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# THE CONTRIBUTION OF MATHEMATICS ONLINE GAMES TO QUALITIVE DIFFERENTIATION AND INTRINSIC MOTIVATION OF STUDENTS WITH MILD INTELLECTUAL DISABILITIES

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**Abstract:**
The purpose of this research is to examine the influence of a special education program, incorporating online digital games, on the understanding of basic mathematical concepts by students with mild intellectual disabilities. The research involved four students (one girl and three boys) with mild intellectual disabilities divided into two groups, an experimental (combined intervention) and a control group (standard intervention). The students' performance was assessed before the intervention program, immediately after the end of the program and two weeks after the completion of the intervention. Based on the results, improved performance was observed in the experimental group's students, in the areas of intervention, in relation to the students in the control group. The experimental group's students continued to perform at high standards, contrary to those of the control group. The findings show that the teaching approach integrating online digital games has a positive impact on the understanding of basic mathematical concepts by students with mild intellectual disabilities.

**Keywords:** mild intellectual disability, mathematical performance, basic mathematical concepts, online digital games, learning strategies, intrinsic motivation

## 1. Introduction

Intellectual disability is a permanent condition characterized by significant limitations in the intellectual functioning (Schalock & Luckanson, 2004) and in the adaptive capacity of individuals regarding perceptual, social and adaptive skills (self-management, living at home, self-reliance, health and safety, practical learning, recreation and work). According to statistics (based on the DSM-IV-TR definition), 2.5% of the population should have intellectual disability, and 85% of these individuals

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should fall into the mild range (Shapiro & Batshaw, 2015). They are educated in mainstream schools and may become self-reliant with systematic and programmed assistance. For their training, combined behavioral and cognitive strategies are usually applied. However, the trend for innovative interdisciplinary approaches to address students with intellectual disabilities is strong. In this context, activities are needed, through which the knowledge and skills will be acquired, after being constructed and integrated through daily teaching practice. It is emphasized that the student should actively participate in these activities (Cobb, Yackel & Wood, 1992). Alternative methods and strategies are useful for addressing the specific needs of children with mild intellectual disabilities. Information and Communication Technologies (ICT) can be effectively used for the education of people with intellectual disabilities.

The nature of school mathematics renders it a complex and "multi-level" learning object. Specifically, the basic mathematical concepts are the basis of mathematical learning hierarchy and an organic part of most mathematical operations. Basic mathematical concepts are the concept of number, that of the positional value of digits, the distinction, reading and writing of numbers and numerical symbols and the ability to measure, count and enumerate.

The educational sector is keenly interested in educational software as a complementary factor and as a learning tool. This approach is known as Computer Assisted Instruction (CAI), where written and visual information is presented in a logical sequence to a student on a computer. The familiarity of the student population with the use of computers leads to educational planning towards an increased provision of PCs, since more than half of the students use PCs during the school day (Kleiner & Lewis, 2004). Indeed, a particular sector was created, that of educational computer games - edutainment or digital game-based learning, aimed to teach specific subjects through gaming platforms.

The research community is interested in the teaching of mathematics using new technologies and digital gaming. The results show a positive impact of digital games in mathematical performance, as they can increase the performance in mathematics and problem-solving (Shin, Sutherland, Norris & Soloway, 2012). Indeed, the digital game assists in teaching mathematics more effectively than the educational videos (Lin et al, 2013). Overall, the results show a significant contribution of digital games or applications in areas such as logical correlations or specific cognitive skills (e.g. problem solving) (Bottge, 2001). However, while in the international literature there is sufficient evidence for the usefulness of incorporation of digital games in the teaching of mathematics, there is a lack of sufficient information and knowledge regarding their use in education for children with intellectual disabilities. The few studies related to this field have weaknesses (Bahr & Rieth, 1991; Podell, Tournaki-Rein & Lin, 1992). These weaknesses are usually related to the methodological design (e.g. no control group, no preservation measurement results after the intervention), the type of software, variables that have to do with the students themselves and the small number of samples or period of intervention (short-term experiments and interventions).

Motivation is the dominant element in the educational process and what pushes a person into action. As motivation is considered, it is everything that moves, pushes or entrains a person to act, or the "reasons underlying a person's behavior". They are categorized into external (e.g. fees, penalties, fears) and internal (e.g. instincts, desires). Internal motivations are considered more desirable as they lead to better learning results and are related to the cognitive processes that mobilize the behavior leading to achievement of the desired objective. The survey shows a relatively stable relationship between motivation and performance in reading and mathematics. The role of digital games in the activation of intrinsic motivation seems to be important, as digital games occupy an important part of students' free time, causing fascination and a strong commitment and involvement. Digital games trigger the students' intrinsic motivations, contrary to the official curriculum. Research programs like T.E.E.M. (Teachers Evaluating Educational Multimedia) and CGE (Computer Games in Education) investigated the use of commercial digital games in schools to benefit the development of the students' skills and motivation. In the area of mathematics in particular, many researchers believe that they are the perfect tool, providing important motivation towards the improvement of mathematical education. According to Schiefele and Csikszentmihalyi (1995), students' motivation in mathematics is related to their performance. Digital Math games can be used to enhance the learning of mathematics in the classroom (Bai, Pan, Hirumi & Kebritchi, 2012). The E-GEMS program (Electronic Games for Education in Math and Science) showed that digital games create increased motivation in children. The use of games for mobile devices has led to improved motivation and learning results compared to traditional instruction in math and reading. Students enjoy playing digital games because they are interactive (Lopez-Morteo & Lopez, 2007) and provide them with a "cosmetic ingredient" (sensory component), which may involve many different students with multiple learning styles. An important aspect of motivation activation through digital games are the possibilities of cooperation. People with intellectual disabilities, aside from cognitive deficits, are likely to have impairment associated with problematic motivation, same as people with normal intelligence (Pepi & Alesi, 2002). Mental disability affects negatively a person's activation effectiveness of his/her self-control. An influence which, interacting with cognitive and metacognitive deficiencies leads to ineffective learning (Switzky, 2001).

