



Title Structure and quality evaluation of computer animation technologies for enhancing student learning

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**Structure Evaluation of Computer Human
Animation Quality**

By

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fulfilment of the requirements for the degree of
Doctor of Philosophy**

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Structure Evaluation of Computer Human Animation Quality

Abstract

This work will give a wide survey for various techniques that are present in the field of character computer animation, which concentrates particularly on those techniques and problems involved in the production of realistic character synthesis and motion. A preliminary user study (including Questionnaire, online publishing such as flicker.com, interview, multiple choice questions, publishing on Android mobile phone, and questionnaire analysis, validation, statistical evaluation, design steps and Character Animation Observation) was conducted to explore design questions, identify users' needs, and obtain a "true story" of quality character animation and the effect of using animation as useful tools in Education. The first set of questionnaires were designed to accommodate the evaluation of animation from candidates from different walks of life, ranging from animators, gamers, teacher assistances (TA), students, teaches, professionals and researchers using and evaluating pre-prepared animated character videos scenarios, and the study outcomes has reviewed the recent advances techniques of character animation, motion editing that enable the control of complex animations by interactively blending, improving and tuning artificial or captured motions.

The goal of this work was to augment the students learning intuition by providing ways to make education and learning more interesting, useful and fun objectively, in order to improve students' respond and understanding to any subject area

through the use of animation also by producing the required high quality motion, reaction, interaction and story board to viewers of the motion.

We present a variety of different evaluation to the motion quality by measuring user sensitivity, observations to any noticeable artefact, usability, usefulness etc. to derive clear useful guidelines from the results, and discuss several interesting systematic trends we have uncovered in the experimental data. We also present an efficient technique for evaluating the capability of animation influence on education to fulfil the requirements of a given scenario, along with the advantages and the effect on those deficiencies of some methods commonly used to improve animation quality to serve the learning process. Finally, we propose a wide range of extensions and statistical calculation enabled by these evaluation tools, such as Wilcoxon, F-test, T-test, Wondershare Quiz creator (WQC), Chi square and many others explained with full details in the next few chapters.

Keywords:

Computer graphics, animation, experimentation, measurement, reliability, motion capability, motion editing, motion capture, Forward/Inverse kinematics, Sub Space Deformation, Multi weight Enveloping, Multimedia Media Technology (MMT), Air for Android publishing, Sam's Cognitive Ability Test (ASCAT).

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Glossary

Computer Graphics: are graphics created using computers and the representation of image data by a computer specifically with help from specialized graphic hardware and software.

Animation: animation refers to any application that generates a series of frames, so that each frame appears as an alteration of the previous one, and in which the sequence of frames is determined either by the designer or the user.

Dynamic information: information that involves a change over time, such as Translations trajectories, motions, transformation deformation, relative positions and actions; and progression (adjunction or subtraction of elements).

Control: the possibility for the learner to act upon the pace and/or the direction of the succession of frames in a multimedia presentation.

Interactivity: the possibility for the learner to act upon what will appear on the next frame by action on parameters (e.g., by clicking directly on sensitive areas or by scaling up and down cursors) in a multimedia presentation.

ActionScript: it's an object-oriented language for Macromedia's Flash authoring tool, now developed by Adobe Systems. Which provide basic navigation controls, with commands such as "play", "stop", "getURL", and "gotoAndPlay" in a multimedia presentation?

A dynamic environment: consists of changing surroundings in which the agent navigates. So unlike the static case, the agent must adapt to new situations and overcome possibly unpredictable obstacles (problems).

Evaluation: an appraisal of the value of the work.

Rating: a classification according to order or grade; ranking.

Ranking: a listing of items in a group, according to a system of rating or a record of performance which indicate a position in such a list.

Feedback: is regarded as information given by software or learner about the appropriateness of his or her response.

Motivational Messages: messages that motivate and encourage the learners. The messages affect the learners positively and encourage learners not give up and or to improve on what they have acquired.

Participant observer: an observer who participates in the experiment by assisting the subjects during animation execution.

Outcomes Based Education: a learner-centred methodology and activity-based approach that allows learner to pace their own learning in order to acquire knowledge, skills and attitudes.

Drag and Drop: a feature that is common to computer graphical interfaces that allow users to select a virtual object in the interface, drag it around and drop it over /on an object.

Game: interactive drill and practice with some features of games that engages learners in practice that repeats material under study or learning content until it is mastered.

Quiz: the act or action of quizzing; *specifically* a short oral or written test. Also known as a form of game or mind sport in which the players (as individuals or in teams) attempt to answer questions correctly.

Multiple choices: is a form of assessment in which respondents are asked to select the best possible answer (or answers) out of the choices from a list.

A narrative game: (or **story**) is any account that presents connected events, and may be organized into various categories: non-fiction (e.g. New Journalism, creative non-fiction) and fiction.

Multimedia: combination of text, audio, still images, animation, video, or interactivity content forms which is usually recorded and played, displayed, or accessed information content processing devices, such as computerized and electronic devices.

Flash Buttons: Buttons are interactive interface elements on which a user can click.

Motion Capture: is the process of recording the movement of objects or people. It is used in military, entertainment, sports, and medical applications, and for validation of computer vision and robotics.

Motion Builder: is professional 3D character animation software. It is used for Virtual Production, Motion capture, and traditional key-frame animation.

Android devices: boots to the home screen, the primary navigation and information point on the device, which is similar to the desktop found on PCs. Android, are typically made up of app icons and widgets.

Social media: refers to the means of interactions among people in which they create, share, and exchange information and ideas in virtual communities and networks.

Perception: the act or the effect of perceiving.

Reliability: Capable of being relied on; dependable.

Forward kinematic animation: is a method in 3D computer graphics for animating models.

The essential concept of forward kinematic animation is that the positions of particular parts of the model at a specified time are calculated from the position and orientation of the object, together with any information on the joints of an articulated model.

Inverse kinematics: refers to determine the joint parameters that provide a desired position of the end-effector. Inverse kinematics is an example of the kinematic analysis of a constrained system of rigid bodies, or kinematic chain.

ANOVA: Analysis of variance (ANOVA) is a collection of statistical models used to analyse the differences between group means and their associated procedures (such as "variation" among and between groups), in which the observed variance in a particular variable is partitioned into components attributable to different sources of variation.

SCAT: (Sam's Cognitive Ability Test) **T-Test:** Cognitive test is the construction of thought processes, including remembering, problem solving, and decision-making.

Tukeys HSD: also known as the Tukey range test, Tukey method, Tukey's honest significance test, Tukey's HSD (honestly significant difference) test. It is used in conjunction with an ANOVA to find means that are significantly different from each other.

Software used: 3DSMax, Poser, Motion Builder, Motion Capture, and Adobe Flash Pro.

P-value: or probability value is a statistical measure that helps to determine if the hypotheses are correct. It is directly related to the significance level, which is an important component in determining whether the data obtained from scientific

research is statistically significant. You can use a table to find the p-value after you calculate other statistical values. Chi-square is one of the statistical values you must find first.

Chapter 1

Introduction and research statement

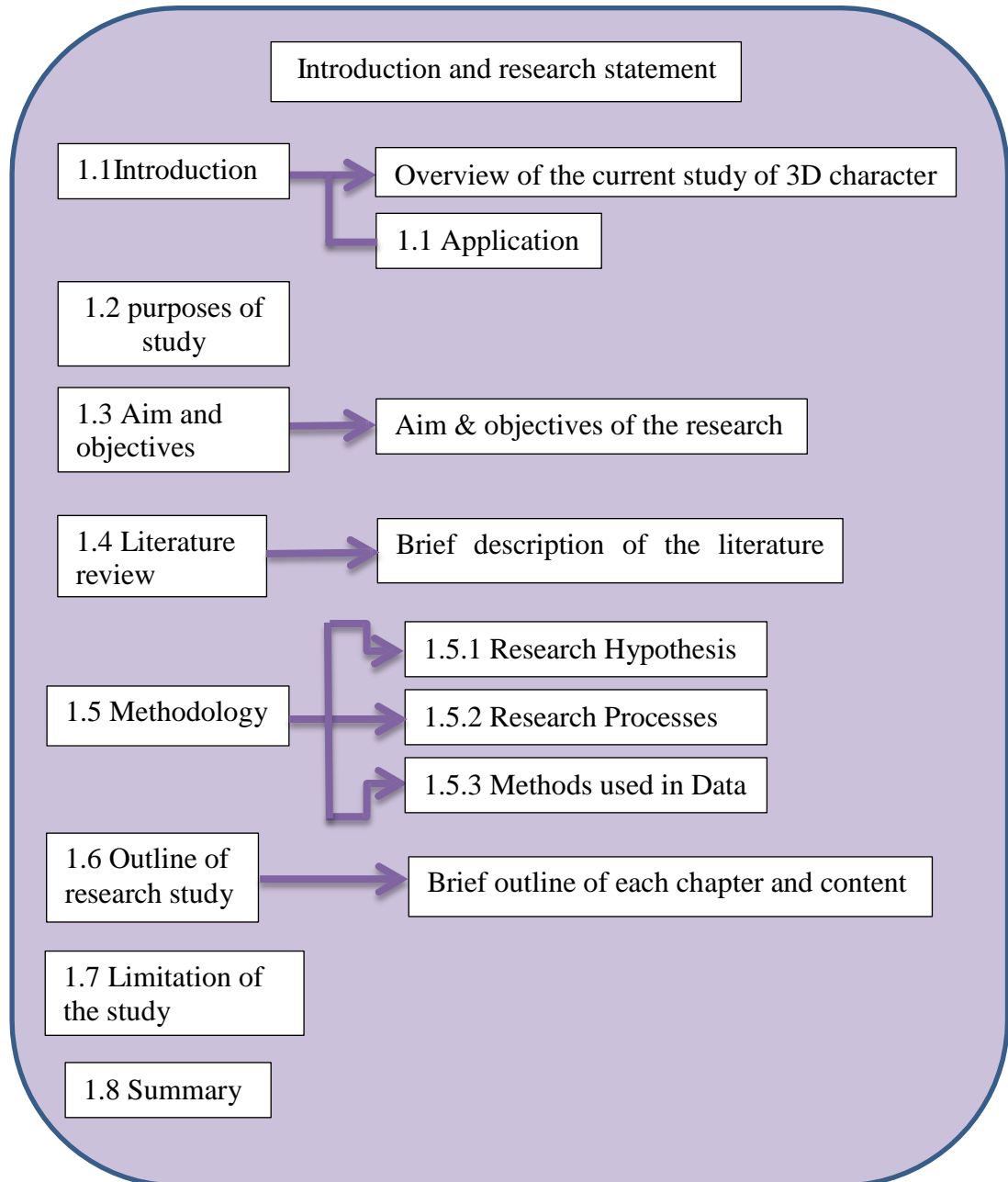


Figure 1.1: Overview of Chapter 1 indicating the content discussed

Chapter 1

Introduction and research statement

1.1 Introduction

The quality of character animation is a crucial problem in Computer Graphics. Many artificial scenes involve virtual humans, virtual reality and video games, etc. Synthesizing realistic character motion is a challenge task due to artefacts in the motion, and locomotion is observed and noticed by all viewers which may be unable to give an objective reason/criticism why a motion is unrealistic. These points increase the difficulty of the task. The study of character motions has generated much interest in other fields such as biomechanics and robotics. The interest for this area has never decreased in the Computer Animation community, even though the task is not easy, since techniques based on kinematics, dynamics, biomechanics, robotics and signal processing may be required. Indeed, animation or simulation of character animation interests several fields of application including robotics such as the biped robot, art, behavioural simulation, entertainment, education and biomedical researches. According to all kind of application, the constraints that the model has to solve are different. On the other hand, for video games and virtual reality, one of the major constraints is to minimize the ratio between the computation cost and the capabilities of the model (adapting the gait to the environment, taking external forces into account).

1.1.1 Application

Other applications of Computer Graphics is video-clips or special effects in cinema which also require designing accurate models that deal with artistic or cartoon's laws studied by D. Thalmann, J. Shen [1] without caring of the computation cost, where they used Virtual Environments, Telecooperative work, and multimedia in order to make the virtual actors realistic during the motion process. They also presented different methods for representing realistic deformations for virtual humans with various characteristics: gender, age, height and weight.

For these reasons, models currently proposed in computer animation are designed in order to be applied in a specific application area. These models can be identified in two main groups:

Interactive models that involve low computation costs and *of-line models* that can use heavy computation time in order to obtain the required motion.

The capabilities of improving commercial packages such as those provide user with tools that automatically synthesize walks and deal with motion-capture data, in order to be applied in other application areas like interactive animation, biomedical simulation, etc.

This first step of this research will provide a comparative study of different methods applied to improve the quality of character animation and solutions explained in detail in chapter 2. This have been adopted in computer animation coming from robotics or other areas such as biomechanics or simulation, and different skinning techniques applied on the characters during animation, which will lead the way to explore, design and create new 3D and 2D animations taking

advantage of applying different advanced software, methods and techniques to improve, increase knowledge and expand the effects of animation as an essential tool to play an important role for future learning and education; which has been applied, achieved and illustrated in chapter 3 to 11 of this thesis.

1.2 Purpose of study

The purpose of this study is to investigate a structure evaluation of computer human character animation quality, and to establish the affective use, usefulness, influence and effects of animations on different participants in learning and education. Allowing the new generation to gain and expand their horizon and knowledge through the use of different methods, tools and techniques regarding animation.

