_occupation=1 190 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.31)
53. Mother_educational_qualification=0 Father_educational_qualification=0 184 ==> Father_occupation=1 183 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.3)
54. Father_educational_qualification=0 Child_position=1 177 ==> Father_occupation=1 176 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.29)
55. Mother_educational_qualification=0 Mother_occupation=1 175 ==> Father_occupation=1 174 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.29)
56. Good_Neighbourhood_Peers=0 174 ==> Father_occupation=1 173 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.28)
57. Mother_occupation=1 Family_size=0 173 ==> Father_occupation=1 172 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.28)
58. Weak_Class_Peers=0 164 ==> Father_occupation=1 163 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.27)
59. Mother_educational_qualification=0 Father_educational_qualification=0 Mother_occupation=1 160 ==> Father_occupation=1 159 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.26)
60. Mother_educational_qualification=0 Child_position=1 159 ==> Father_occupation=1 158 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.26)
61. Father_educational_qualification=0 Mother_occupation=1 Child_position=1 155 ==> Father_occupation=1 154 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.25)
62. Mother_occupation=1 Good_Neighbourhood_Peers=0 153 ==> Father_occupation=1 152 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.25)
63. Child_position=1 Good_Neighbourhood_Peers=0 149 ==> Father_occupation=1 148 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.24)
64. Mother_occupation=1 Weak_Class_Peers=0 147 ==> Father_occupation=1 146 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.24)
65. Mother_educational_qualification=0 Father_educational_qualification=0 Child_position=1 146 ==> Father_occupation=1 145 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.24)
66. Family_size=0 Child_position=1 144 ==> Father_occupation=1 143 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.24)
67. Weak_Neighbourhood_Peers=1 141 ==> Father_occupation=1 140 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.23)
68. Mother_educational_qualification=0 Mother_occupation=1 Child_position=1 140 ==> Father_occupation=1 139 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.23)
69. Father_educational_qualification=0 Family_size=0 139 ==> Father_occupation=1 138 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.23)
70. Child_position=1 Weak_Class_Peers=0 137 ==> Father_occupation=1 136 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.22)
71. Mother_educational_qualification=0 Family_size=0 129 ==> Father_occupation=1 128 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.21)
72. Mother_occupation=1 Child_position=1 Good_Neighbourhood_Peers=0 129 ==> Father_occupation=1 128 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.21)