The students consider failure as expected and the expectation of success is almost nonexistent or extremely low, developing the characteristic of "reduced expectation of success" (Bennett-Gates & Zigler, 1999; Merighi, Edison & Zigler, 1990). Another goal of this special educational intervention is a different learning environment oriented towards the abilities of self-control, impulse control and motivation management (Cuskelly, Zhang & Gilmore, 1998). There is evidence that the motivations of people with intellectual disability are triggered when playing digital games. Virtual environments for people with intellectual disabilities can play an important role in facilitating the acquisition of skills and the improvement of their cognitive skills in conjunction with entertainment (Saridaki, Gouscos & Meimaris, 2010, Standen, Brown, Anderton & Battersby, 2006). The objectives are achieved more easily when the games are easily customizable.

The purpose of this research is to examine the extent to which an educational intervention program that combines online digital gaming activities could be proved positive for the understanding of mathematics by students with mild intellectual disabilities. The teaching and understanding of mathematical concepts by students with mild intellectual disabilities should be part of a more general teaching philosophy and practice in order to better implement the "learning hierarchy" of "learning stages" (Polloway & Patton, 1997).

The experimental method seeks a learning process qualitatively differentiated with an increased degree of understanding, using strategies and metacognitive skills. It aims to become a didactic selection with activities more satisfactory for the students, increased participation, feedback provision and increased levels of student interest.

### 1.1. The Aim of Current Study

Based on the above theory and research, we were led to the formulation of the following research questions:

1. Online digital games will contribute to the understanding of basic mathematical skills and concepts and improve the performance of students with mild intellectual disabilities.
2. A significant difference in the performance of students with mild intellectual disabilities participating in this particular intervention program compared with students who follow a conventional intervention program is expected.
3. The difference in performance will be not only quantitative, but also qualitative. It is expected that the students of the experimental group will develop and apply strategies of higher quality and elements of knowledge generalization compared to the students of the control group.
4. The proposed teaching strategy will implement more effectively the qualitative features in relation to common intervention strategies.
5. The degree of intrinsic motivation activation from the participation to the program will be greater in the students of the experimental group in comparison with the students of the control group.
6. The usefulness of the intervention program in relation to the usual intervention methods will be demonstrated.

## 2. Material and Method

### 2.1. Participants

In the survey, four Greek students participated (N = 4), a girl and three boys. The participants were eleven (11) years old, with mild intellectual disabilities, as mentioned in the diagnostic evaluation of the responsible body. The evaluation was conducted by the Differential Diagnosis and Support Center. The Wisc III evaluation tool was used and the results showed mild intellectual disability. As indicated in the report, attention deficit, hyperactivity disorder (A.D.H.D.), or any other special health problems, were not observed in any of the students. The participants were randomly divided into an experimental group (N = 2) called group (EG) and a control group (N = 2) called group (CG). The two groups are equal considering the following main factors:

1. The intellectual capacity level
2. The mathematical knowledge level

The groups were considered equivalent since their subjects have about the same chronological and mental age, the same aid level and come from similar educational background (parental education level) and socio-economic environment (occupational and marital status). Also, students received the same level of help by the school and family environment.

**2.2. Experimental design and procedure**

The experimental procedure was designed to test the effect of the proposed intervention on the mathematical performance of the students. The implementation of the intervention took place in two phases. During the first phase, the level of mathematical competence of students of both groups was assessed.

The second phase comprised practical intervention embodiment, the total length of which was eight weeks. The intervention areas were:

- The concept of number and numbering capability (number identification and quantity estimate, numerical scale ascent and descent),
- The positional value of the numbers (e.g. tens-units) and their comparison and order (which number is higher or lower),
- Mental calculation (addition and subtraction) and,
- The growing of measurement capacity (length, weight, time).

The control group (CG) followed an entirely conventional intervention program. The experimental group (EG) followed a combinatorial form of interference; where part of the program has been replaced by digital online gaming activities.

The objectives and structure of the intervention program by sector was as follows:

**Area:** Identification numbers; estimate quantities; ascent and descent numerical scale

**First Session objectives:**

Cardinality – quantity estimation - arithmetic sequence formation - numbering (at ten and twenty)

**Second Session objectives**:

Numbers 20-30 - numerical scale ascent and descent (1-1, 2-2 etc.) – Sets of numbers creation and composition analysis

**Third session objectives**:

Numbers 30-100-compound sets and separation-number comparison and estimation-addition and subtraction of numbers in *enactive (action-based)* and *iconic* (image-based) level.