1.3 Aim and objectives

This work attempts to provide an overview of the most influential and commonly used real-time character animation techniques, different methods and approach to structural evaluations, with an emphasis on the animation of articulated structures, which will lead me to focus on the main following objectives:

1. To design and develop 3D quality character animation containing synthesizing realistic character motion free from any major artefacts, in addition to create 2D animations samples with aid of multimedia software to create game, quizzes, comics narrative animation etc. to serve the purpose of using animation as a powerful influencing tools in learning and education. This has been achieved in most of our animations presented in chapter 2 to 11. Some pinching, penetration part of the character body and

losing texture artefacts has shown in the animation presented in table 1.4.

These undesired results have been addressed and conquered in the rest of our animations product.

2. To achieve the design steps, and to cover all necessary aspects of animation. This has been applied successfully in all chapters (2 to 11) produced in this thesis.
3. To improve the quality of animations by taking audience perceptions and their rating levels of satisfaction into account. This step been addressed and applied carefully not only for the animations produced, but also for the thesis as a whole, despite the fact that few candidates showed their dislike to use animation. Table 1.4, will reflect on the animations results.
4. To investigate lighting, colouring, camera effect, and material mapping techniques emphasizes certain objects and appearances to accompany the moving character. This step has been achieved and clearly showed the effect of lighting, colouring, camera effect and material mapping on the animations in chapter 2, 3, 4, 5, and 6 due to the animation in these chapter has enjoyed the benefit of using 3DS Max. The rest of the animation presented in chapter 7, 8, 9, 10 and 11 enjoyed the benefit of using Adobe design multimedia CS6 and adobe air to be presented using the digital media, where colouring, material mapping effect and certain motion like shape tween etc. was applied to give the final touch and glowing effects to the motion.
5. To explore the use of different animation approaches that can be applied on 3D and 2D character animation such as rig construction, weight,

skinning, elasticity, mask, and bounce back effect etc. These approaches has been applied and delivered to the animations created in 3DS max and CS6. These approaches have been demonstrated clearly on the animations displayed in chapter 2 to 11 and their results are shown in table 1.4.

6. To develop novel kinematics approach that addresses the use of control objects. This step has been fulfilled the aim and the objective of creating the 3D character animation used in the chemistry experiment presented in chapter 2 to 7 where the characters showed clear reaction, and decision making to the surroundings environment reflecting the dynamic systems.
7. To make comparison between some methods, evaluation techniques, advantages, limitation and applications that has been used in the development of character animation. This step has been perfected and accomplished through the methods and techniques and presented in tables and figures in almost all chapters of this thesis.
8. To review the recent advanced methods techniques used for character animation, motion editing that enables the control of complex animations by interactively blending, improving and tuning artificial or captured motions, for the present and future work. Where this thesis has enjoyed the advantages of using recent advanced methods and tools to accomplish and fulfil the requirement of participants and produced satisfactory animation results to serve future animation, not only for learning purpose, but also for all aspects of life where animation is required and concerned.

1.4 A brief literature review giving background and context for the study

Many authors have introduced the use and techniques, to support the animator of general computer aspects of character animation, such as G. Smith and B. J. Burkhart [2, 3]. Character animation has used many interesting, funny and educative events translating the emotion and feelings of lines and colours, as an indispensable instructional media for all levels of education to increase the imagination of the people.

In some other areas of animation based on similar surveys are skilled animation cartoons where artists can transform the paint to storytelling from verbal into visual show events, and make audiences perceive sound, touch and imagination P.Sookchareon, [4], in sequences of still images or frames with changed frame speed per second (fps.). Normally animation movie uses 12-24 fps. This rate will show the acting of characters like real life. The qualification of animation cartoon is in the expression, thinking, imagination, sarcasm, as well as caricature and feature. Also this work focuses on methods and techniques for generating the motion of skeletons of articulated figures that will represent realistic virtual characters. These techniques based on *forward and inverse kinematics*, *Motion Capture*, *Blending and warping*, which play important roles in calculating the positions and orientation of the model parts at a specified time, for a small set of key-frames, generation of characters motion, empirical and biomechanical knowledge on character motion in order to compute realistic motions, studying the problems involved in the design of convenient key-frames, and the choice of adequate interpolation techniques. In addition to the exclusive use of forward

kinematics makes it difficult to add constraints to the motion, such as the problem with penetration, and different locomotion, as well as highlighting the advantages uses; and limitation of these approaches.

Also this work sheds a light on another important aspect of the design steps which is the use, and effect of light such as *path tracing or photon mapping* on 3D character during the animation process;

The work took interest in highlighting the art of creating character animation to show that it is possible to convey emotions of an artificial character through change in shape, using *facial animation techniques* in real-time character animation, taking into account the sensitivity of human perception to a variety of motion patterns when trying to create convincing artificial characters; in addition to conveying comic, quizzes, imaginable science, and games.

Another vital step took place in this work, is the compressing of three linear skinning frameworks: Skeletal Subspace Deformation (SSD), Multi-Weight Enveloping (MWE), Pose Space Deformation (PSD), and EigenSkin which they are computationally efficient enough to be used for real-time animation. These three methods are studied comprehensively in-terms of determine the effects of any temporal artefacts introduced in their use, advantages, limitations, and application. The other step was to demonstrate and evaluate the use, influence, and effects of these animations on users learning especially in the educational fields.

Research into this area has resulted in a number of skinning frameworks. There has, however, been no objective attempt to compare these methods using different kinds of evaluations including statistical validation methods to address users from

a different level of understanding, and experience in creating any kind of animation and addressing their requirements.

Connecting the audience with the character caused very strong focus on what is happening in the scene using the simple and short animated sample produced for this task. The audience were able to remember what is in the scene easier especially when it was connected with a specific reaction, which gave me the opportunity to identify artefacts and concentrating on the main aim and objectives of this work i.e. improving the quality of character animation to produce a realistic character animation to benefit us in future in many aspects of daily life particularly in the educational environment.

Our approach, using variety of evaluation methods proved to be a better way to integrate several methods in order to achieve and produce better results than many authors' methods; this is because our methods have provided:

- 1) Wide variety of users support, knowledge and encouragement as a kick off point to create and attempt using animation as a learning tool.
- 2) Address weaknesses, theme, wide range of user requirements and what they would like to anticipate, as an improvement in the future of character animation.
- 3) It has provided sufficient theoretical knowledge about character animation, to accommodate variety of different levels of knowledge and abilities.

1.5 The Methodology

1.5.1 Research Hypothesis:

The result of the research steps involved, questionnaires, Observation checklists, an Interview, a moderation session, social browsing, multiple choice questions, benchmarking and statistical evaluation. The design of the evaluations provides candidates from both genders, to gain a level of satisfaction and content perception about character animation. These steps were based on the research shaped in two types of approaches. These are *satisfaction and rating*, and *content perception*.

a) *Satisfaction and rating:* to ask respondents their views, opinion, benefit and rating, about the animation appeared in the designed websites or other media types we have used, which was based on quality, features, texturing, rendering, conveying subject ideas, and rating the animation whether they are (good, very good, poor or excellent). This has been illustrated in the next chapters of this thesis.

b) *Content perception:* These evaluation objectives designed to study the candidate's requirements and what they would like to see in character animation after selecting and watching the pre prepared video animation used in the websites, or presented in multimedia animations as a short wave file (SWF) format, and participating by leaving comments, views, requirements, perception, and their anticipation for future computer animation.

The above evaluations and validations were achieved and the results are illustrated in each chapter of our work.

1.5.2 Research Processes

The steps of research work are detailed in the flow chart below which consists of 5 steps:

a) *Study and Analysis:* This step was conducted to investigate the theoretical approaches used to evaluate methods followed in character animations used in this work, implementation, and description of similarities and differences, usefulness, strengths, weaknesses, and their relative performance.

b) *Design the research instruments:* The tools used in this section were: 3D and 2D character animation created in 3D computer graphics (3DS max), Poser, Make Human, Motion Builder Adobe Design and Web Premium CS6 Flash / Dreamweaver / Adobe InDesign, and questionnaires, multiple choice questions, quizzes, games etc. have been presented in each chapter to demonstrate the animations used for the purpose of this research.

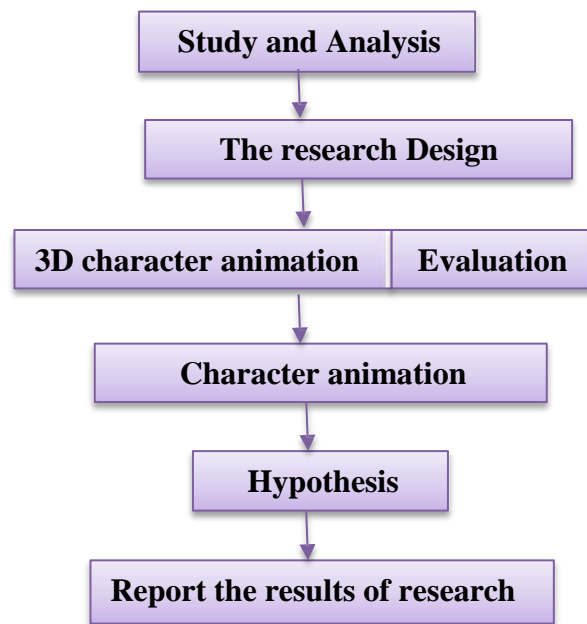
c) *Character animation production:* The animation production process starts with the art of creating a variety of animated character and content design, addressing different animation areas to be the animations director; followed by character modelling, texturing and animating. After rendering, both moving characters and scene, making sequences of moving images edited by Video Media Player (VMP) video production, results in a final and simple character animation. The 3D character animation was used; valued successfully and achieved the purpose of the research exercise, Chapter 2 to 7 has displayed the results of this achievement. The second part of the animation created in multimedia displayed as SWF via networked computers, social media “flickr.com”, and air for android (phone and tablet) has harvested the achievements of their validations, reflection of their

benefits, the positive influences on student's education and learning in chapter 8 to 11 respectively.

d) *Hypothesis Test:* starts by showing all animations products to candidates from a different level of knowledge and professions, by selecting the WMP video animations accessed via a designed website and gives an output to their observation by filling a questionnaires consisting of 51 questions as a first exercise in this research. The data analyses for the hypothesis testing, mean of standard deviations SD were conducted. After obtaining the results, a column chart was produced to represent the rating quality of the animation obtained as an outcome from the respondents, in addition to a written report as a final stage. The research then took another path as an ambitious attempt for the animation framework to target non-professionals and novice users. This represents social information, support teaching, and simulation by creating a dynamic animation, control environment such as particle systems and investigates the use of dynamic environment using science subjects (chemistry and biology) to help illustrate realistic animations and enjoy the benefit of using quality animation to be applied as a helping tool to influence students learning and make life a lot easier to visualise and see something near to reality which they can't view it in real life but, can through the use of animation.

e) *Report the results of research:* Data analysis for hypothesis testing, uses means of statistical calculation such as: means, standard deviation (SD), and many others statistical methods has been used to evaluate the users perception and animation products, results in writing the report. This approach has been applied and successfully achieved in all our calculations through the project chapters.

The total candidate numbers were 30 from different levels of knowledge and professions involved in this first part of the work; and a maximum of 30 students from our organization with the permission of the principle of the school and guided by their class teacher, used the animation in the second part of this thesis.



Flow chart of the Research Processes

1.5.3 Data collection

The above objectives are a case study to determine how users interact with animation in a different interactive environment. In order to reach the objectives of the research study, we have used qualitative and quantitative data collection methods as set out in table 1.1.

Critical Question	Data Collection Method
1) What learning takes place from an affective perspective, and how?	Interviews Observations chick list Questionnaire Moderation session
2) What methods/techniques, do the participants prefer to use?	Benchmarking Questionnaire Multiple choice questions Websites
3) Determining the relative importance of animation in learning.	Questionnaire Interviews Observations chick list Social browsing Multiple choice questions Moderation session Benchmarking Statistical evaluation Websites
4) How users can identify the quality of the animation presented to them and refers to any unwanted artefacts.	Moderation session Benchmarking Questionnaire
5) How do participants evaluate the enhancement and effectiveness of 3D character animation?	Statistical evaluation Multiple choice questions
6) “How participants respond to animation in their learning environment? And how beneficial and influential animation can be to them?”	Digital Media Questionnaire Observations chick list Multiple choice questions Moderation session Benchmarking Websites

Table 1.1: Data Collection methods addressing the research questions.

1.6 Outline of Research study

The thesis is organised into thirteen chapters, described in table 1.2.

Chapter	Content
1. Introduction and research statement	Introduction to content of the thesis, purpose of the study, and research problem
2. Quality in Character Animation Techniques	Kinematics-based animation frameworks
The above 2 chapters followed by new 3D animations and evaluation	
3. What is the role of animation in learning	Introduce the role of animation in learning, and discuss the validity of the animation based on likert scale.
4. Potential Learning through Animation	Proposing an experimental strategy for verifying and fitting a quantitative model to estimates the potential of animation as an educational aid.
5. Interview and Visual Assessment	The procedure of Visual Assessment evaluation method
6. Evaluation using T-Test	The procedure of t-test evaluation method
7. Comparing the enhancement and effectiveness' of 3D character animated videos (A, B, C) using social media browsing	The procedure of using social media browsing
Continuation to introduce learning Animation in Multimedia & more statistical evaluation	
8. Multimedia animation and Learning	The procedure of animation in multimedia
9. Educational Chemistry Words Guessing Game	The procedure of chi square test
Continuation to introduce learning Animation in Digital Media (Air for Android devices Apps)	
10. The Effects of Multimedia Animation in Learning	The procedure of Friedman test
11. Using Air for Android in Education and learning	The procedure of bench marking

Summary & Conclusions	
12. Summary	Summary of the thesis and work involved
13. Conclusion	Conclusion to the thesis and work involved

Table 1.2: outline of the research study

1.6.1 Structure of the Dissertation

The dissertation structure can be highlighted as follow:

Chapter 1: this chapter will give an introduction and research statement, which will list the main important sections and content of the thesis, the purpose of this study, the aim and objectives achieved and nearly achieved, research methodology, hypothesis, process, problems involved, data collection and advantages and limitations to the method used in the creation of the animation, evaluations and to the project as a whole.