73. Mother_educational_qualification=0 Father_educational_qualification=0 Mother_occupation=1 Child_position=1 127 ==> Father_occupation=1 126 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.21)
74. Mother_occupation=1 Weak_Neighbourhood_Peers=1 125 ==> Father_occupation=1 124 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.2)
75. Mother_occupation=1 Family_size=0 Child_position=1 125 ==> Father_occupation=1 124 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.2)
76. Father_educational_qualification=0 Good_Neighbourhood_Peers=0 123 ==> Father_occupation=1 122 <conf:(0.99)> lift:(1) lev:(0) [0] conv:(0.2)
77. Mother_educational_qualification=0 Family_size=0 129 ==> Father_educational_qualification=0 122 <conf:(0.95)> lift:(1.33) lev:(0.1) [30] conv:(4.64)
78. Mother_educational_qualification=0 Ready4School=1 177 ==> Father_educational_qualification=0 164 <conf:(0.93)> lift:(1.3) lev:(0.12) [37] conv:(3.64)
79. Mother_educational_qualification=0 Father_occupation=1 Ready4School=1 177 ==> Father_educational_qualification=0 164 <conf:(0.93)> lift:(1.3) lev:(0.12) [37] conv:(3.64)
80. Mother_educational_qualification=0 Ready4School=1 177 ==> Father_educational_qualification=0 Father_occupation=1 164 <conf:(0.93)> lift:(1.31) lev:(0.13) [38] conv:(3.68)
81. Mother_educational_qualification=0 199 ==> Father_educational_qualification=0 184 <conf:(0.92)> lift:(1.3) lev:(0.14) [42] conv:(3.58)
82. Mother_educational_qualification=0 Father_occupation=1 198 ==> Father_educational_qualification=0 183 <conf:(0.92)> lift:(1.3) lev:(0.14) [41] conv:(3.56)
83. Mother_educational_qualification=0 Child_position=1 Ready4School=1 140 ==> Father_educational_qualification=0 129 <conf:(0.92)> lift:(1.29) lev:(0.1) [29] conv:(3.36)
84. Mother_educational_qualification=0 Father_occupation=1 Child_position=1 Ready4School=1 140 ==> Father_educational_qualification=0 129 <conf:(0.92)> lift:(1.29) lev:(0.1) [29] conv:(3.36)
85. Mother_educational_qualification=0 Child_position=1 Ready4School=1 140 ==> Father_educational_qualification=0 Father_occupation=1 129 <conf:(0.92)> lift:(1.3) lev:(0.1) [29] conv:(3.39)
86. Mother_educational_qualification=0 199 ==> Father_educational_qualification=0 Father_occupation=1 183 <conf:(0.92)> lift:(1.3) lev:(0.14) [41] conv:(3.4)
87. Mother_educational_qualification=0 Child_position=1 159 ==> Father_educational_qualification=0 146 <conf:(0.92)> lift:(1.29) lev:(0.11) [32] conv:(3.27)
88. Mother_educational_qualification=0 Father_occupation=1 Child_position=1 158 ==> Father_educational_qualification=0 145 <conf:(0.92)> lift:(1.29) lev:(0.11) [32] conv:(3.25)
89. Mother_educational_qualification=0 Mother_occupation=1 Ready4School=1 154 ==> Father_educational_qualification=0 141 <conf:(0.92)> lift:(1.29) lev:(0.1) [31] conv:(3.16)
90. Mother_educational_qualification=0 Mother_occupation=1 Father_occupation=1 Ready4School=1 154 ==> Father_educational_qualification=0 141 <conf:(0.92)> lift:(1.29) lev:(0.1) [31] conv:(3.16)
91. Mother_educational_qualification=0 Mother_occupation=1 Ready4School=1 154 ==> Father_educational_qualification=0 Father_occupation=1 141 <conf:(0.92)> lift:(1.29) lev:(0.1) [31] conv:(3.2)
92. Weak_Class_Peers=1 142 ==> Ready4School=1 130 <conf:(0.92)> lift:(1.03) lev:(0.01) [3] conv:(1.18)
93. Father_occupation=1 Weak_Class_Peers=1 142 ==> Ready4School=1 130 <conf:(0.92)> lift:(1.03) lev:(0.01) [3] conv:(1.18)
94. Weak_Class_Peers=1 142 ==> Father_occupation=1 Ready4School=1 130 <conf:(0.92)> lift:(1.03) lev:(0.01) [3] conv:(1.18)
95. Mother_educational_qualification=0 Mother_occupation=1 175 ==> Father_educational_qualification=0 160 <conf:(0.91)> lift:(1.28) lev:(0.12) [35] conv:(3.15)
96. Mother_educational_qualification=0 Mother_occupation=1 Father_occupation=1 174 ==> Father_educational_qualification=0 159 <conf:(0.91)> lift:(1.28) lev:(0.11) [35] conv:(3.13)
97. Mother_educational_qualification=0 Child_position=1 159 ==> Father_educational_qualification=0 Father_occupation=1 145 <conf:(0.91)> lift:(1.29) lev:(0.11) [32] conv:(3.08)
98. Mother_occupation=1 Good_Class_Peers=0 169 ==> Ready4School=1 154 <conf:(0.91)> lift:(1.02) lev:(0.01) [3] conv:(1.14)
99. Mother_occupation=1 Father_occupation=1 Good_Class_Peers=0 169 ==> Ready4School=1 154 <conf:(0.91)> lift:(1.02) lev:(0.01) [3] conv:(1.14)

100. Mother_occupation=1 Good_Class_Peers=0 169 ==> Father_occupation=1 Ready4School=1 154 <conf:(0.91)> lift:(1.02) lev:(0.01) [3] conv:(1.14)

9.2 The k-means algorithm WEKA results

=== Run information ===
Scheme: weka.clusterers.SimpleKMeans -N 5 -A "weka.core.EuclideanDistance -R first-last" -I 500 -num-slots 1 -S 10
Relation: Ready2Learn-weka.filters.unsupervised.attribute.Remove-R1-2-weka.filters.unsupervised.attribute.Remove-R7-9-weka.filters.unsupervised.attribute.Remove-R11-19
Instances: 306
Attributes: 11
Mother_educational_qualification
Father_educational_qualification
Mother_occupation
Father_occupation
Family_size
Child_position
Good_Class_Peers
Weak_Class_Peers
Good_Neighbourhood_Peers
Weak_Neighbourhood_Peers
Ready4School
Test mode: split 66% train, remainder test