The Consolidation and Expansion of knowledge in each subject was achieved through online digital game activities. Indicative activities (figure 1 & 2)

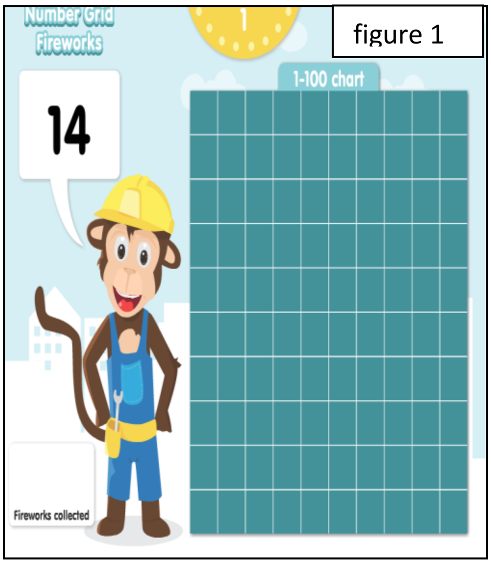



figure 1

http://www.abcya.com/100_number_grid.htm

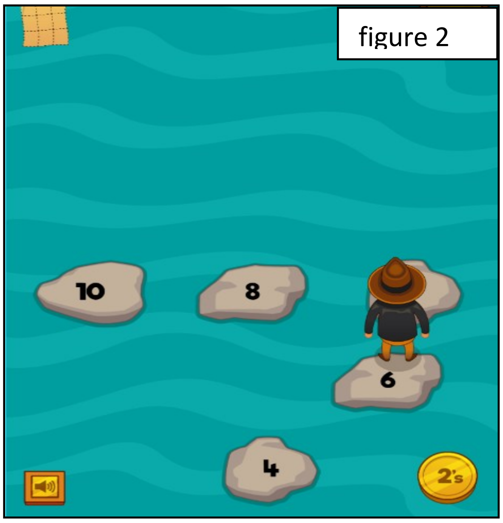



figure 2

http://www.abcya.com/adventure_man_counting.htm

**Area:** positional value – number comparison and ordering

**First Session objectives:**

Object grouping and set formation - collection data grouping in tens.

**Second Session objectives:**

Recognition of tens and units - number *decompose* in tens and units

**Third Session - Structure intervention objectives:**

Number comparison and ordering

The consolidation and expansion of knowledge in each subject was achieved through online digital game activities. Indicative activities (figure 3 & 4)

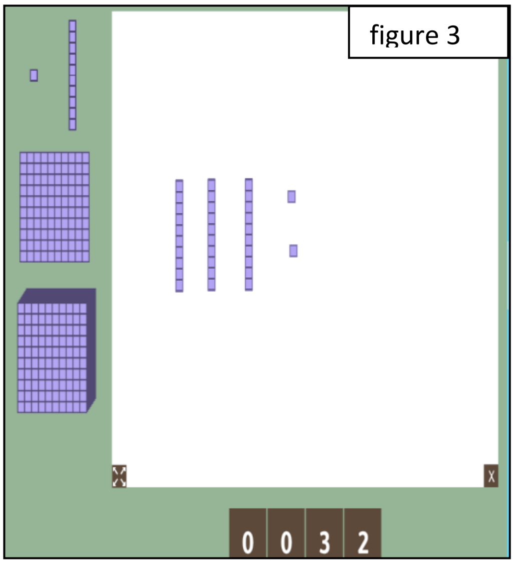



figure 3

http://www.abcya.com/base_ten.htm

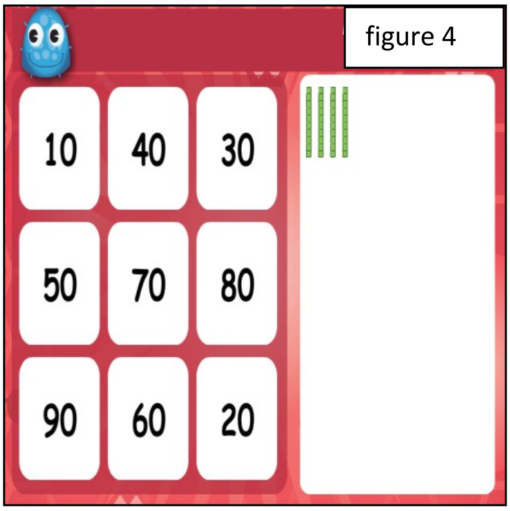



figure 4

http://www.abcya.com/base_ten_bingo.

**Area:** mental calculation (addition and subtraction)

**<u>First Session objectives:</u>**

Acquaintance with the concepts of addition and subtraction (*enactive* level) - mental estimate and verification of additions and subtractions

**<u>Second Session objectives:</u>**

Numbers Analysis - maintenance of all within cardinality- automatic enhancement- calculation strategies recollection

**<u>Third Session objectives:</u>**

Mental calculation

The Consolidation and Expansion of knowledge in each subject was achieved through online digital game activities. Indicative activities (figure 5 & 6)