Chapter 2: This chapter introduces the Quality in Character Animation Techniques. Introduced the study of 3D character animations generated in the field of Computer Graphics and its applications, as well as data collection methods, evaluation, analysis of the results obtained from character animation with the aid of the design steps generated to address a variety of different areas in animation. Also this chapter explains who this research has carried on to progress and address all issues necessary as a next step and to achieve a long term goal to obtain real-time detailed realistic rendering character animation.

Chapter3: this chapter introduces the role of animation in learning, and discuss the validity of the animation based on likert scale. The evaluation in this chapter has accommodated non-professionals and novice users, in order to represent them

with social information, support teaching and learning, in addition to introduce the concept of dynamic animation and control environment such as particle systems to represent variety of applications ranging from modelling fire, texturing, etc. also showed the different variety of quantitative methods to validate the animation quality such as questionnaire and a moderation session.

Chapter 4: this chapter demonstrates the Potential Learning through Animation by proposing an experimental strategy for verifying and fitting a quantitative model to estimate the potential of animation as an educational aid. Also the use of MSE (Mean Squared Error) method which showed the advantages of determining the accuracy of the displayed quality of information with aid of animation. Perception of evaluation and how well it addressed participant needs to enable them visualise the key to scientific concepts through the use of animation. To establish that learning with animation is effective, easier and useful.

Chapter 5: this chapter has led the way to use the visual assessment method or interview, where eliciting information by questioning methods was applied and the purpose of using this method; in addition to the significant results and evaluation obtained to address the importance of using animation as an enhancement for students learning.

Chapter 6: this chapter studied the evaluation using T-Test, the procedure of t-test evaluation in order to establish more facts regarding the use, improve and advance the animation as a learning aid which has been obtained from students feedback.

Chapter 7: Comparing the enhancement and effectiveness' of 3D character animated videos using the procedure of social media browsing has been

conducted in this chapter with aid of using **SCAT** (Sam's Cognitive Ability Test) T test and Tukey's HSD Post Hoc evaluation techniques accompanied with multiple-choice, instructing the use of Wondershare Quiz Creator.

Chapter 8: this chapter is a continuation to introduce learning animation in multimedia technology which is another form of representation to utilise the animation in a new format and motivate students to use variety of different animations presentation methods. This chapter also explained the use of Wilcoxon statistical test evaluation and its significant results obtained from students using animation to generate better recall of their information stored.

Chapter 9: this chapter has introduced the use of education computer quiz/ games with the aid of chi square test evaluation. The use of these activities has shown positive attraction to pupils 'attention, motivation and positive influence on pupils' emotions, attitudes and beliefs linked with subjects studied.

Chapter 10: this chapter has introduced the effects of multimedia animation in learning, and the use of Friedman evaluation method. The use of technologies and online gaming has shown how well documented, effective learning tools, and attractive way to build mental representations from words and pictures that are presented to students through animation.

Chapter 11: this chapter presents multimedia animation in a different environment and takes advantage of the new advanced digital technology such as air for android. Also this chapter has implemented the use of benchmarks by a number of advanced toolkits to identify the effectiveness of the animation and toolkits for different kinds of activities, and how this approach has helped students

maintain focus and develop essential problem-solving skills, collaboration, creativity and communication.

Chapter 12: summary of the research and thesis has been concluded as a part of this chapter, were a unified framework to measure and evaluate the important aspects of animation, and to derive practical results from the data obtained were explained, followed by addressing the research's key problems, contributions, reviewing the recent advanced method techniques used for character animation, the long term goal for this research, and the next research steps.

Chapter 13: this chapter summarise the main results of this dissertation and discusses potential future research directions.

The thesis constructed by using appropriate commonly used real-time character animation techniques, with different methods and approaches to provide realistic animation of articulated structures and structural evaluations, taking into account the participant's perceptions.

In support of this thesis, I present a unified framework for real-time modelling of 3D character and environment animations representative techniques used in this work with satisfactory results of evaluations. This framework complements animated, articulated characters with skeletal skin structure effects and biped motion, demonstrated mainly in the animation used in chapters 2 to 7. My framework also supports modelling texturing of 2D animations represented as game, quiz, animated text format and comic format, where different approaches took place to present participants with a dynamic system and environment to convey social information, support teaching, and simulation by creating a dynamic animation and control environment such as particle systems, and offer

participants the advantages of using animation in their learning process, and to enrich instructive education and make it more educationally attractive and interesting to use. The eagerness to this approach has been generated from respondent's feedback and their anticipation and requirement for the use of animation.

I proposed the creation of dynamic animation and control environment which have been proposed previously, but I introduce novelty of using particle systems to present its applications ranging from modelling fire, texturing, etc. and reflect these effects on an avatar to generate a realistic animation result, which will provide benefit in many ways: 1) creates realistic animation operating in real time, 2) adapts easily to different environments, 3) increases skill, imagination, and knowledge about physic-based animation specially in the field of education, industry, computer games...etc. and guides students learning and decision making. This novelty been generated from students requirements and their academic needs for various subjects area, although this thesis treated two important and core subject i.e. chemistry and biology on different groups of the same year presented in chapters 3 to 7.

I enhanced the use of statistical quantitative and qualitative evaluation methods, which is a new approach for this thesis. The quantitative evaluation allows:

- enhancing the generalisation of the results.
- for greater objectivity and accuracy of results.
- to provide summaries of data that support generalisations about the phenomenon under study.

- the involvement of few variables and many cases, and employs prescribed procedures to ensure validity and reliability.
- Summaries of vast sources of information and facilitates comparisons, addressing un- desired results across the different categories of the animation.

Although sometimes answers will not necessarily reflect how candidates really feel about a subject and in some cases might just be the closest match.

Qualitative evaluation allows:

- in depth and detail analysing ranks and counts by recording attitudes, feelings and behaviours
- openness i.e. encouraging participants to expand on their responses, and can open up new topic areas, and ideas.
- participant's individual experiences to build detailed pictures in their mind.

The qualitative method has disadvantage of been difficult to make systematic comparisons especially when candidates give widely differing responses that are highly subjective.

I have also proposed a method that enables intuitive control over the use of new recent advance digital technology Air for Android presented in chapter 11. The greatest advantage that AIR offers is cross platform compatibility. The AIR runtime is built to run on Android, devices such as mobile and tables, which have been used in our case to perform and publish the 2D animation environment. This approach gives the new generation (students) the encouragement not only to learn the new technology and digital devices but also the enthusiasm to create and use

animation as learning tools. The chart below will illustrate the dynamic animation targets for this thesis.

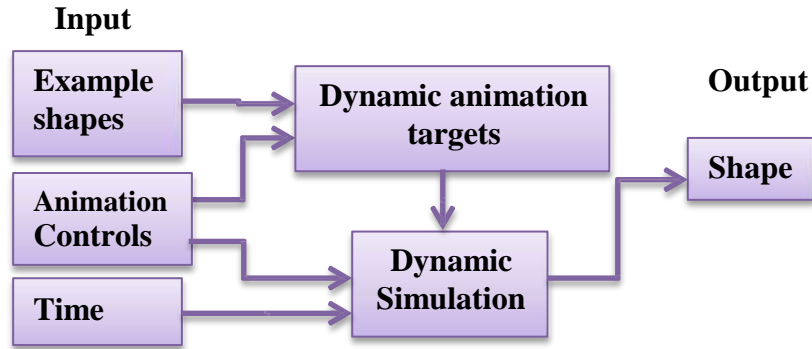


Chart to show the dynamic animation targets

The objectives which have been achieved and not fully achieved in this thesis are listed in table 1.3.

Chapters number	Objectives achieved	Objectives not fully achieved
2	1)Design and development 2)Design steps 3) Improve quality of animations 4) Animation techniques 5) Animation approaches 7) Methods of evaluation techniques 8)Review the recent advances methods techniques used for character animation	6)Some pinching, penetration part of the character body and losing texture artefacts
3,4,5,6,7 The same animation samples has been used in these chapters	1)Design and development 2)Design steps 3) Improve quality of animations 4) Animation techniques 5) Animation approaches 6) Kinematics approach 7) Methods of evaluation techniques 8)Review the recent advances methods techniques used for character animation	3) Video 2: (Rb+Water) appeared to be fast animation for some participants.

8,9,10,11 The same animation samples has been used in these chapters	1)Design and development 2)Design steps 3) Improve quality of animations 4) Animation techniques 5) Animation approaches 6) Kinematics approach 7) Methods of evaluation techniques 8)Review the recent advances methods techniques used for character animation	3) The day in chemistry animation sample code was not compatible for publishing on Air for android due to the availability of adobe CS6; however it has worked find on the computers and laptops.
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Table 1.3 the study achievements

1.7 Limitations of the Study

Whilst aware of the limitations of the research study, the work nonetheless strived towards a research study that was beyond reproach in terms of validity and evaluations. The limitations were as follows:

- It was conducted with one year group i.e. year 10 students in the second part of this work;
- The animations were designed and applied on limited subjects to suit the purpose of the topic under study by students;
- The artefacts showed in the animations produced for this thesis are shown in table 1.4 below.
- The study was concluded over the duration of lesson periods;
- The evaluations were conducted using the tools that students are familiar and available to them in school.

Although the questionnaire questions which appeared in chapter two were a considerably large number, it gave the project the right approach and shines the light on many factors regarding the animation products, quality, usefulness, and application especially where users and learner perceptions are concerned.

Chapters number	Animations
Chapter 2	<p>Video 1, 2, 3, 4, 8, 9, 10, 14 and 15 showed good reaching, walking... etc. motion animation.</p> <p>Video 5, 6, 7 showed few undesired results such as penetration, losing texture and colors.</p>
Chapter 3, 4, 5, 6, 7	<p>Video 1: (Na + water) no artefacts showed</p> <p>Video2: (Rb + Water) no artefacts showed on the character or environment; however the video was very fast for some participants.</p> <p>Video 3: (K+ Water) good animations and environment.</p>
Chapter 8, 9, 10, 11	<p>All 2D animation produced were good, clear, and fun to use on all available prevails (Computers, and digital media), however the guessing chemistry words game actionscript code was not compatible with CS6 actionscript code , therefore couldn't be published using advanced digital media , this was down to the availability of the software.</p>

Table 1.4: Chapters vs. Animations

1.8 Summary

This chapter briefly introduced the overall research study presented in this thesis. The 3D character animations generated in the field of Computer Graphics and its applications, as well as data collection methods, evaluation, analysis of the results obtained from character animations with the aid of the design steps showed in Appendix (1), which addressed a variety of different areas in animation, and the limitations of this research study.

Chapter 2

Quality in Character Animation Techniques

Figure 2.1 below presents a layout of chapter 2 and shows content discussed under the different headings