=== Clustering model (full training set) ===
kMeans
======
Number of iterations: 9
Within cluster sum of squared errors: 320.5208760921712
Missing values globally replaced with mean/mode

Cluster centroids:

		Cluster#				
Attribute	Full Data	0	1	2	3	4
	(306)	(84)	(73)	(87)	(31)	(31)
Mother_educational_qualification	Secondary	Secondary	1st_degree	Secondary	1st_degree	Secondary
Father_educational_qualification	Secondary	Secondary	1st_degree	Secondary	Secondary	Secondary
Mother_occupation	Private	Private	Private	Private	Private	Government
Father_occupation	Private	Private	Private	Private	Private	Private
Family_size	4.7026	4.9643	4.6849	4.5862	4.3548	4.7097
Child_position	1.9346	2.2738	1.7671	1.8621	1.5806	1.9677
Good_Class_Peers	2.9641	4.0476	2.9726	1.9195	3.2903	2.6129
Weak_Class_Peers	2.8203	3.0357	2.9041	2.5517	3.1290	2.4839
Good_Neighbourhood_Peers	2.8725	2.7976	2.8630	3.0920	2.7097	2.6452
Weak_Neighbourhood_Peers	2.8268	3.2857	2.8082	2.1954	2.8065	3.4194
Ready4School	Yes	Yes	Yes	Yes	Yes	Yes

Time taken to build model (full training data) : 0.03 seconds

=== Model and evaluation on test split ===
kMeans
======
Number of iterations: 14
Within cluster sum of squared errors: 228.14912670587015

Missing values globally replaced with mean/mode

Cluster centroids:

		Cluster#				
Attribute	Full Data	0	1	2	3	4
	(201)	(39)	(35)	(38)	(37)	(52)
Mother_educational_qualification	Secondary	Secondary	Secondary	Secondary	Secondary	1st_degree
Father_educational_qualification	Secondary	Secondary	Secondary	Secondary	Secondary	1st_degree
Mother_occupation	Private	Private	Private	Private	Private	Private
Father_occupation	Private	Private	Private	Private	Private	Private
Family_size	4.7164	4.6667	4.5429	4.8158	4.7297	4.7885
Child_position	1.9353	1.7949	1.9429	2.1316	2	1.8462
Good_Class_Peers	3.0149	2.7692	3.1143	2.6053	3.6757	2.9615
Weak_Class_Peers	2.8358	2.9487	1.9143	1.9474	4.1892	3.0577
Good_Neighbourhood_Peers	2.9701	4.2821	3.9429	1.7895	1.7568	3.0577
Weak_Neighbourhood_Peers	2.7015	1.9231	4.2286	1.5789	3.2973	2.6538
Ready4School	Yes	Yes	Yes	Yes	Yes	Yes

Time taken to build model (percentage split) : 0.02 seconds

Clustered Instances
0 15 (14%)
1 23 (22%)
2 17 (16%)
3 23 (22%)
4 27 (26%)

9.3. The Expectation-Maximisation (EM) algorithm WEKA results

=== Run information ===
Scheme: weka.clusterers.EM -I 100 -N 4 -X 10 -max -1 -ll-cv 1.0E-6 -ll-iter 1.0E-6 -M 1.0E-6 -num-slots 1 -S 200
Relation: Ready2Learn-weka.filters.unsupervised.attribute.Remove-R1-2,9-11,16-24
Instances: 306
Attributes: 11
Mother_educational_qualification
Father_educational_qualification
Mother_occupation
Father_occupation
Family_size
Child_position
Good_Class_Peers
Weak_Class_Peers
Good_Neighbourhood_Peers
Weak_Neighbourhood_Peers
Ready4School
Test mode: split 66% train, remainder test

=== Clustering model (full training set) ===
EM
==
Number of clusters: 4
Number of iterations performed: 26