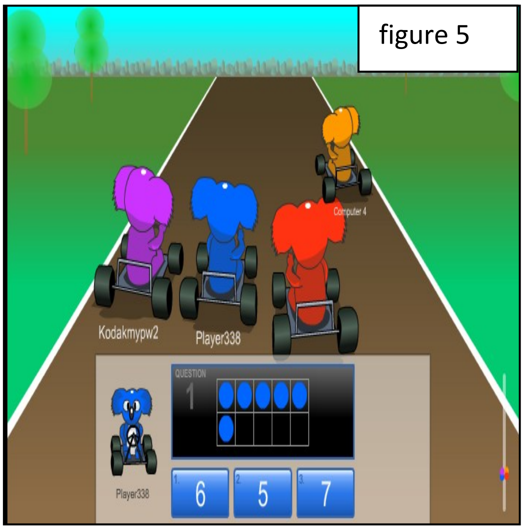



figure 5

http://www.abcya.com/base_ten_bingo.htm

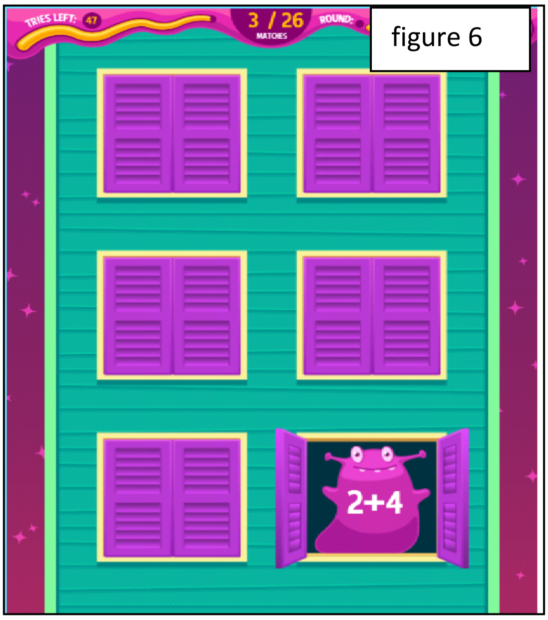



figure 6

http://www.abcya.com/math_match.htm

**Area:** measurements

**<u>First Session objectives:</u>**

Notion of distance-comparison and ordering of length- basic length measurement unit

**<u>Second Session objectives:</u>**

Concept of 'weight' - basic measurement unit of weight - correct weight estimation, comparison and verification

**<u>Third Session objectives:</u>**

Understanding of temporal concepts (awareness of time concepts) -time measurement-proper time reading- period estimation

The Consolidation and Expansion of knowledge in each subject was achieved through online digital game activities. Indicative activities (figure 7 & 8)


figure 7

http://www.topmarks.co.uk/Flash.aspx?b=maths/measures

http://www.ictgames.com/weight.html

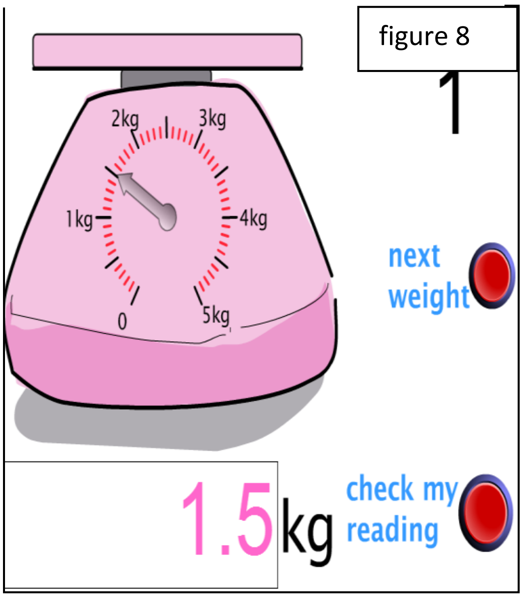



figure 8

http://www.topmarks.co.uk/Flash.aspx?b=maths/measures

After completing the program, the two groups (experimental and control) were evaluated, to determine:

- The achieved level of mathematical performance in the intervention areas, using the same tool of mathematical performance that was used during the initial evaluation, which was developed by the University of Patras (Karantzis & Porpodas 2005).

- The level of use and development of notable learning strategies by the students.
- The degree of quality difference between the proposed teaching strategy compared to conventional teaching methods.
- The assessment of entertainment, interest, importance and satisfaction of both groups using the Intrinsic Motivation Inventory (Intrinsic Motivation Inventory, Ryan 1982; McAuley, Dancan & Tammen, 1989 – Greek adaptation Goudas & Papacharisis, 2005).

After completing the program, the two groups (experimental and control) were evaluated, to compare the results between the initial and final evaluation regarding the degree of mathematical performance using the previously mentioned evaluation tool (Karantzis & Porpodas, 2005).of each person in each group (intra-individual control), to identify any performance differences between individuals in the same group (intra - group control) and to detect differences between the two groups (inter -group control). 15 days after the end of the program another assessment followed (final -follow up) to estimate the degree of the improvement's persistence.