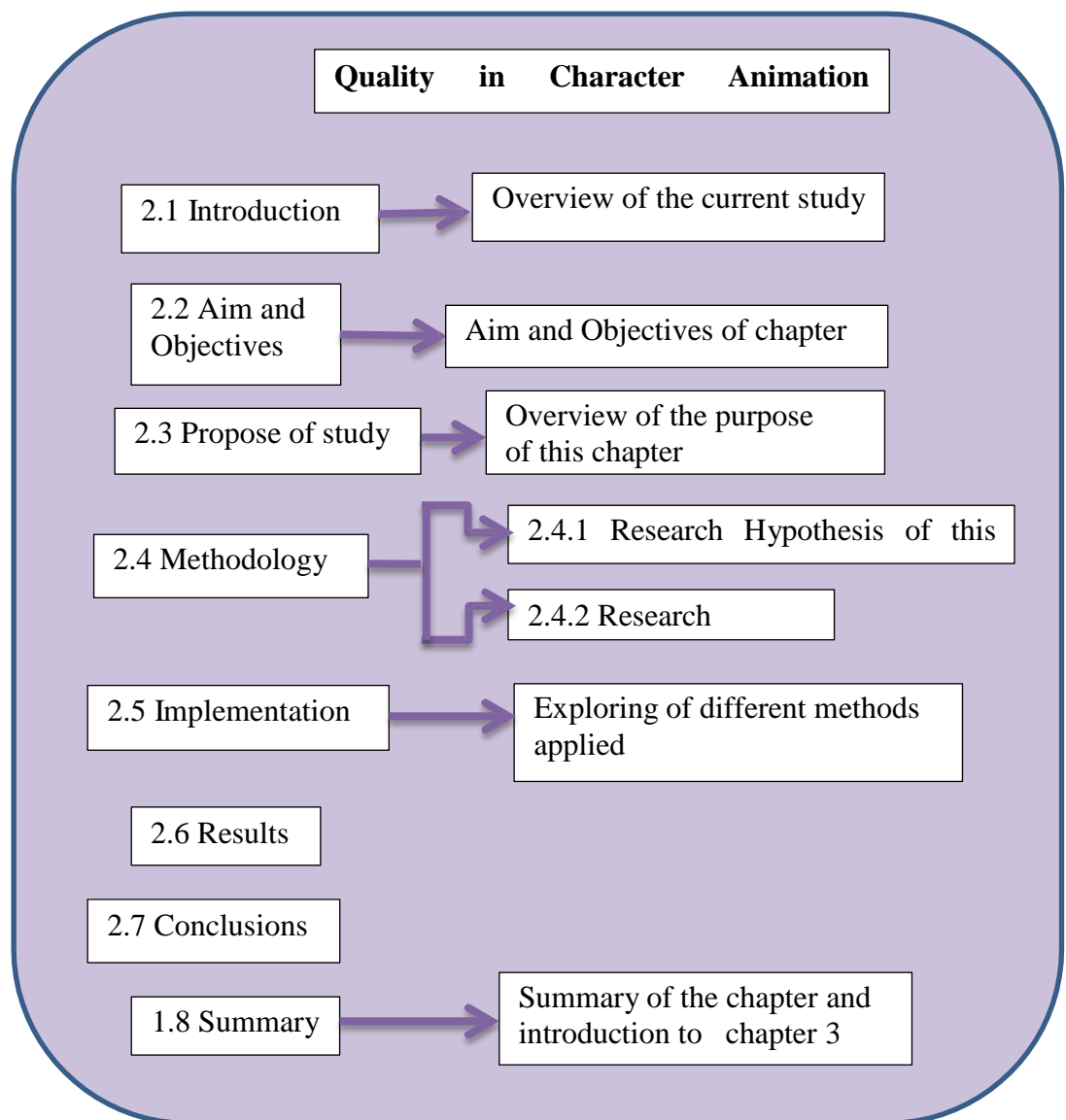


Figure 2.1: Overview of Chapter 2 indicating the content discussed

Chapter 2

Quality in Character Animation Techniques

2.1 Introduction

Many applications involve densely populated virtual environments, where characters and objects continuously interact with each other and with their surroundings. Proper animation of such interaction is important for the perceived realism of these virtual environments. However, creating realistic responsive animation is challenging, because the range of possible animated interactions techniques are enormous and subtle variations in initial interaction conditions may result in substantially different acts and appearances.

Kinematics-based animation frameworks rely heavily on existing motion data (either recorded or manually crafted) when generating animation. During interactions, responsive actions are selected using a carefully designed system of events, rules and scripts etc.; the matching responsive animations are then generated through utilization of motion clips. Despite great advances both in the availability and utilization of motion data, as well as in algorithms responsible for selecting appropriate response motions, although this approach suffers from a drawback that the ability to generate realistic and non-repetitive responsive animation is always restricted by the contents of the motion. Some authors have offered the use of physics simulation approach to computer animation to integral part of the animation loop. All motion in the virtual environment is the direct result of physics simulation, and control within the environment occurs only through the application of forces and torques similar to real world motion. The

result is that all responses of interacting entities are physically realistic by definition. In this chapter we will provide a comparative study of different methods applied to improve the quality of character animation, different skinning techniques, and solutions that have been adopted in computer animation.

The composition framework will address the kinematic animation approach, in addition to highlight their intrinsic advantages and limitations.

2.2 Aim and objectives

The aim of this chapter framework is to resort to kinematics-based approaches to animate active virtual characters, this, due to the controllability. In physics based character animation, the pose of a character cannot be controlled directly, but only through the application of forces and other factors. Control of position and orientation should occur through manipulation of external contacts; also due to the control of style and naturalness of the character, where many applications require control of style, to reflect mood, personality or intention of a character.

Objectives: The objectives of this chapter after designing and developing 3D quality character animation containing synthesising realistic character is:

1. To achieve accurate design for 3D character animation free from major artefacts applying the necessary aspects of animation. Which has been applied and achieved through the animations created in this chapter despite the fact some artefacts appeared on the characters where has been highlighted in table 1.4 of chapter 1.
2. To design animations that takes audience perceptions into account. This step has been well demonstrated and evaluated by the audience.

3. To study the effects of colouring, camera effects and material mapping techniques of the scene that will accompany the moving character. This has been achieved through the animation videos of this work.
4. To explore the use of different animation approaches that can be applied on 3D character animation such as rig construction, weight, features, skinning, etc. These methods were considered carefully and applied on the animation created to give it a realistic appearance and bring it closer to a real human looks.
5. To review the recent advanced techniques used for character animation, and motion editing, in addition to review the methods and techniques that have been used in the development of Character Animation such as Subspace Deformation SSD and Multi-Weight Enveloping MWE. Clear explanation and review has been conducted to support this objective.

2.3 Purpose of this study

The purpose of this chapter is to provide a review and comparative study of different methods applied to improve the quality of character animation, different skinning techniques, and solutions that have been adopted in computer animation.

The composition framework can be classified into the following steps, in addition to highlight of their intrinsic advantages and limitations:

1. Methods based on kinematic animation.
2. Interactive edition of either captured or synthetic motions.
3. Incorporate dynamic constraints in the generation of motion or to use dynamics simulation.
4. Character animation techniques.

The research objectives based on: the design and improvement of the 3D animation, and studying the levels of satisfaction, with quality of the animation and techniques applied which have been addressed by taking into account the different outcome obtained from various gender and professions, by creating 3D animation using 3DS max presented in Windows Media Player (WMP) files and questionnaire.

Another vital step took place in this work, is the comparison of three linear skinning frameworks: Skeletal Subspace Deformation (SSD), Multi-Weight Enveloping (MWE), Pose Space Deformation (PSD), and EigenSkin which they are computationally efficient enough to be used for real-time animation. These three methods are studied comprehensively in-terms of determining the effects of any temporal artefacts introduced in their use, advantages, limitations, application, and ways to improve them as shown in table (2.1) and use them as an important ingredients to create a new series of animation samples for the next step of this work. The other step was to demonstrate the use, influence, and effects of these animations on users learning specially in the educational fields.

Research into this area has resulted in a number of skinning frameworks. There has, however, been no objective attempt to compare these methods using different kinds of evaluations including statistical validation methods to address users from a different level of understanding, and experience in creating any kind of animation.

Connecting the audience with the character caused very strong focus on what is happening in the scene using the simple and short animated video produced for this task. The audience was able to remember what is in the scene easier when it

was connected with a specific reaction, which gave me the opportunity to identify artefacts and concentrating on the main aim and objectives of this work i.e. improving the quality of character animation to produce a realistic character animation to benefit us in future in many aspects of daily life especially in the educational environment.

Our approach using a variety of evaluation methods proved to be a better way to integrate several methods to produce better results than many authors' methods, this, because our methods have provided:

- 1) Wide variety of users the support, knowledge and encouragement as a kick off point to create and use animation as a learning tool.
- 2) Addressing weaknesses, theme, wide range of user requirement and what they would like to anticipate, as an improvement in the future of character animation.
- 3) Sufficient theoretical knowledge about character animation, to accommodate a variety of different level of knowledge and abilities.

Method	Advantages	Shortcomings	Applications
Skin Space Deformation (SSD)	SSD remains popular of its simplicity and computational efficiency.	<p>Generated meshes exhibit volume loss as joints are rotated to extreme angles. Which cause joint collapses and candy-wrapper effects shown in fig (8).</p> <p>Lack of flexibility and scalability in the framework</p> <p>The linear interpolation of these matrices is not equivalent to the linear interpolation of their rotations.</p> <p>In some of the methods applied in SSD an increase in the number of example meshes is necessary to</p>	<p>Motion Capture, Animation and games.</p> <p>It is used in many 3D animation packages (OpenGL and Direct3D)</p>

		produce higher quality results but this increases the storage and computation costs.	
Multi weight Enveloping (MWE)	<p>Could be used to automatically generate deforming creatures.</p> <p>Controls a character via a skeleton.</p> <p>Offers a powerful but concise Representation for skin movement.</p> <p>Works well with large numbers of poses, and the resulting of the deformation does not get complex as the number of poses increases.</p> <p>Rotational regression is an effective way of capturing muscle bulging, twisting and areas such as the shoulder.</p> <p>MWE is quite flexible therefore; the increase flexibility should reduce the volume loss. And it can be used to correct artifacts exhibited by other methods such SSD.</p>	<p>Over fitting.</p> <p>Increase in weight could cause defects in the flexibility.</p>	<p>film production, games and virtual reality.</p> <p>Animation</p>
Pose Space Deformation (PSD)	<p>Decrease the cost for real-time shape synthesis.</p> <p>Allows the user interactively correct vertex positions on the deformed surface of a character.</p>	Required a large storage	<p>As blending features in animation.</p> <p>Animation and clustering product.</p>
<i>EigenSkin</i> Method	<p>Determines the new position of a vertex by linearly combining the results of the vertex transformed rigidly with each bone with the aid of introducing weight to each influencing bone. Required a less storage than PSD</p> <p>works best when SSD corrections are localized, providing independence between different parts of the mesh, and are stable (i.e.,</p>	<p>Buckling of skin near joints, e.g., elbows, in extreme poses.</p> <p>Poor behaviour near more complicated joints, such as shoulders and thumbs.</p> <p>Restrictions on the range of deformations that can be easily modeled and displayed for various character poses.</p>	<p>It has been used in commodity computer graphics hardware.</p> <p>Video games.</p>

	<p>corrections vary slowly over poses-pace), allowing accurate and efficient interpolation.</p> <p>It can create visually dramatic improvement.</p> <p>Good Eigen-displacement bases can often be constructed using displacements resulting from single joint motions, in practice it is desirable to allow general pose sets and to recover nonlinear joint-joint coupling phenomena.</p> <p>Decrease the cost for real-time shape synthesis.</p>		
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Table (2.1) Animation methods advantages, limitations, application

2.4 Methodology

The framework of real-time simulation will be used to improve the quality of 3D character animation and to model character behaviour and reactions to different environment by creating a dynamic animation and control environment such as particle systems to represent social information support teaching and learning.

The methods to develop these aspects can be outlined as:

- a) Constructing and capturing motion postures for 3D character models.
- b) Classification on the behaviours and reactions.
- c) Modification and improvement.

a) Constructing and capturing motion postures for 3D character model:

This section has allowed us to model character behaviours and reactions under different environments. The animation will utilise 3D computer animation techniques, combined with psychology, to model character behaviour, reactions and decision making under expected/unexpected dangers, external forces, or any

changes in virtual environments, and capturing different motion postures with the aid of 3DS Max and Motion Builder. Working within these tools will be subdivided into planning the scenario and the contents example of creating variety of different animations samples , modelling 3D character animation models for the scene, 3D model's perceptions and decision making, obtaining a range of different character movements such as (walking, falling, running) and emotions such as scared and astonish, etc., these motion will starts with T pose to be fitted with a skeleton model, and then bond with a character skin model; to be interacted with the different environments.

b) Classification on the behaviours and reactions

Different behaviours and reactions are classified for different groups of participants' targeting candidates from different walks of life, ranging from animators, gamers, teaching assistants (TA), students, teachers, professionals and researchers using and evaluating pre-prepared animated character video scenarios, encountering different situations to reflect motion in the scene. This classification has been accomplished through the literature review, samples of different interactively blending animations combined with different methods and techniques, questionnaires and surveys in order to obtain candidate's requirements, and their anticipation for the animations provided.

c) Modification and improvement

Applying in more depth the skinning methods such as Subspace Deformation (SSD) and Multi Weight Enveloping (MWE) on the animation to improve the quality, and rectify any artefacts in the animation. Also pay particular attention to kinematics approach in order to get best control of the movement of the character

either for the existing or new animation, so that reasonable and more realistic results will be produced for this work and future animations.

2.4.1 The Hypothesis of this work

The result of the questionnaires makes the candidates from both genders and professions; gain a level of satisfaction and content perception about character animation. The *questionnaire* design was shaped in two types of questions. These are *satisfaction and rating and content perception*.

Satisfaction and rating: to ask respondents their rating about the animation appeared in the designed website based on quality, features, texturing, rendering , animation, and rating them whether they are (good, very good, poor or excellent), this is illustrated in table 2.3.

Content perception: This questionnaire's objective is to study the candidate's requirements and what they would like to see in character animation after selecting and watching the pre prepared video animation used in the websites Appendix (1), and participating by leaving comments, views, requirements, perception, and their anticipation for future computer animation.