	Cluster			
	0	1	2	3
	(0.28)	(0.55)	(0.03)	(0.14)
Mother_educational_qualification				
Primary	1.0814	1.0554	2.9917	4.8716
Secondary	3.2824	153.2146	2.4290	38.0740
1st_degree	79.6616	15.3416	6.9338	3.0630
2nd_degree	3.4803	1.3248	1.0118	1.1831
MD	2.4575	1.0126	1.5276	1.0023
PhD	1.0180	1.0016	1.0003	1.9801
[total]	90.9811	172.9506	15.8943	50.1740
Father_educational_qualification				
Primary	1.0821	1.0583	2.9918	5.8678
Secondary	16.9678	154.3899	6.3541	37.2882
1st_degree	65.7893	14.1211	3.2292	2.8604
2nd_degree	1.5708	1.2655	1.0100	2.1537
MD	4.5712	1.1158	1.3092	1.0038
PhD	1.0000	1.0000	1.0000	1.0000
[total]	90.9811	172.9506	15.8943	50.1740
Mother_occupation				
UnEmployed	6.8854	20.8486	2.7372	6.5288
Private	51.9359	136.8048	1.5246	34.7347
Government	29.1598	12.2972	8.6324	5.9106
[total]	87.9811	169.9506	12.8943	47.174
Father_occupation				
UnEmployed	1.0022	1.9410	1.0030	1.0538
Private	75.8401	153.3461	9.9799	40.8338
Government	11.1388	14.6634	1.9113	5.2864
[total]	87.9811	169.9506	12.8943	47.1740
Family_size				
Big	60.3667	94.1779	1.3863	45.0691
Small	26.6144	74.7727	10.5080	1.1049
[total]	86.9811	168.9506	11.8943	46.174
Child_position				
Late	11.5188	4.1964	1.0385	40.2463
Top	75.4623	164.7542	10.8557	5.9277
[total]	86.9811	168.9506	11.8943	46.1740
Good_Class_Peers				
Good	34.1558	67.3908	5.5991	13.8542
Weak	52.8254	101.5597	6.2951	32.3198
[total]	86.9811	168.9506	11.8943	46.174
Weak_Class_Peers				
Good	36.6143	85.5786	1.2019	22.6051
Weak	50.3668	83.3719	10.6924	23.5689
[total]	86.9811	168.9506	11.8943	46.174
Good_ Neighbourhood _Peers				
Good	38.6347	67.2160	8.3640	21.7853
Weak	48.3464	101.7345	3.5303	24.3887
[total]	86.9811	168.9506	11.8943	46.1740
Weak_ Neighbourhood _Peers				
Good	38.9568	78.6484	4.6824	22.7124
Weak	48.0243	90.3021	7.2119	23.4616
[total]	86.9811	168.9506	11.8943	46.174

Ready4School				
NotReady	6.2312	19.2632	5.2429	5.2627
Ready	80.7499	149.6873	6.6514	40.9113
[total]	86.9811	168.9506	11.8943	46.1740

Time taken to build model (full training data) : 0.13 seconds

=== Model and evaluation on test split ===
EM
==
Number of clusters: 4
Number of iterations performed: 15

	Cluster			
	0	1	2	3
	(0.67)	(0.18)	(0.14)	(0.01)
Mother_educational_qualification				
Primary	1.0014	1.0048	1.0009	1.9929
Secondary	118.7411	2.5448	3.6229	1.0912
1st_degree	17.5305	32.1962	26.2287	1.0447
2nd_degree	1.0682	2.8270	1.1051	1.9997
MD	1.0190	2.1451	1.8354	1.0005
PhD	1.0000	1.0000	1.0000	1.0000
[total]	140.3602	41.7178	34.7929	8.1291
Father_educational_qualification				
Primary	1.0014	1.0048	1.0009	1.9929
Secondary	125.1342	4.8114	11.9522	1.1021
1st_degree	11.1159	32.1136	16.6646	1.1059
2nd_degree	1.0169	1.0269	1.0293	1.9269
MD	1.0918	1.7610	3.1459	1.0012
PhD	1.0000	1.0000	1.0000	1.0000
[total]	140.3602	41.7178	34.7929	8.1291
Mother_occupation				
UnEmployed	11.0942	3.4893	4.3554	2.0611
Private	113.1045	23.4636	15.4609	1.9710
Government	13.1615	11.7650	11.9766	1.0969
[total]	137.3602	38.7178	31.7929	5.1291
Father_occupation				
UnEmployed	1.9509	1.0013	1.0385	1.0094
Private	122.6440	30.0981	28.2693	2.9886
Government	12.7653	7.6184	2.4851	1.1311
[total]	137.3602	38.7178	31.7929	5.1291
Family_size				
Big	90.4762	33.3225	9.0878	3.1135
Small	45.884	4.3953	21.7051	1.0156
[total]	136.3602	37.7178	30.7929	4.1291
Child_position				
Late	22.4184	9.2881	1.2288	2.0647
Top	113.9418	28.4297	29.5641	2.0643
[total]	136.3602	37.7178	30.7929	4.1291
Good_Class_Peers				
Good	47.9633	9.1317	18.8523	3.0528
Weak	88.3969	28.5862	11.9406	1.0762
[total]	136.3602	37.7178	30.7929	4.1291