**2.3. Measurements**

To assess the initial mathematical performance (Table 1), the "Utrecht Early Numeracy Test" (Barbas, Vermeoulen, Kioseoglou & Menexes, 2008) was used, as well as the diagnostic evaluation procedure proposed by the psychology laboratory - Department of Primary Education - University of Patras (Porpodas, 2005), regarding the basic mathematical concepts. In particular, the oral numbering area includes 15 activities, the positional value - number comparison and ordering area includes 8 activities, the area of mental calculation 8 activities and the area of measurement 7 activities. To assess the use of qualitative characteristics by the students during the evaluation process an observation and recording list has been used. The registration list was created based on the proposals of Barroody and Ginsburg (1991) and includes the recording of data on the informal mathematical knowledge, strengths and weaknesses of the student, how he/she utilizes mathematical skills, identification of used strategies, the recording and classification of student errors, the degree of readiness for the conquest of new knowledge, metacognitive strengths and weaknesses and the recording of the student's emotional situation. For the assessment of the intrinsic motivation, the Intrinsic Motivation Inventory (Ryan, 1982; McAuley, Dancan & Tammen, 1989 - Greek adaptation Goudas & Papacharisis, 2005) was used, adapted for the purposes of this survey. The questionnaire includes four subscales (Enjoyment – Interest- Effort - Importance, perceived ability, Pressure - Distress). The questionnaire included twenty questions. During the intervention program the observation and recording of students' views was achieved through the "thinking aloud process". To find out why the student thought in this way, the best way is to ask him/her. By observing and studying the mistakes, necessary feedback is gathered and the necessary adjustments have been made to the process.

The implementation reliability of the pilot project was secured with the greatest possible control of threats to internal and external validity with the method of triangulation (Cohen, Manion & Morrison, 2007). This method can ensure reliability by cross checking various data. For the purposes of methodological triangulation, a multi – methodical approach to the collection and checking of the data was followed. To control the accuracy of the intervention program, the teachers were given written instructions to avoid any differences in the experimental procedure that may affect the results. Moreover, the teachers used a self-written list of steps, filled step by step during the program.

## 3. Results

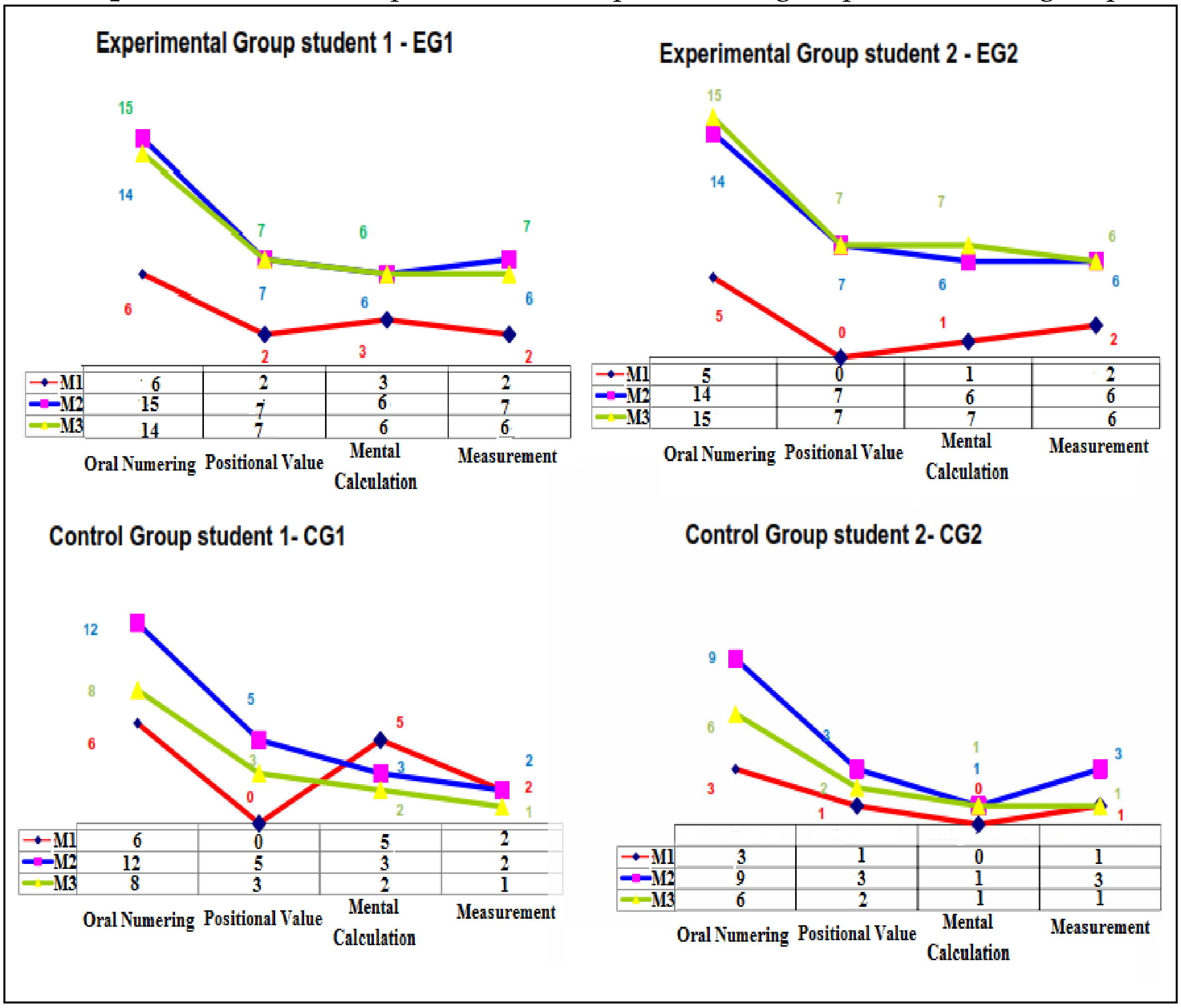
The study aimed to assess the effects of interventions in the areas of oral numbering, positional value – number comparison and ordering, mental calculation and measurements. Table 1 presents the results of the mathematical aptitude psychometric criterion of Utrecht granted during the initial assessment to the students of both groups. All students, based on their performance are ranked at the lowest (fifth) performance level.