2.4.2 The Processes of this work

The important stages in this research work are displayed and highlighted in the chart below:

a) *Study and Analysis:* This step is investigate the theoretical approaches used to compare methods followed in character animation and describes their similarities

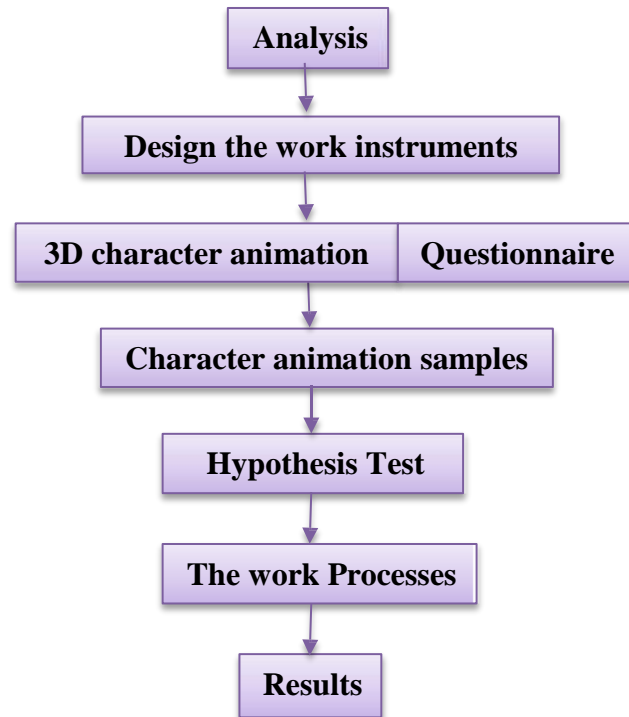
and differences, solution, strengths, weaknesses, and their relative performance stated in table 2.1.

b) *Design the research instruments:* The tools used in this section were: 3D character animation created in 3D computer graphics (3DS max) and questionnaire Appendix 1.

c) *Character animation production:* The animation production process starts with the art of creating variety of animated characters and content design, addressing different animation areas, to be the animation director. Then it follows character modelling, texturing and animating. After rendering the scene sequences of moving images edited by Media Player (WMP) video production, resulted in final and simple character animation.

d) *Hypothesis Test:* starts by showing (16) animations samples to 30 candidates, to select the animations by WMP video accessed via a designed website, Appendix1, to observe the animations and give an output to their observation by filling a questionnaire consisting of 51 questions. The data analysis for hypothesis testing used mean of standard deviations **SD**. After obtaining the results, a column chart was produced to represent the rating quality of the animation obtained as an outcome from the respondents, in addition to a written report as a final stage.

e) *Report the results:* Data analysis for hypothesis testing, use means, SD, result in writing the report



Flow chart of the Research Processes

2.5 Implementation

This chapter has explored a comparative study of different methods applied to improve the quality of character animation, different skinning techniques, and solutions that have been adopted in computer animation. This animation production process, starts with the art of creating 3D characters and content design i.e. the movement required to direct the character, example sport, setting, claiming, walking on different terrain...etc. followed by 3D modelling, texturing and animating as shown in the layout below of figure 2.2.

The composition framework based on the four methods mentioned as a purpose of this work which can be explored in details in this section along with their intrinsic advantages and limitations listed in table 2.1, to fulfil this purpose:

1. Methods based on kinematic animation.

The first set of tools developed for motion specification is based on forward and inverse kinematics, which is essential concept for calculating the positions and orientation of the model parts at a specified time, together with any information on the joints this specification is usually done for a small set of key-frames. The main problems with that are the design of key-frames and the choice of interpolation techniques, which has been studied by Watt (5) (Advanced Animation and Rendering Techniques 1992).

The exclusive use of forward kinematics makes it difficult to add constraints to the motion, such as the problem of penetration part of the body into the ground during the support phases. These constraints can be solved using inverse kinematics IK algorithms. The motion of the end link of a chain is specified by the animator in world coordinates. The system computes the variation $\Delta\theta$ of the state vector. The relation between the main task ΔX and the angular displacements takes the form:

$$\Delta X = J\Delta\theta \quad (1)$$

Where J , is the Jacobian matrix of the system. J is often not directly invertible, due to the different dimensions of X and θ therefore,

$$\Delta\theta = j^+ \Delta X + \alpha (I - j^+ j) \Delta Z \quad (2)$$

Where J^+ is the pseudo-inverse of the Jacobian matrix J , $\alpha = \text{constant}$, $I = \text{identity matrix}$, and $\Delta z = \text{secondary task}$ used to enforce on the null space of the main task, and account for joint angular limits or to minimize some energetic criteria. We can address the IK use method by referring to one of many examples:

Movement of Walking character using Kinematic animation

Most of the kinematic approaches used for generating synthetic character locomotion rely on biomechanical knowledge, and combine forward and inverse kinematics for computing motions. First method, for ensuring non-penetration with the ground, used by A. Bruderlin [6] who simulated an inverted pendulum for computing realistic motion for the stance-leg. Bruderlin and Calvert improve the technique by simultaneously simulating all the degrees of freedom, leading to smooth and parameterisable walking gaits.

Another way to maintain extra constraints on the foot position is the use inverse kinematic algorithms R. Boulic [7]. A leg-correction process is then used to modify invalid in-between postures as shown in figure 2.3

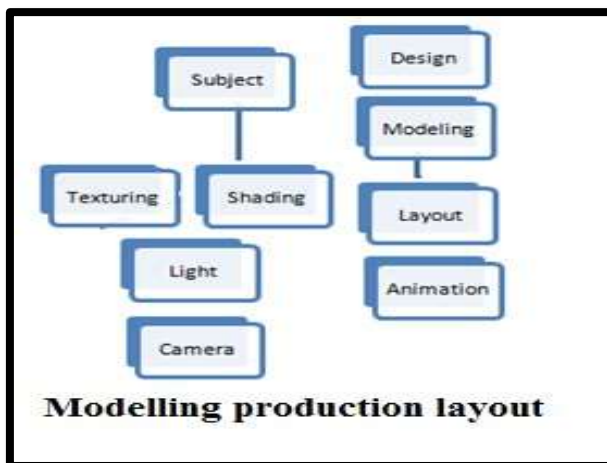


Figure 2.2: Modelling Production layout locomotion

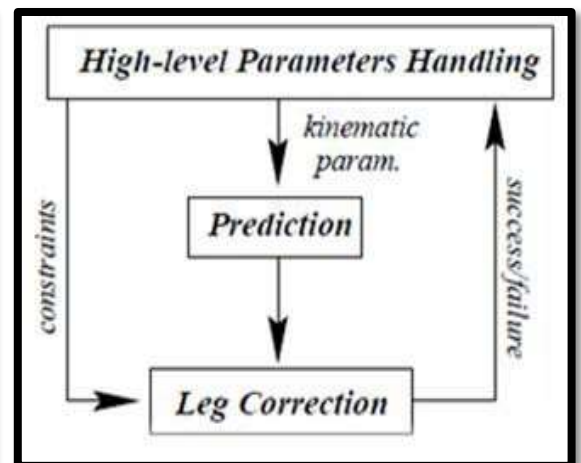


Figure 2.3: Synopsis of Boulic's system.

The main advantages are the low cost of computations, high level velocity, and step length parameters they provide. The complexity of inverse kinematic algorithms is with respect to the number of joints (due to the inversion of the Jacobian matrix); this does not have an important effect on the efficiency of computations. Another limitation is the interpolation process may filter the

intrinsic dynamics of the locomotion, leading to a loss of realism. Although terrains are not flat, the adaptation of the walk to such terrains would have to be described while designing the model.

2. Interactive edition of either captured or synthetic motions

To ensure realism for any model, approaches and techniques such as *Motion Capture*, *Motion Blending*, and *Motion warping* need to be applied on the animation, which it has many advantages and limitations.

Motion Capture: the process of recording movement and translating it to a digital model which is used in entertainment, sports, and medical applications. The animation data obtained from this method is mapped to a 3D model to perform the same actions as the actor. The advantages and limitation offered are:

- More rapid, low costs, complex movement and realistic physical interactions such as secondary motions, weight and exchange of forces can be easily recreated in a physically accurate manner.
- Motion blending has low computation cost, and the use of motion capture trajectories as primary data.

Limitations

- In motion capture, specific hardware and special programs are required to obtain and process the data, and specific requirements for the space it is operated in, depending on camera field of view or magnetic distortion; therefore, when problems occur, it is easier to reshoot the scene rather than trying to manipulate the data.

- The initial results are limited to what can be performed, within the capture volume without extra editing of the data, and the movement that does not follow the laws of physics, generally cannot be captured.
- If the computer model has different proportions from the capture subject, artefacts may occur, e.g., if a cartoon character has large, over-sized hands, these may intersect the character's body if the human performer is not careful with their physical motion.

Motion blending needs a database of characteristic motions based on blending frequency or temporal domain and consists in interpolating between their parameters in order to produce new motions. In motion blending the number of possible effects such as weariness and nervousness, relies on the pre-recorded motions, moreover, the transitions between two parameter sets are linear and continuous in time.

Motion warping the techniques that take well known trajectories described by key frames or motion captured trajectories and modify them in order to change the motion.

3. Incorporate dynamics constraints in the generation of motion or to use dynamics simulation.

To ensure the motion is realistic the following points must be addressed:

If the synthetic character carrying loads react to external forces, energy required to produce the motion belongs to a realistic interval.

Forward/inverse dynamic techniques are the fundamental principle of dynamics using Newton's laws to calculate the motion generated by a given force, while the other calculates the forces that would generate a given motion:

Newton's law of physics $f = m \cdot \ddot{x}$ (3)

Where \ddot{x} the second derivative with respect to time of the position vector x .

The equation looks similar for rotations, where torques and angular positions are linked by:

$$t = I\ddot{\theta} + \dot{\theta} \cdot I\dot{\theta}$$
 (4)

Where t = torque, I the inertia matrix, $\dot{\theta}$ is the angular velocity and $\ddot{\theta}$ the angular acceleration. Other approaches are:

Lighting and Rendering and High-Quality Ambient Occlusion.

The simulations of global illumination are specialized algorithms, which can effectively simulate the global illumination. These are *path tracing or photon mapping*, which they can be used to solve the rendering equation as shown in figure (2.3, 2.4), with an illustration to their advantages and disadvantages.

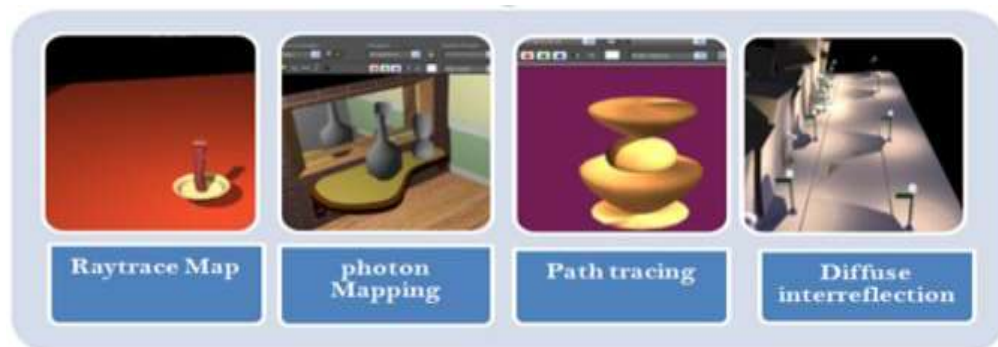


Figure 2.4: Path tracing obtained by diffuse map, raytrace map and photon mapping using 3DS max

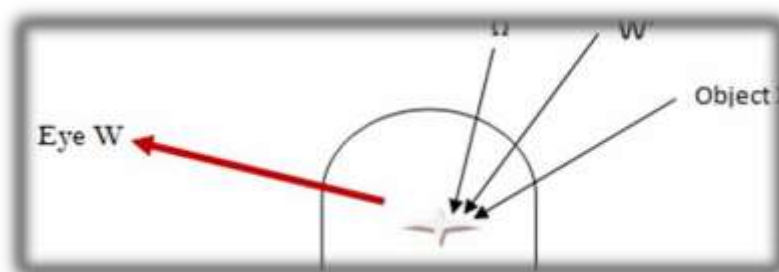


Figure2.5: the refraction of light photon mapping.

Advantages:

- To avoid emitting unnecessary photons, therefore, Instead of simply sending out photons in random directions, they are sent in the direction of a known object to either focus or diffuse the light.
- To avoid unnecessary collision testing in direct illumination.
- Soft indirect illumination.
- To optimize image quality, specially used for cone filter.

The filter gives weight to photons contributions to radiance depending on how far they are from ray-surface intersections. This can produce sharper images.

Its *limitation* is reducing the rendering speed.

4. Character animation Techniques

The power to convey emotions of an artificial character through change in shape, taking into account the sensitivity of human perception to a variety of motion when trying to create convincing artificial characters.

- It provides an overview of commonly used real-time character animation techniques with an emphasis on the animation of *articulated structures* and *surface deformation algorithms*.
- The goal is to minimize the effort and complexity needed to represent realistic poses while providing realistic deformation behaviour. *Character animation techniques are:*

1) Facial Animation

The blend shape is a collection of n surface meshes defined by vertices of a polygon mesh or control points and their individual attributes. The resulting vertex position v can be calculated as:

$$v = \sum_{i=1}^n w_i v_i \quad (5)$$

Where w_i being the weight of blend shape i . v_i is the position of the vertex or control point in the i th blend shape.

The range of blended shapes is restricted to be the *convex hull* of the n blend shapes which can be written as:

$$\sum_{i=1}^n w_i = 1 \quad w_i \geq 0 \quad \forall i \quad (6)$$

After the blend shapes are constructed, meaningful controls features and physically motivated segmentation algorithm can be added as shown in the figure (2.6).



Figure 2.6: typical blend shape used to constitute facial expressions using Making Human.

The limitation of *articulated structures* in-terms of increase number of blend shapes, control body poses and the time required, led to drives the deformation such as *SSD and WME* to take place.