Weak_Class_Peers				
Good	70.3994	16.4449	7.0645	3.0912
Weak	65.9608	21.273	23.7284	1.0378
[total]	136.3602	37.7178	30.7929	4.1291
Good_ Neighbourhood _Peers				
Good	53.0704	15.6327	14.2677	2.0292
Weak	83.2898	22.0851	16.5252	2.0999
[total]	136.3602	37.7178	30.7929	4.1291
Weak_ Neighbourhood _Peers				
Good	67.2351	16.4299	19.2255	3.1095
Weak	69.1251	21.288	11.5674	1.0196
[total]	136.3602	37.7178	30.7929	4.1291
Ready4School				
NotReady	17.2763	2.5023	7.2169	2.0045
Ready	119.0839	35.2156	23.5760	2.1245
[total]	136.3602	37.7178	30.7929	4.1291

Time taken to build model (percentage split) : 0.05 seconds
Clustered Instances
0 75 (71%)
1 17 (16%)
2 11 (10%)
3 2 (2%)
Log likelihood: -6.85906

9.4. The ID3 algorithm WEKA results

=== Run information ===

Scheme: weka.classifiers.trees.Id3
Relation: Ready2Learn-weka.filters.unsupervised.attribute.Remove-R1-2,9-11,16-24
Instances: 306
Attributes: 11
Mother_educational_qualification
Father_educational_qualification
Mother_occupation
Father_occupation
Family_size
Child_position
Good_Class_Peers
Weak_Class_Peers
Good_Neighbourhood_Peers
Weak_Neighbourhood_Peers
Ready4School
Test mode: split 66.0% train, remainder test

=== Classifier model (full training set) ===

ID3
Father_occupation = UnEmployed: NotReady
Father_occupation = Private
| Father_educational_qualification = Primary
| | Mother_occupation = UnEmployed: Ready

```
| | Mother_occupation = Private
| | | Mother_educational_qualification = Primary
| | | | Child_position = Late: NotReady
| | | | Child_position = Top: Ready
| | | Mother_educational_qualification = Secondary: Ready
| | | Mother_educational_qualification = 1st_degree: null
| | | Mother_educational_qualification = 2nd_degree: null
| | | Mother_educational_qualification = MD: null
| | | Mother_educational_qualification = PhD: null
| | Mother_occupation = Government: Ready
| Father_educational_qualification = Secondary
| | Mother_occupation = UnEmployed: Ready
| | Mother_occupation = Private
| | | Weak_Neighbourhood_Peers = Good
| | | | Mother_educational_qualification = Primary: null
| | | | Mother_educational_qualification = Secondary
| | | | | Good_Neighbourhood_Peers = Good
| | | | | | Family_size = Big: Ready
| | | | | | Family_size = Small
| | | | | | | Good_Class_Peers = Good
| | | | | | | | Weak_Class_Peers = Good: Ready
| | | | | | | | Weak_Class_Peers = Weak: Ready
| | | | | | | Good_Class_Peers = Weak: Ready
| | | | | Good_Neighbourhood_Peers = Weak
| | | | | | Good_Class_Peers = Good
| | | | | | | Family_size = Big
| | | | | | | | Child_position = Late: Ready
| | | | | | | | Child_position = Top
| | | | | | | | | Weak_Class_Peers = Good: Ready
| | | | | | | | | Weak_Class_Peers = Weak: Ready
| | | | | | | Family_size = Small: Ready
| | | | | | Good_Class_Peers = Weak
| | | | | | | Child_position = Late: Ready
| | | | | | | Child_position = Top
| | | | | | | | Family_size = Big
| | | | | | | | | Weak_Class_Peers = Good: Ready
| | | | | | | | | Weak_Class_Peers = Weak: Ready
| | | | | | | | Family_size = Small
| | | | | | | | | Weak_Class_Peers = Good: Ready
| | | | | | | | | Weak_Class_Peers = Weak: Ready
| | | | Mother_educational_qualification = 1st_degree
| | | | | Good_Neighbourhood_Peers = Good: NotReady
| | | | | Good_Neighbourhood_Peers = Weak: Ready
| | | | Mother_educational_qualification = 2nd_degree: null
| | | | Mother_educational_qualification = MD: null
| | | | Mother_educational_qualification = PhD: null
| | | Weak_Neighbourhood_Peers = Weak
| | | | Child_position = Late
| | | | | Weak_Class_Peers = Good
| | | | | | Mother_educational_qualification = Primary: null
| | | | | | Mother_educational_qualification = Secondary
| | | | | | | Good_Class_Peers = Good: Ready
| | | | | | | Good_Class_Peers = Weak
| | | | | | | | Good_Neighbourhood_Peers = Good: Ready
| | | | | | | | Good_Neighbourhood_Peers = Weak: Ready
```