**Table 1**: Results of Utrecht Early Numeracy Test

| Student | Mathematical performance | Characterization |
|---|---|---|
| **EG 1** | 62<69 | Level E |
| **EG 2** | 61<69 | Level E |
| **CG 1** | 62<69 | Level E |
| **CG 2** | 64<69 | Level E |

Graph 1 shows the mathematical performance of the experimental group and the control group in all three measurements (M1, M2, M3).

**Graph 1**: Mathematical performance-experimental group and control group




Students in both groups, as derived from the initial assessment, were at about the same learning level. They showed a low level of mathematical efficiency (Table 1) and poor performance in all four areas tested (Graph 1). The effectiveness of the teaching intervention is derived from the difference of student achievement of the experimental group (EG) compared to the control group (CG) students in the assessment criteria provided. As shown by the results there is a significant performance difference, with the students in the experimental group achieving much better results in all four areas of intervention in comparison to the students in the control group (Graph 1). Indeed, the improved performance was maintained, as demonstrated by the final performance control (follow up) held fifteen days after the intervention. In particular, the performance of the experimental group individuals (EG) was significantly improved compared to the starting point in all areas (Graph 1), also demonstrating performance homogeneity, as indicated by the results of intra group check (performance comparison of the same group's students). Similar results were also observed in the follow up study of performance maintenance, as the performance was almost the same in the final measurement for the students of the experimental group (EG) which is interpreted as the effect of the teaching intervention (Graph 1).

The performance of the individuals in the control group (CG) was low, as demonstrated by the intra individual control. During the intra-group check, it was shown that in the areas where low performance was experienced (mental calculation, measurements), there was also performance homogeneity, while in the areas where the performance was higher (oral numbering, positional value- number comparison and ordering) homogeneity was not observed (Graph 1). A similar picture also appears in the final evaluation of the performance level preservation (Graph 1).

### 3.1. Qualitative Elements of the Intervention Program

The results of the research in children with intellectual disabilities show difficulties in cognitive functions (low operation capability) and differences in the functions of attention (Mercel & Snell, 1977; Zeaman & House, 1979) and memory compared to typical development students (Bray, Fletcher & Turner 1997; Merrill, 1985, 1990). The difference between the two groups (experimental and control) as a result of the effects was not only quantitative (in performance) but also qualitative. The use of certain strategies on the part of students is a key feature and that is the reason they were recorded. The chosen methodology was that of thematic qualitative analysis where the observation results are analyzed and categorized into categories and themes. From the results of the observation and recording emerged five (5) themes and a total of fifteen (15) categories. Table 2 shows the themes, categories and frequency (reports) of the phenomenon.

**Table 2:** Thematic axes and categories of observation and recording

| **Thematic axes** | **Categories** | **Reports** | | | |
|---|---|---|---|---|---|
| | | **EG1** | **EG2** | **CG1** | **CG2** |
| **Use of strategies for problem solving** | • Use of prior knowledge;<br>• Alternative workarounds. | 40<br>20 | 37<br>18 | 4<br>2 | 3<br>1 |
| **Use of post cognitive strategies** | • Self-control;<br>• Executive control;<br>• Inhibition mechanism;<br>• Simultaneous information processing;<br>• Mistake correction;<br>• Thinking aloud. | 25<br>15<br>20<br>18<br>27<br>29 | 24<br>12<br>19<br>15<br>20<br>32 | 0<br>0<br>2<br>3<br>10<br>0 | 0<br>0<br>1<br>2<br>7<br>0 |
| **Speed** | • Automation;<br>• Reaction speed (increase);<br>• Activity completion speed. | 19<br>27<br>30 | 16<br>23<br>30 | 9<br>7<br>13 | 6<br>6<br>13 |
| **Understanding of instructions** | • Use of questions;<br>• Problem solving ability without external help;<br>• Problem solving based on acquired knowledge;<br>• Identification of key information. | 27<br>40<br>27<br>42 | 34<br>34<br>22<br>35 | 57<br>14<br>7<br>14 | 60<br>13<br>6<br>13 |

During the period of the intervention, the students in the experimental group developed in all four areas of intervention qualitative elements such as the use of strategies and the constant monitoring of the process, while the awareness of the game status was the main element. For example, the students of the experimental group, during a desired number detection process proceeded to increase the numerical scale (figure 1), using the technique of verbal self-guiding, indicating the steps they will take. The students often counted again (basic function of executive control) to avoid errors.

A beneficial effect was observed in the command – instruction understanding, as students in the experimental group were shown to have less difficulty during oral exercises and the formulation and understanding of the requested problems. Indicative as we mentioned was the fact that the clarifications sought on the implementation of activities decreased progressively. Particularly, in the game (Figure 2) students realized that it was the numerical scale descent by two and after the first attempts they performed the activity without further instructions.