Skeleton-subspace deformation (SSD)

Referred to as Linear Blend Skinning, Vertex Blending, or enveloping; SSD has introduce the rest pose (T Pose) to define the geometric information of all mesh vertices with respect to a certain skeleton configuration. This can be performed by employing SSD equation and the inverse of the rest pose matrix of the bone model \hat{T}_i

$$\hat{v} = \text{mod } el \text{ bone } \mathbf{T}_i^{\Lambda^{-1}} \hat{v} = \text{bone mod } el \hat{T}_i \hat{v} \quad (7)$$

The transformation of bone i describing the skeletal configuration then applied to the result to transform the vertex back into the model coordinate as below:

$$\hat{v} = \text{mod } el \text{ bone } \mathbf{T}_i \hat{v} = \text{mod } el \text{ bone } \mathbf{T}_i \text{ bone mod } el \hat{T}_i \hat{v} \quad (8)$$

Scalar weights for the influence of each bone on the displacement of a single vertex are calculated as an additional step. The calculated weight can be edited by animator (e.g. Painting weights map), i.e. to determine the weighted sum of the blended vertex position can be defined as follow:

$$\sum_{i=1}^b w_i = 1 \text{ where } v = \sum_{i=1}^b w_i \mathbf{T}_i \hat{T}_i^{-1} \hat{v} \quad (9)$$

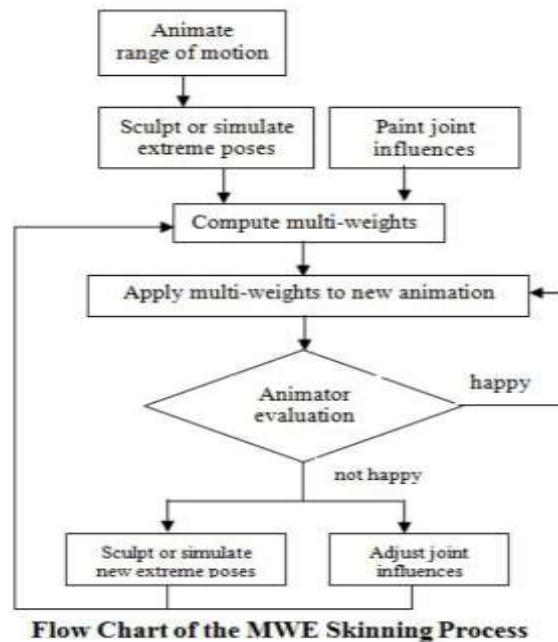
While for a maximum number of influential joints say 4 the vertex position is calculated as follows:

$$v = \sum_{i=1}^4 w_i \mathbf{T}_{bi} \hat{\mathbf{T}}_{bi}^{-1} \hat{v} \quad (10)$$

The advantage of using the above pre calculated equation is to reduce the cost of the per-vertex displacement calculation. The limitation of this method is listed in table 2.1. To overcome this limitation a common approach such as: *Augmenting the SSD model* and *Correctional models for SSD* needs to be addressed which was beyond the scope of this work.

The MWE Skinning Process

Skinning process is summarised in the following flow chart:



MWE has greater flexibility and therefore requires more information in order to set the large number of weights to a bone, which is time-consuming and may lead to problems with over fitting. The changes in the behaviour of a vertex as its weights are changed are often counterintuitive and it may not be clear whether a value exists to give the desired position A. Mohr, and M. Gleicher [8]. The problem can be solved by

- a) Applying weight painting which allow visualization of the weights as colours (black...white).
- b) Direct Manipulation, which will allow the vertex to be moved to a correct position after the bone is bent and automatically compute the weights necessary to get it there.

2.6 Results

The results obtained by developing 3D character animation with the aid of the design steps Appendix (1) to address a variety of different areas in animation (movement, modeling, etc) shown in Appendix (2) respectively. The animation emphasises the design short, simple and clear, showed as a video (.mvi) played via accessing the designed website as shown in a screen shot in Appendix (3), and answering the questions via the questionnaire page Appendix (4). Figure 2.7 demonstrate a screen shoots of some of the animations used for the purpose of this study. Where 16 animation samples, and questions have been produced to reflect the methods and techniques applied on these samples deduced from the design steps in Appendix (1), also to give 30 participants a wide range of animation to choose from, and give them the opportunity to observe, identify any artefacts, requirements, needs and anticipation for future animation, and in return will give us the right opportunity to improve, expand and make animation the demanding and importing tools for entertaining, industry, education and learning and many other areas.

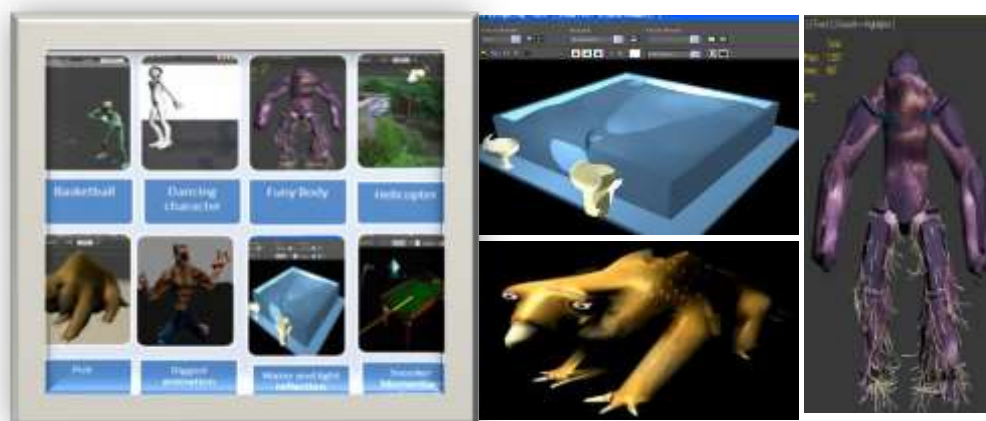


Figure 2.7: Screen shoots of some of the animations used.

The steps of the results are:

1. The questionnaire design

The questionnaire consist of rating (1 Question) and content perception questionnaires in a variety of 50 questions.

A) *Rating questionnaire:* To ask respondents view on the animation quality appendix (5).

Hypothesis testing, use means, of SD to show how much variation or dispersion exists from the average mean values. The SD for male was 2.44 which is higher than female SD = 1.82, and the mean number of satisfactory level of the animation product for male $M = 3.5$, for female $M = 4$, as shown in table 2.3, and presented in a column chart. The results for content perception hypothesis test using **F test** to show the proposed regression model fits the data well calculated to be:

F test = 0.11, within-group degrees of freedom $fW = 6$ and S.D for each individual rating is shown in table 2.4 and its bar chart after obtaining the results. Hypothesis testing, use means, of SD to show how much variation or dispersion exists from the average mean values. The SD for male was 2.44 which is higher than female SD = 1.82, and the mean number of satisfactory level of the animation product for male $M = 3.5$, for female $M = 4$, as shown in table 2.4, and presented in a column chart. The results for content perception hypothesis test using F test to show the proposed regression model fits the data well calculated to be:

- a) F test = 0.11, $fW = 6$ and S.D for each individual rating is shown in table 2.4 and its bar chart after obtaining the results.

Where:

$$SD = \frac{\sqrt{\sum (X - M)^2}}{(n - 1)} \quad (11)$$

$$F = \frac{\text{between - group variability}}{\text{within - group variability}} \rightarrow F = MS_B / MS_W \quad (12)$$

Where

$$S_B = n(\bar{Y}_1 - \bar{Y})^2 + (\bar{Y}_2 - \bar{Y})^2 + n(\bar{Y}_3 - \bar{Y})^2 \quad (13)$$

And n is the number of data values.

$$\begin{aligned} \bar{Y}_1 &= \frac{1}{a} \sum Y_{1i} \\ \bar{Y}_2 &= \frac{1}{a} \sum Y_{2i} \\ \bar{Y}_3 &= \frac{1}{a} \sum Y_{3i} \end{aligned} \quad \text{and} \quad \bar{Y} = \frac{\sum_i \bar{Y}_i}{a} = \frac{\bar{Y}_1 + \bar{Y}_2 + \bar{Y}_3}{a} \quad \text{Where } a \text{ is the number of groups.}$$

The between-group mean square value is:

$$MS_B / f_b \quad (14)$$

Where f_b is the between-group degrees of freedom is one less than the number of groups in our case is (4 - 1).

To calculate the "within-group" sum of squares, begin by centring the data in each group

$$S_W = \sum a_1^2 + a_2^2 + \dots$$

The within-group degrees of freedom is

$$f_w = a(n - 1) \quad (15)$$

B) Content perception questionnaire:

This questionnaire's objective is for testing the candidates' knowledge (candidates who haven't created 3D animation before). Learning from professional who has created or worked with animation their requirements, and perception about character animation, we have established from studying the responses that 48.6% of the candidates would like to see more realism and near to real time animation specially in the field of physical-based simulation, and many other aspects a sample of respondent is answers shown in Appendix (5). These results will give this work the opportunity to achieve the proposed aim and objectives, and focus on future work i.e. addressing the issues raised from respondents, improving the quality of character animation, applying different methods and techniques.

2. The designed website:

A viewing area for the animated (.mvi) files, for audience to view animation, and kindly answering the questionnaires provided.

3. Animation used in this work:

the animation produced was based on different methods and techniques, in particular Inverse/ forward kinematic, motion blending and builder, etc. modification and correction to address participant's requirement, and rectification to some of the artefacts generated through the animation that has been made.

4. Comparison:

To investigate the advantages, limitation and application to the techniques used shown in table 2.1 above & 2.2.

Model	Advantages	Limitation	Applications
Procedural approaches	Low computation cost	No automatic dynamics effects	Virtual reality, Video games, behavioural simulation
Kinematic correction	Ensure realistic poses	No automatic dynamics effects coherence between modules	Virtual reality, Video games, behavioural simulation
Dynamic constraints	Avoid unrealistic dynamics effects	Desired dynamics effects implies ad'hoc constraints coherence between modules	Art, Virtual reality
Space-time constraints	Dynamically sound interpolation	High computation cost	art, biomechanical simulation
Editing Motion Data	Computation cost realistic trajectories	Hard interactive control volume of the motion database	Art, Virtual reality, Video games, behavioural simulation

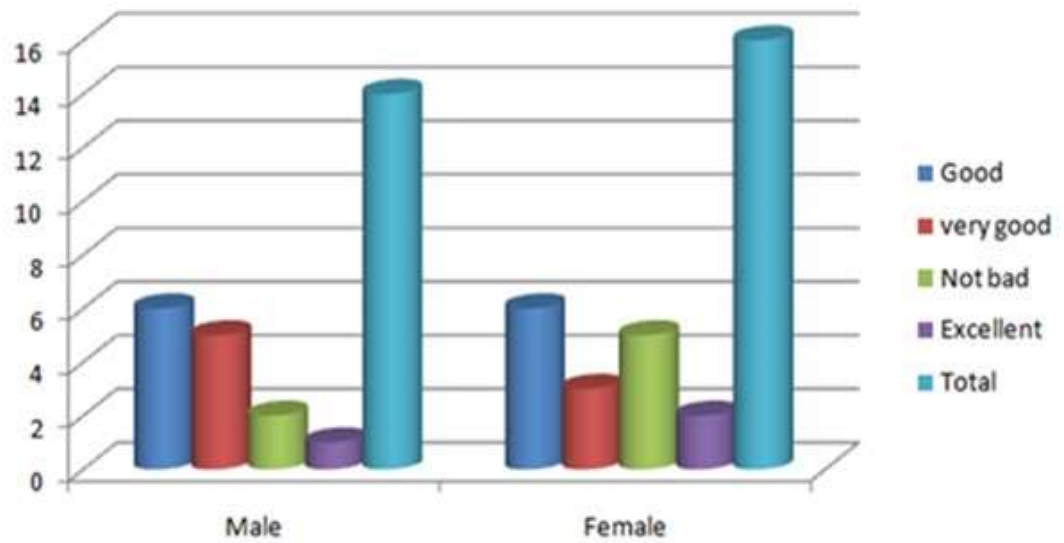
Table 2.2: Advantages, limitation and application to the techniques used in this work

Gender	Good	Very good	Not bad	Excellent	Total	Mean	S.D
Male	6	5	2	1	14	3.5	2.44
Female	6	3	5	2	16	4	1.82

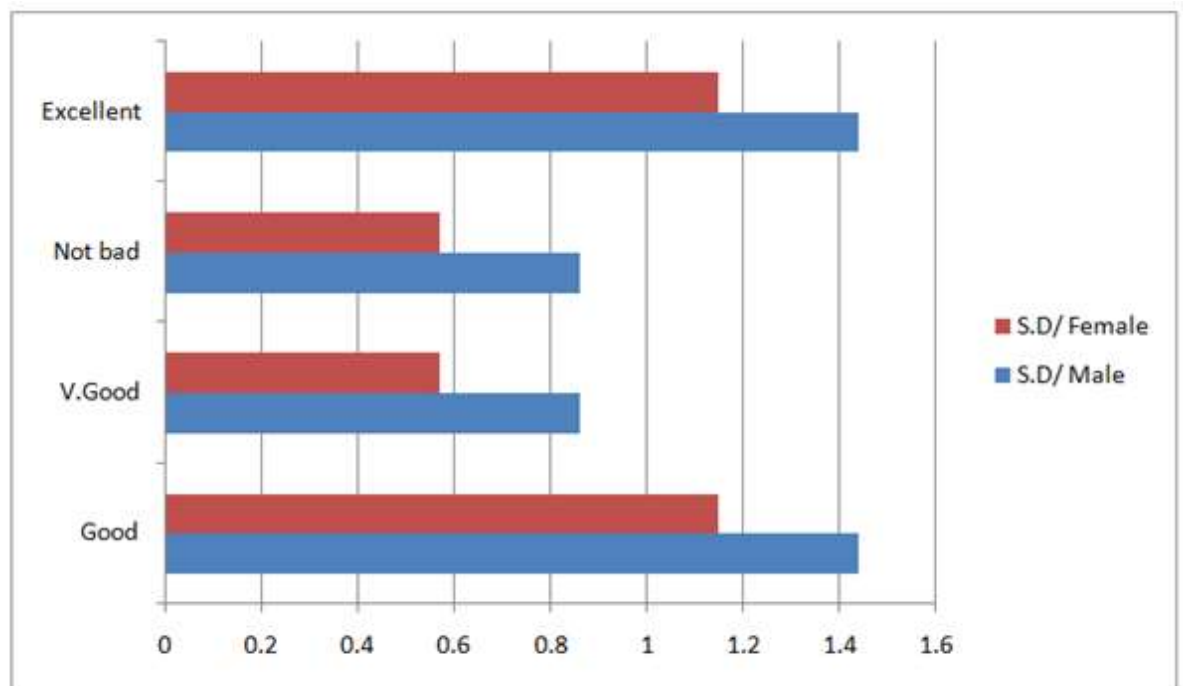
Table (2.3) the mean number of satisfactory level of the animation product between M/F