| | | | | | Mother_educational_qualification = 1st_degree: Ready
| | | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | | Mother_educational_qualification = MD: null
| | | | | | Mother_educational_qualification = PhD: null
| | | | | Weak_Class_Peers = Weak: Ready
| | | | Child_position = Top
| | | | | Weak_Class_Peers = Good
| | | | | | Family_size = Big
| | | | | | | Good_Class_Peers = Good
| | | | | | | | Good_Neighbourhood_Peers = Good: Ready
| | | | | | | | Good_Neighbourhood_Peers = Weak: NotReady
| | | | | | | Good_Class_Peers = Weak: Ready
| | | | | | Family_size = Small
| | | | | | | Good_Neighbourhood_Peers = Good
| | | | | | | | Good_Class_Peers = Good: Ready
| | | | | | | | Good_Class_Peers = Weak
| | | | | | | | | Mother_educational_qualification = Primary: null
| | | | | | | | | Mother_educational_qualification = Secondary: Ready
| | | | | | | | | Mother_educational_qualification = 1st_degree: Ready
| | | | | | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | | | | | Mother_educational_qualification = MD: null
| | | | | | | | | Mother_educational_qualification = PhD: null
| | | | | | | Good_Neighbourhood_Peers = Weak: Ready
| | | | | Weak_Class_Peers = Weak
| | | | | | Good_Neighbourhood_Peers = Good
| | | | | | | Mother_educational_qualification = Primary: null
| | | | | | | Mother_educational_qualification = Secondary
| | | | | | | | Family_size = Big
| | | | | | | | | Good_Class_Peers = Good: Ready
| | | | | | | | | Good_Class_Peers = Weak: Ready
| | | | | | | | Family_size = Small: NotReady
| | | | | | | Mother_educational_qualification = 1st_degree
| | | | | | | | Family_size = Big: Ready
| | | | | | | | Family_size = Small: Ready
| | | | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | | | Mother_educational_qualification = MD: null
| | | | | | | Mother_educational_qualification = PhD: null
| | | | | | Good_Neighbourhood_Peers = Weak
| | | | | | | Good_Class_Peers = Good: Ready
| | | | | | | Good_Class_Peers = Weak
| | | | | | | | Mother_educational_qualification = Primary: null
| | | | | | | | Mother_educational_qualification = Secondary
| | | | | | | | | Family_size = Big: Ready
| | | | | | | | | Family_size = Small: Ready
| | | | | | | | Mother_educational_qualification = 1st_degree: Ready
| | | | | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | | | | Mother_educational_qualification = MD: null
| | | | | | | | Mother_educational_qualification = PhD: null
| | Mother_occupation = Government
| | | Good_Neighbourhood_Peers = Good
| | | | Family_size = Big: Ready
| | | | Family_size = Small
| | | | | Weak_Class_Peers = Good: Ready
| | | | | Weak_Class_Peers = Weak
| | | | | | Weak_Neighbourhood_Peers = Good: NotReady