Therefore, in this case the teacher as mentioned in the survey results, is limited to a facilitator role assigned with helping students to construct their own knowledge (Lerman, 1989; Simon, 1995). There was a significant improvement in the experimental group also in the promptness in particular, i.e. the speed of execution of activities due to the improvement of eye-movement coordination and the increase to automated - holistic level of information organization (automatic information revocability). The eye-movement coordination failures negatively affect the mnemonic burden and the emotional world of the child (Pillon, Lochy, Zesiger & Seron, 2002). The students were spending progressively less time playing the games, as a result of their familiarization with them and of the increased calculation and choice speed. Students learned how to make automatically respond to the problems and realized the beneficial effect. As shown at this instance of a game (figure 5) the student must find as quickly as possible the number 6. In the initial stages of intervention, they counted the blue circles one by one. However, they soon realized that the first row contains five circles and that one additional circle of the second row raises the number to 6. Thus, they stopped counting the first set, starting from the first circle of the second row instead (number 6). They did the same with every number. This is a successful implementation of enumeration. Also, competition and time pressure resulted in an increase of speed, i.e. the fast execution of activities, sensitization of numbers, their analysis and synthesis and mental calculations.

Students in the experimental group showed significant improvement of memory function. In particular, direct data retention (short term memory) and conscious (working memory) and automated data use showed improvement. The result and provided information recollection was easier and more accurate. Moreover, the completion of the necessary procedures through multiple, consecutive steps (sequence memory) was easier, which also seems to confirm the overall improved mnemonic operation since, in the digital games, remembering the rules of the game and other relevant information was a prerequisite for success. This is particularly important since, according to the literature, although it is clear that the numeracy knowledge and skill area is important for success in mathematics (Gilmore, McCarthy & Spelke, 2010; Jordan, Glutting & Ramineni, 2010), it shows that cognitive factors play an important role as well. In particular, the sector of general skill exploitation and use of information performed mentally (working memory) has been found to be critical (Raghubar, Barnes & Hecht, 2010). We present a characteristic activity of mental calculation (figure 6) wherein the role of effective information retention is very important. In this activity, students are asked to perform the mental calculations and remember the result of each operation behind the closed window.

During the implementation of the proposed intervention, students in the experimental group were showing higher self-confidence with respect to their performance in mathematics. They were discouraged less easily and the initial existence of discomfort and discontent towards mathematics no longer appeared. At the beginning of the game activities, they were often saying to another student or to the teacher "I know", "I got it", "I do not want help", "I can do it". They experienced success feelings and realized that they can succeed. These findings confirm the results of researches showing that digital games have the potential to enhance the confidence of the students in themselves (Cunningham, 1994; Radford, 2000), as we saw in the students of the experimental group. We know that children with intellectual disabilities develop a characteristic "reduced expectation of success" regarding new or difficult activities (Bennett-Gates & Zigler, 1999; Merighi, Edison & Zigler, 1990), show exploratory behavior less often, seem to lack motivation and show reluctance to learn something new or try something for the first time, even if they have the cognitive and physical abilities to accomplish it (Merighi et al., 1990). It seems possible however, that they can overcome these difficulties.

### 3.2. Satisfaction and intrinsic motivation

The fact is that learning is an emotional and cognitive process (Piaget, 1951), and when students are engaged in activities that stimulate intrinsic motivation, it has been shown that learning is "deep". Satisfaction with the course and the creation of internal incentives and motivation are the most important innovations. Satisfaction is the sum of a number of factors such as cognitive, emotional and behavioral (Aldemir & Gülcan, 2004). In satisfaction are involved (Donald & Denison, 1996; Harvey, 2003; Morrison, 1999) factors such as school, classroom, teachers, students, courses. In this research, after the implementation of educational intervention, the students in the experimental group and the control group were evaluated with respect to the level of internal incentives and the levels of pleasure - interest, effort - importance, perceived competence, pressure - stress of children identified through the questionnaire of intrinsic motivation. The results presented at table 3, showed that the students in the experimental group had very high performance which was significantly above average in interest factors - pleasure, effort - importance, perceived competence. In contrast, they had a very low pressure - stress performance, approaching the one negative deviation below the average which indicates that digital games have a positive effect on reducing anxiety and stress.

**Table 3**: Results of internal motivation level

| Factors | EG 1 | EG 2 | CG 1 | CG 2 |
|---|---|---|---|---|
| **Pleasure interest** | 4,40 | 4,60 | 3,20 | 3,00 |
| **Effort importance** | 4,20 | 5,00 | 3,20 | 3,60 |
| **Perceived ability** | 4,20 | 4,40 | 2,80 | 2,40 |
| **Pressure stress** | 1,80 | 1,80 | 4,40 | 3,80 |

The results of the children of the experimental group are in accordance with the references that reveal the important role of digital games as enjoyable activities and success experiences for children with mild intellectual disabilities, (Chen, Liao, Cheng, Yeh & Chan, 2012; Conati & Zhao, 2008; Eliens & Ruttkay, 2009a; Lee & Cheng, 2009; Owen, 2007; Prensky, 2003)

## 4. Conclusion and Discussion

This paper has the characteristics of a "case study", which have recently seen a rise in popularity in education research (Tellis, 1997). This type of research is suitable for understanding and analyzing complex research questions, particularly when a holistic, in-depth analysis is required. Case studies include both quantitative and qualitative data, thus helping explain a phenomenon through analysis and reconstruction of the data (Tellis, 1997).