Male rating list	Perception	\bar{X}	S.D	Female rating list	Perception	\bar{X}	S.D
6	Good	1.71	1.44	6	Good	1.5	1.15
5	Very good	1.42	0.86	3	Very good	0.75	0.57
2	Poor	0.57	0.86	5	Poor	1.25	0.57
1	Excellent	0.28	1.44	2	Excellent	0.5	1.15

Table (2.4) individual rating



Rating Column chart: to represent respondents view on the animation quality obtained from table 2.3



Bar chart for calculating S.D for both genders obtained from table 2.4

2.7 Conclusion

- We met our objectives by describing and studying the issues associated with character animation, to demonstrate realistic character movement throughout the animation process presented in appendix 1.
- An improvement and correction to any artefacts in the current animations is necessary especially in the area of modelling, realism, and adding some dynamic system character animation, which will be applied to new animation creations. In addition to apply modification to validate the animation quality, this will be taking place in the coming chapters.
- The use of real-time IK to adapt existing motion showed us the advantage of reducing visual artefacts, i.e. the motion is successfully retargeted to the new character and environment.
- FK is simple which gives an arc motions similar to natural movements whereas IK interpolates in a straight line, it is application include editing key-frame postures, producing interactive animation, and generating motion such as reaching and walking as achieved in video(1,10, 14,15) Appendix (2).
- To render skin realistically, we need to account for subsurface light scattering, bump mapping, and any other elements for improvement in my future work as it was not fully achieved in this chapter.
- The quality of the motion depends on the quality of the model.

- Reduce the amount of large number of questions when considering another questionnaire in the next coming chapters of this thesis, as this will affect participant's interest.

2.8 Summary

This chapter briefly introduced the study of 3D character animations generated in the field of Computer Graphics and its applications, as well as data collection methods, and evaluation, analysis of the results obtained from character animation with the aid of the design steps Appendix (1), which addressed a variety of different areas in animation, and the limitations of this research study.

The research will carry on to progress and address all issues necessary in the next step and to achieve a long term goal to obtain real-time detailed realistic rendering character animation.

The next chapter will take this work to the next research steps for the animation framework to accommodate non-professionals and novice users, in order to represent them with social information, support teaching and learning, in addition to introduce the concept of dynamic animation and control environment such as particle systems to represent variety of applications ranging from modelling fire, texturing, etc.

The goal to improve, and reach a good realistic character animation free from any major artefacts was generated from respondents feedback regarding various animations, which I have created for the purpose of this exercise. Different variety of quantitative methods to validate the animation quality such as questionnaire and a moderation session, will lead the way to carry out new 3D animations and statistical evaluation in the next chapters.

Chapter 3

What is the role of animation in learning?

3.1 Introduction

Animating such realistic and directable characters is a particularly challenging goal; this is due to the fact that we are so intimately familiar with human motion from our day-to-day lives, even untrained viewers have strict requirements for what they will consider to be realistic human movement. Our sensitivity to subtle details of human motion is very high, meaning seemingly minor details of human motion carry significant information and impact. A character with an unrealistic motion or whose motion contains details that are ill-suited to the scenario can detract significantly from the goal of the application. Learning and entertaining applications which often rely on engaging and immersing the learners/ views suffer when a motion appears implausible or ill-suited. Training applications, particularly those which require the emotional involvement of the trainee Hill et al. 2003[9] may suffer similar reductions in effectiveness.

In this chapter of the study we have introduced a realistic 3D character animation to demonstrate the purpose of using entertaining, interactive useful animation for learners where sensitivity, accuracy, reaction, dynamic environment, and any special effects were considered to involve validation methods to shine light on the reach of this task.

The method of validation is the process by which it is established. Performance characteristics of the method meet the requirements for the intended analytical applications, and should demonstrate that the method is fit for its purpose and can

follow a plan that includes the scope of the method that needs to be validated or revalidated before their introduction into routine use.

This chapter describes research to be undertaken to discuss Validation of 3D Character Animation. It will demonstrate chemistry experiments in the classroom as mentioned in chapter 1 and 2. This is to establish how learners respond to animation in a science environment and in particular Chemistry or Biology lessons. The main questions that can be asked are:

How students from both genders respond to animation in their learning environment?

How beneficial and influential animation can be to them?

An overview of this chapter indicating the content discussed are illustrated in figure 3.1.

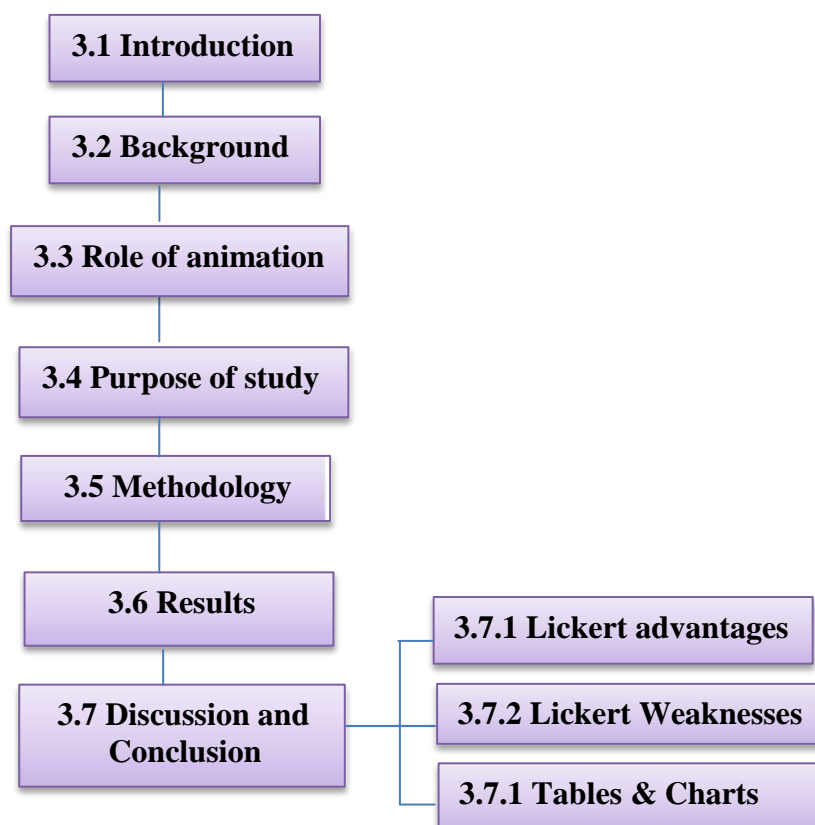


Figure 3.1: Overview of chapter 3 indicating the content discussed

3.2 Background

The research was done with the agreement of the principle at my working place JLA academy, where students from science classes are predominantly from different genders and level of knowledge. The availability of computers and modern equipment created an opportunity for students to use animations and multimedia learning environments in their study.

3.3 What is the role of animation in learning

The most exciting forms of pictorial presentation are animation.

Animation refers to a *simulated motion picture* depicting movement of drawn (or simulated) objects. The main features of this definition are as follows:

- (1) Picture an animation-a kind of pictorial representation
- (2) Motion an animation-depicts apparent movement
- (3) Simulated an animation- consists of objects that are artificially created through drawing or some other simulation method. In contrast, video refers to a motion picture depicting movement of objects.

In this chapter we focus on the potential of an ‘animation’ as an educational tool and whether animation promotes learning?

3.4 Purpose of study

The purpose of this chapter is to establish affective effects of using animation as an important tool in students learning and how animation can motivate, engage and highlight key information through animated figures. It can facilitate information and recall their response to the tool.

This study aimed to identify the 3D animations as representations of three chemistry experiments, to verify if 3D animation video executed movements of the character and the reaction, quality, realism, processed in the visual/pictorial channel and narration reflecting the use of the animation in education using methods discussed in chapter 2, to present/validate the technique for animating the biped performing, and to evaluate the influence of using animation as a learning tool for students and to provide good exam preparation aid to their education and learning process. Do students learn more from animation than from other modes of presentation? Should we increase the use of animation in educational programs? These questions fit within a classical tradition of this research, in which the goal is to determine whether students learn better with one medium compared to another.

3.5 Methodology

This investigation is a case study to determine how students interact with 3D animation in science interactive learning where dynamics environment are present. The work has taken the following steps:

a) Sample

In a science chemistry lesson of year 10, 15 students have been chosen with the help of their teacher as a plenary stage to view the animation and kindly answering the questionnaire presented in the website, a sample of the questionnaire is presented in Appendix (6).

b) Materials and Methods

In this section use of the videos were shot from perspective view as an AVI file created with the aid of 3DS max and Poser were presented, to demonstrate a

chemical reaction selected from the periodic table to cover the topic need to be studied as a part of the academic syllabus, such as Sodium, Potassium, and rubidium reaction with water ($\text{Na} + \text{H}_2\text{O}$, $\text{K} + \text{H}_2\text{O}$ and $\text{Rb} + \text{H}_2\text{O}$) respectively.

c) Website Creation

A website was idealized and designed with easy access for students, where they would be able to provide this validation. The validation process was divided in three parts:

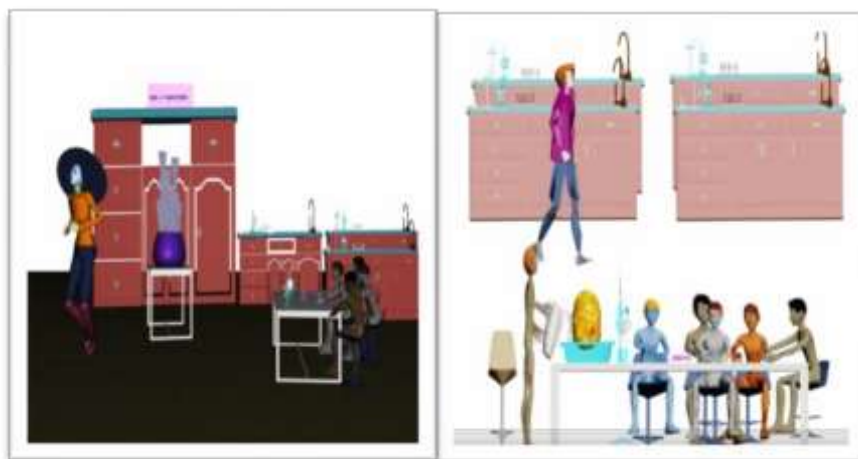
Introduction, animation process, and questionnaire;

The ***introduction*** part informed the students about the experiment procedure and the danger of the metal reaction with water.

The ***animation process*** can be accessed through selecting the right button indicated in the videos. The students have the chance to visit this site and play the video as many times as they like.

The ***questionnaire*** part presented three statements and one question to students about the experiment. The affirmatives were evaluated through the Likert scale, and the question designed according to the ordinal scale has been studied by Read and MacFarlane [10]. After answering this page, they were asked to choose the next video with the second experiment animation process. The same procedure was followed by the third video. The validation will be saved in a provided folder.

The animation video samples are shown in figure 3.2



(A) NA+water

(B) K+ water



(C) Rb+ water

Figure 3.2: Animation video samples

3.6 Results

The evaluation of 3D character animations were processed by year 10 (KG's group) students' opinions. 15 students have evaluated three affirmatives through the Likert scale, and answered one question, also in ordinal scale, about the quality of the animation and how it is useful to use animation as a learning tool. The calculated medians for the first, second and third affirmatives were 6, 8 and 9 fully agree and 9, 7, 6 somewhat agree Table 3.1 respectively. The percentage of

answers that scored for the agreement as a whole (Fully and somewhat agreed) was varied from 93.3% to 100% as shown in table 3.2.

- ***The first affirmative stated:***

“Using this video animation is quite effective to complete and perform the Sodium in Water experiment tasks scenario under supervision.”

The students’ medians were 11 (fully agree) and their percentage of agreement were: 80% (Video 1); 73% (Video 2); 60% (Video 3), as shown in table 3.3.

- ***The second affirmative stated:***

“The animation gave clear reflection of the danger and the chemical reaction of the (Alkali metals) with water explosion during the experiment.”

The students’ medians were 6(fully agree) and their percentage of agreement were: 46% (Video1); 80% (Video 2); 40% (Video 3).

- ***The third affirmative stated:***

“The environment and apparatus set in the animation video was clear and reflected realism”

The students’ medians were 8 (fully agree) and their percentage of agreement was: 66% (Video1); 60% (Video 2); 60% (Video 3).

- ***The fourth statement:***

Consists of a question about the quality of the animation:

“How do you evaluate the quality of this animation?”

The animation scored “very good” and “good” for all three animations.

The percentages of agreement were: 100% (Video1); 100% (Video 2); 93% (Video 3).

The percentage of agreement represents the amount of “Fully agree” and “Somewhat Agree” answers. The median was applied to represent the quantitative data **central tendency measure**, because they are based on an ordinal scale.