| | | | | | Weak_Neighbourhood_Peers = Weak
| | | | | | | Mother_educational_qualification = Primary: null
| | | | | | | Mother_educational_qualification = Secondary
| | | | | | | | Good_Class_Peers = Good: NotReady
| | | | | | | | Good_Class_Peers = Weak: Ready
| | | | | | | Mother_educational_qualification = 1st_degree
| | | | | | | | Good_Class_Peers = Good: Ready
| | | | | | | | Good_Class_Peers = Weak: NotReady
| | | | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | | | Mother_educational_qualification = MD: null
| | | | | | | Mother_educational_qualification = PhD: null
| | | Good_Neighbourhood_Peers = Weak: Ready
| Father_educational_qualification = 1st_degree
| | Good_Class_Peers = Good
| | | Weak_Class_Peers = Good: Ready
| | | Weak_Class_Peers = Weak
| | | | Mother_occupation = UnEmployed
| | | | | Family_size = Big: NotReady
| | | | | Family_size = Small: NotReady
| | | | Mother_occupation = Private
| | | | | Weak_Neighbourhood_Peers = Good: Ready
| | | | | Weak_Neighbourhood_Peers = Weak
| | | | | | Mother_educational_qualification = Primary: null
| | | | | | Mother_educational_qualification = Secondary: NotReady
| | | | | | Mother_educational_qualification = 1st_degree
| | | | | | | Family_size = Big
| | | | | | | | Child_position = Late: Ready
| | | | | | | | Child_position = Top
| | | | | | | | | Good_Neighbourhood_Peers = Good: Ready
| | | | | | | | | Good_Neighbourhood_Peers = Weak: NotReady
| | | | | | | Family_size = Small: Ready
| | | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | | Mother_educational_qualification = MD: null
| | | | | | Mother_educational_qualification = PhD: null
| | | | Mother_occupation = Government
| | | | | Family_size = Big: Ready
| | | | | Family_size = Small: NotReady
| | Good_Class_Peers = Weak
| | | Mother_educational_qualification = Primary: null
| | | Mother_educational_qualification = Secondary
| | | | Family_size = Big: Ready
| | | | Family_size = Small
| | | | | Weak_Class_Peers = Good: NotReady
| | | | | Weak_Class_Peers = Weak: Ready
| | | Mother_educational_qualification = 1st_degree: Ready
| | | Mother_educational_qualification = 2nd_degree: Ready
| | | Mother_educational_qualification = MD: Ready
| | | Mother_educational_qualification = PhD: null
| Father_educational_qualification = 2nd_degree
| | Mother_educational_qualification = Primary: null
| | Mother_educational_qualification = Secondary: null
| | Mother_educational_qualification = 1st_degree: null
| | Mother_educational_qualification = 2nd_degree: NotReady
| | Mother_educational_qualification = MD: null
| | Mother_educational_qualification = PhD: Ready

| Father_educational_qualification = MD: Ready
| Father_educational_qualification = PhD: null
Father_occupation = Government
| Weak_Neighbourhood_Peers = Good
| | Good_Class_Peers = Good: Ready
| | Good_Class_Peers = Weak
| | | Good_Neighbourhood_Peers = Good: Ready
| | | Good_Neighbourhood_Peers = Weak
| | | | Child_position = Late: NotReady
| | | | Child_position = Top
| | | | | Mother_educational_qualification = Primary: null
| | | | | Mother_educational_qualification = Secondary: Ready
| | | | | Mother_educational_qualification = 1st_degree
| | | | | | Mother_occupation = UnEmployed: NotReady
| | | | | | Mother_occupation = Private
| | | | | | | Father_educational_qualification = Primary: null
| | | | | | | Father_educational_qualification = Secondary: Ready
| | | | | | | Father_educational_qualification = 1st_degree: NotReady
| | | | | | | Father_educational_qualification = 2nd_degree: null
| | | | | | | Father_educational_qualification = MD: null
| | | | | | | Father_educational_qualification = PhD: null
| | | | | | Mother_occupation = Government: null
| | | | | Mother_educational_qualification = 2nd_degree: null
| | | | | Mother_educational_qualification = MD: null
| | | | | Mother_educational_qualification = PhD: null
| Weak_Neighbourhood_Peers = Weak: Ready

Time taken to build model: 0.01 seconds

=== Evaluation on test split ===
Time taken to test model on training split: 0 seconds