The results are consistent with international findings of research according to which, "high level" procedures, like internal mediation processes (metacognitive) must be combined with "low level" procedures, which means those related to fundamental cognitive functions such as perception, attention, memory. This combination is effective and should be a component of intervention programs (Bulter, 1998a; Gaskins & Pressley, 2007). Digital games as innovative programs seem to achieve this combination. Innovative programs of new technologies have the potential to mediate in cognitive processes (Jonassen & Reeves, 1996) by providing support and critical knowledge to the stakeholders, in order to build dynamic mental models that engage students in even deeper processing and better learning. They help students to overcome the limitations of their usually low cognitive capabilities through "low level" procedures such as memory, storage and retrieval of information. They serve as supplements that allow the learner to think more productively, and participate in important structure and reflection processes (high level skills), which are the foundations of higher categories of thought and construction of knowledge. When a student uses a cognitive tool effectively, he/she participates (actively), thinks (deeply), and properly structures knowledge (Jonassen, 1994). Based on the results of the teaching intervention, it was successful in the mathematical performance area, since the improvement introduced was important, as recorded by the evaluation results. The results are similar to the corresponding findings of studies that were implemented in students with standard mental development. They suggest that teaching interventions based on the use of new technologies, particularly the use of digital games are more effective than those of the conventional type (Ke, 2013; Kebritchi, Hirumi & Bai, 2010; Kiger, Herro & Prunty, 2012 ; Kim & Chang, 2010; Shin, Sutherland, Norris & Soloway, 2012). Similar are the results of investigations concerning the use of digital games in mathematics (Ke & Grabowski, 2007). According to these, students participating in groups using digital educational math games benefited more than the team that did not play a digital game. Similar are the findings of the few relevant intervention programs for students with intellectual disabilities incorporating digital games addressing various fields of mathematics (Bahr & Rieth, 1991; Friedman & Hofmeister, 1984; Singh & Agarwal, 2013). But the effectiveness of a teaching intervention is judged by whether the improved performance was maintained. The results showed that the retention performance of students in the experimental group differed significantly from the retention performance of the control group students. Students in the experimental group clearly had a higher mathematical performance.

Noteworthy is the fact that the second person of the experimental group (EG2) has achieved impressive results in the conservation measurement (3rd measurement-follow up) as there was no drop in performance in any sector. On the contrary, there appeared to be a performance growth in two sectors. It seems that these two areas of basic mathematical concepts (oral counting, mental calculation), where this phenomenon was observed are subjects interdependent and interrelated. As a result, the teaching intervention in one area has an effect on other sectors. It should also be noted that in the field of mental calculation the first student in the control group (CG1) showed a drop in two subsequent measurements in relation to the baseline performance. It seems that conventional interventions tire and burden students and sometimes leads to the known phenomenon often observed in the education of children with intellectual disabilities, known as “sensory overload”. This is the burdening of the child from the inability to process the wealth of information provided to him/her resulting in confusion and a decline in performance. Therefore, we verified our research questions, since adding digital game activities in a typical educational assistance program contributed to the understanding of mathematical skills and concepts by students with mild intellectual disabilities and improved their performance. Based on the results the difference in student performance was not only quantitative but also qualitative. Students in the experimental group developed and applied cognitive and metacognitive strategies such as the use of prior knowledge, alternative resolution of activities, self-regulation, executive control, corrections and verbal self-guiding. They also developed higher speed, automation and increased reaction speed. They showed a greater degree of independence and action and less need for guidance. Therefore, the students in the experimental group showed more effective and integrated characteristics compared to standard teaching interventions.

In this research, after the implementation of educational intervention, the students in the experimental group and the control group were evaluated with respect to the level of internal incentives and the levels of pleasure - interest, effort - importance, perceived competence, pressure - stress of children identified through the questionnaire of intrinsic motivation. The results ιn this research, after the implementation of educational intervention the students in the experimental group and the control group were evaluated with respect to the level of internal incentives and the levels of pleasure - interest, effort - importance, perceived competence, pressure - stress of children identified through the questionnaire of intrinsic motivation, showed that students in the experimental group had significantly above average performance and reached, and in some cases exceeded, one positive standard deviation for interest factors - pleasure, effort - importance, perceived competence. In contrast, the pressure - stress performance was very low, approaching one negative deviation below the average which indicates that digital games have a positive effect on reducing anxiety and stress. As it turns out, the role of digital games as enjoyable activities and success experiences in children with mild intellectual disabilities is important. Regarding the final score in the intrinsic motivation of the experimental group students, it was much higher compared to that of children in the control group students. The above results showed that the degree of pleasure and satisfaction of students with mild intellectual disabilities derived by participating in the teaching program of mathematics through digital games is greater than the common intervention methodology.

## 5. Recommendations

The sample consisted of 4 students from one primary school of Greece (Prefecture of Preveza). This is constitutes an important limitation of this research. For this reason, we estimate that a sample of a larger geographic range and size is required. Despite this limitation, this study is highly important.

The use of digital games to improve mathematical performance of students with mild intellectual disabilities is an interesting and innovative practice, which was also proven to be effective, due to the degree of familiarization the students already have with multimedia. The outcome is accompanied by particular qualitative observations mainly related to the use of strategies. Moreover, taking into account the fact that students were increasingly motivated, makes the integration of digital games into the educational process an even more interesting approach.

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