=== Summary ===

Correctly Classified Instances	86	82.6923 %
Incorrectly Classified Instances	17	16.3462 %
Kappa statistic	0.0278	
Mean absolute error	0.1612	
Root mean squared error	0.3523	
Relative absolute error	95.2445 %	
Root relative squared error	144.9646 %	
Coverage of cases (0.95 level)	89.4231 %	
Mean rel. region size (0.95 level)	57.6923 %	
UnClassified Instances	1	0.9615 %
Total Number of Instances	104	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.167	0.124	0.077	0.167	0.105	0.030	0.466	0.069	NotReady
	0.876	0.833	0.944	0.876	0.909	0.030	0.549	0.938	Ready
Weighted Avg.	0.835	0.792	0.894	0.835	0.862	0.030	0.544	0.888	

=== Confusion Matrix ===

```
 a      b        <-- classified as
 1      5        |  a = NotReady
12     85        |  b = Ready
```

9.5.The J48 algorithm WEKA results

```
=== Run information ===

Scheme:       weka.classifiers.trees.J48 -U -M 4
Relation:     Ready2Learn
Instances:    306
Attributes:   11
              Mother_educational_qualification
              Father_educational_qualification
              Mother_occupation
              Father_occupation
              Family_size
              Child_position
              Good_Class_Peers
              Weak_Class_Peers
              Good_Neighbourhood_Peers
              Weak_Neighbourhood_Peers
              Ready4School
Test mode:    split 66.0% train, remainder test

=== Classifier model (full training set) ===

J48 unpruned tree
------------------

Weak_Neighbourhood_Peers <= 4
|   Father_occupation = UnEmployed: No (1.0)
|   Father_occupation = Private
|   |   Mother_educational_qualification = Primary: Yes (5.0/1.0)
|   |   Mother_educational_qualification = Secondary
|   |   |   Weak_Neighbourhood_Peers <= 3: Yes (110.0/8.0)
|   |   |   Weak_Neighbourhood_Peers > 3
|   |   |   |   Mother_occupation = UnEmployed: Yes (5.0)
|   |   |   |   Mother_occupation = Private
|   |   |   |   |   Good_Neighbourhood_Peers <= 1: No (4.0/1.0)
|   |   |   |   |   Good_Neighbourhood_Peers > 1
|   |   |   |   |   |   Family_size <= 4: Yes (9.0/1.0)
|   |   |   |   |   |   Family_size > 4
|   |   |   |   |   |   |   Child_position <= 2
|   |   |   |   |   |   |   |   Good_Class_Peers <= 2: No (4.0/1.0)
|   |   |   |   |   |   |   |   Good_Class_Peers > 2: Yes (7.0/1.0)
|   |   |   |   |   |   |   Child_position > 2: Yes (7.0/1.0)
|   |   |   |   Mother_occupation = Government: Yes (3.0/1.0)
|   |   Mother_educational_qualification = 1st_degree
|   |   |   Weak_Class_Peers <= 4: Yes (60.0/3.0)
```

| | | Weak_Class_Peers > 4
| | | | Child_position <= 1: No (4.0/1.0)
| | | | Child_position > 1: Yes (12.0/2.0)
| | Mother_educational_qualification = 2nd_degree: No (1.0)
| | Mother_educational_qualification = MD: Yes (1.0)
| | Mother_educational_qualification = PhD: Yes (1.0)
| Father_occupation = Government: Yes (26.0/3.0)
Weak_Neighbourhood_Peers > 4: Yes (46.0)

Number of Leaves : 18
Size of the tree : 29
Time taken to build model: 0.01 seconds

=== Evaluation on test split ===
Time taken to test model on training split: 0 seconds

=== Summary ===

Correctly Classified Instances	95	91.3462 %
Incorrectly Classified Instances	9	8.6538 %
Kappa statistic	-0.0308	
Mean absolute error	0.1672	
Root mean squared error	0.2816	
Relative absolute error	94.1331 %	
Root relative squared error	109.2774 %	
Coverage of cases (0.95 level)	98.0769 %	
Mean rel. region size (0.95 level)	87.9808 %	
Total Number of Instances	104	

=== Detailed Accuracy By Class ===

	TP Rate	FP Rate	Precision	Recall	F-Measure	MCC	ROC Area	PRC Area	Class
	0.000	0.021	0.000	0.000	0.000	-0.038	0.581	0.108	No
	0.979	1.000	0.931	0.979	0.955	-0.038	0.581	0.945	Yes
Weighted Avg.	0.913	0.934	0.869	0.913	0.891	-0.038	0.581	0.889	

=== Confusion Matrix ===

a b <-- classified as
0 7 | a = No
2 95 | b = Yes