The raw data for our examples is outlined in table 3.1 below from 15 participant responses to help relate this data to the statistics which we calculated in the section below.

Tables 3.2, 3.3, 3.4, and 3.5 provide two variations of the descriptive statistics that can be calculated for the above raw data table

3.1. Tables 3.2 and 3.3 show the median, mode, range, and inter quartile range for the raw data.

Table 3.2 treats all the responses together as a whole.

Table 3.3 breaks down the same statistics into our three experimental categories (NA, Rb, and K) in order to aid in the comparison of these groups.

Tables 3.4 and 3.5 go on to aggregate the number of responses for each Likert scale in each question where, **Table 3.4** again treats all the responses as a whole.

Table 3.5 distinguishes between (NA, Rb, and K) experimental student responses.

Table 3.6 shows the Likert Scales’, Quantitative data of the animation videos.

The mean of central tendency of all 3 animations were demonstrated in table 3.7.

All charts have been generated using the above tables.

The mean of our measurement of central tendency was: 7.6 for Fully Agree and 7.3 for somewhat Agree.

3.7 Discussion and Conclusion

The nearest approach to these work goals was studied by Joonkoo and, Deborah [11]. A Quantitative Approach to Movement Skill Assessment for Children with Mental Retardation This study examined the psychometric properties of Ulrich's (1988) Actual Physical Competence Scale for children with mental retardation.

Also, Cook and Skinner [12]; How to Perform Credible Verification, Validation, and Accreditation for Modelling and Simulation Cross Talk?

Our method is different to the above, as it has introduced animation and evaluated statistically the outcome, usefulness, results and good achievements for student to learn through using animation.

During the animation process some steps were processed with carefulness to control the animation variables to ensure a better representation and to strengthen the validation, these steps:

- a) The original experiments in the videos were performed by a science teacher in classroom, after using the animation as an aid for learning.
- b) A website was created to facilitate access and to permit the evaluation of the animation to occur.
- c) The evaluators were chosen by my school students in the Science laboratory with agreement of the school and the class teacher.
- d) The website contains an introductory explanation to the students about the task they would perform, and also the awareness of the danger of any metal with water reaction, equipment and diagrams to illustrate the actions. Shown in Appendix 6.

- e) Three statements and a question were asked for each stage of the animation progression.
- f) The answers were automatically sent to different e-mail accounts to prevent loss of data.
- g) Results were statistically treated for a proper description and interpretations.
- h) The medians and the percentage of agreement have shown adequate evidence of validity for the 3D character animation, for the applied animation technique, for controlling the 3D animation positioning and speed, the type of the applied light and camera position, to reflect a good interactive and attractive source of learning material for student and to show the quality of the animation.

The present study has shown evidence of statistical validity based on likert scale for the developed animation representing the Chemistry experiment.

The applied technique was helpful for short duration videos to give support for education and teaching.

The above conclusion and calculation will lead the way to investigate and evaluate deeper into the importance of the animation for this work, and the aim to explore the potential learning through animation in the next chapter.

3.7.1 The Main advantages of using Likert Scale in this work:

- Simple to construct
- Likely to produce a highly reliable scale
- Easy to read and complete for participants

3.7.2 Likert Scale Weaknesses:

- Central tendency bias, therefore, participants may avoid extreme response categories
- Acquiescence bias, the students may agree with statements in order to please the experimenter.
- Social desirability bias
- Lack of reproducibility
- Validity may be difficult to demonstrate i.e. has the affirmative been set to measure what it has been set out to measure?

3.7.3 Tables and their charts

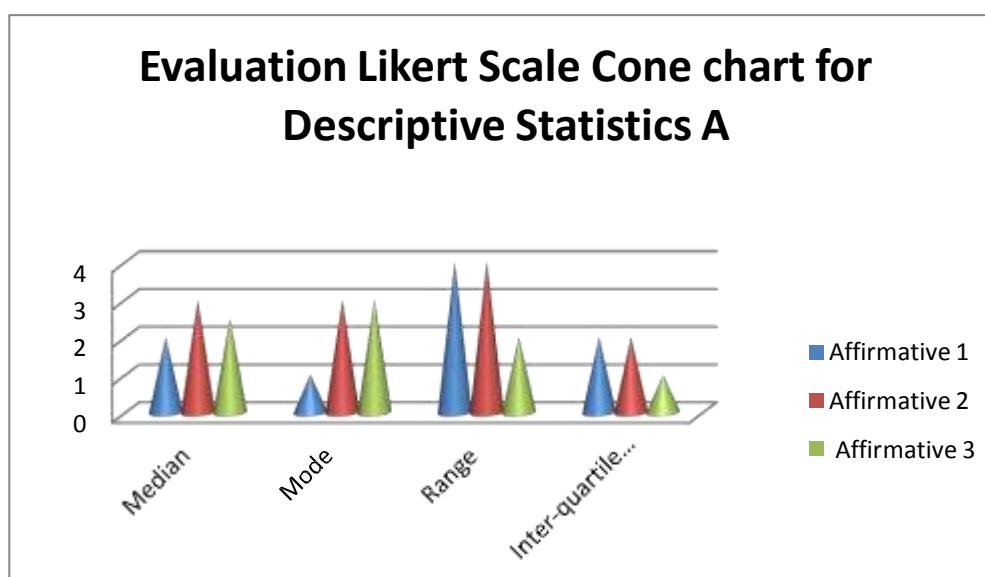
Tables from (3.1 - 3.7) with their data charts

Participant	Category	Affirmative 1	Affirmative 2	Affirmative 3
1	NA	1	1	3
2		3	1	3
3		1	3	2
4		2	3	1
5		4	3	3
6	K	1	2	2
7		3	3	3
8		1	1	1
9		3	1	3
10		2	4	2
11	Rb	2	1	2
12		1	5	3
13		5	3	2
14		2	2	3
15		1	3	1

Table 3.1: Raw data

	Median	Mode	Range	Inter-quartile range
Affirmative 1	2	1	4	2
Affirmative 2	3	3	4	2
Affirmative 3	2.5	3	2	1

Table 3.2: Descriptive Statistics A



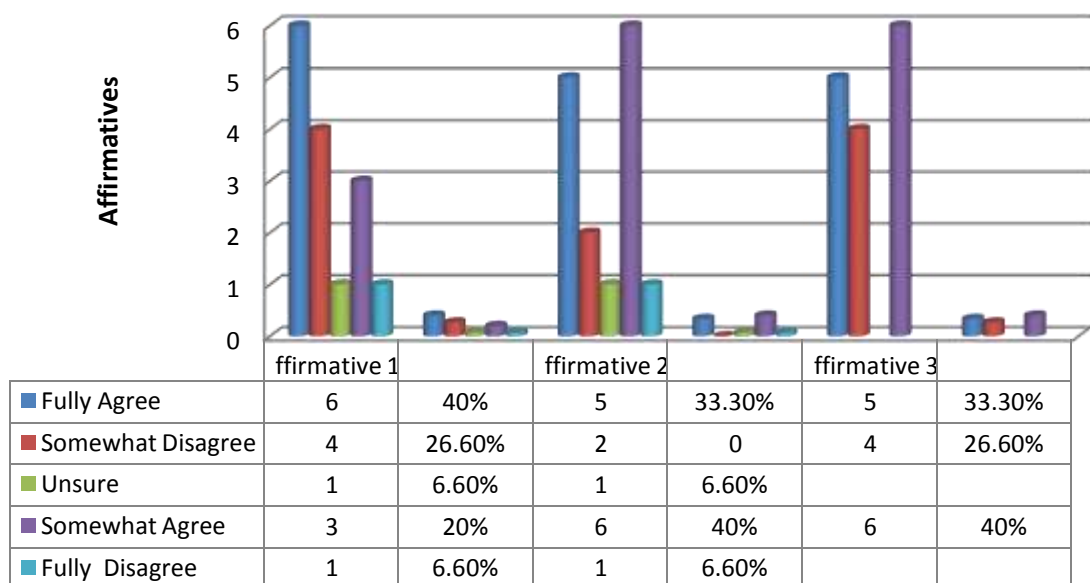
	Median			Mode			Range			Inter-quartile range		
	NA	Rb	K	NA	Rb	K	NA	Rb	K	NA	Rb	K
Affirmative 1	2	2	2	1	1.2	1.3	3	4	2	2.5	2.5	2
Affirmative 2	3	3	2	3	3	1	2	4	3	2	2.5	2.5
Affirmative 3	3	3	2	3	3	2.3	2	1	2	1.5	1	1.5

Table 3.3: Descriptive Statistics B

	Fully Agree	Somewhat Disagree	Unsure	Somewhat Agree	Fully Disagree
Affirmative 1	6	4	1	3	1
	40%	26.6%	6.6%	20%	6.6%
Affirmative 2	5	2	1	6	1
	33.3%	%	6.6%	40%	6.6%
Affirmative 3	5	4		6	
	33.3%	26.6%		40%	

Table 3.4: Descriptive Statistics C

Evaluation Likert Scale Column Chart for Descriptive Statistics C

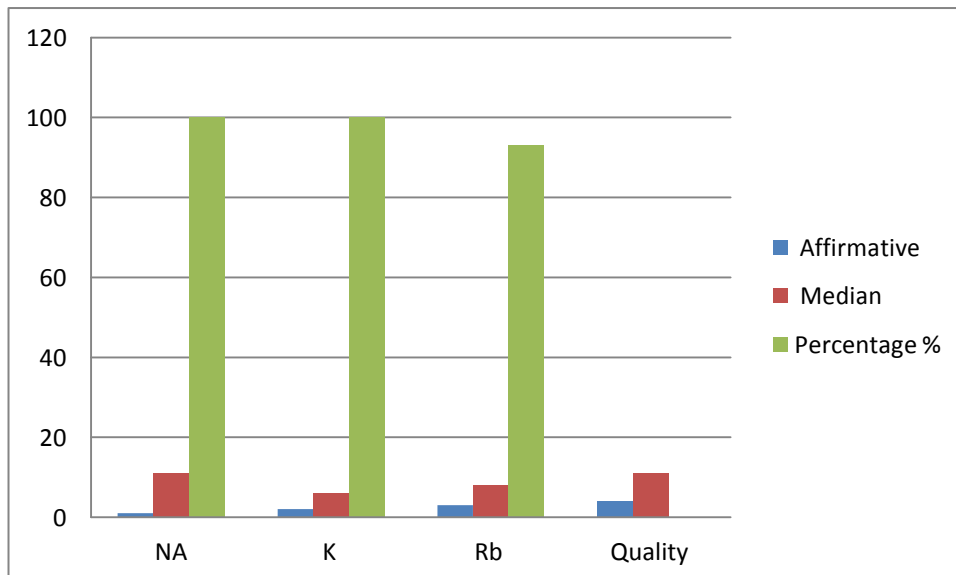


	Fully Agree			Somewhat Disagree	Unsure			Somewhat Agree			Fully Disagree
	NA	Rb	K		NA	Rb	K	NA	Rb	K	
Affirmative 1	12	9	11		0	0	1	3	7	3	
	80%	60%	73%		0%	0%	6%	20%	46%	20%	
Affirmative 2	7	6	12		0	1	0	7	8	3	
	46%	40%	80%		0%	6%	0%	46%	53%	20%	
Affirmative 3	10	9	9		0	1	0	5	5	6	
	66%	60%	60%		0%	6%	0%	33%	33%	40%	

Table 3.5: Descriptive Statistics D

Metal	Affirmative	Median	Percentage %
NA	1	11	100
K	2	6	100
Rb	3	8	93
Quality	4	11	

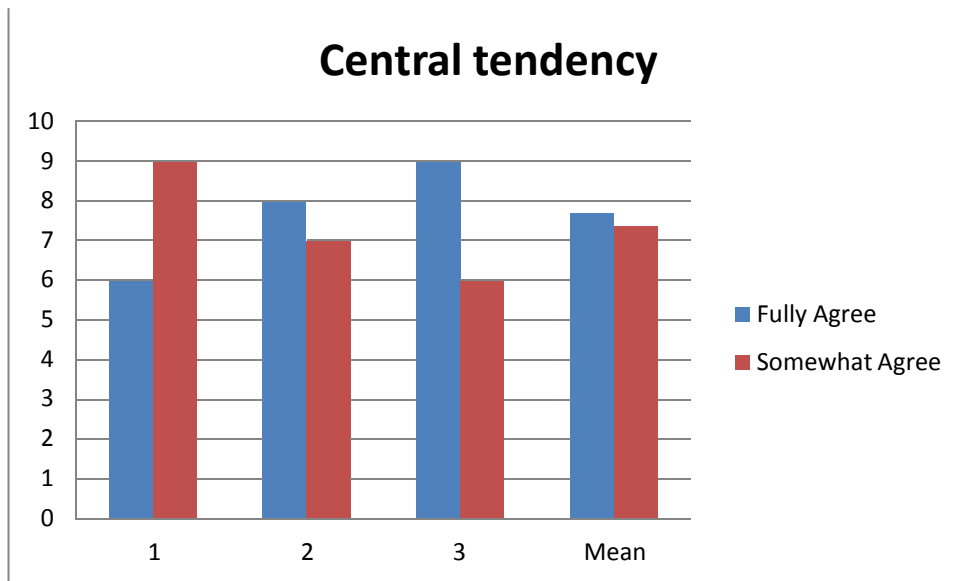
Table 3.6: Likert Scales' Quantitative data of the animation videos.



Evaluation Likert Scale Histogram for table 3.6

Affirmative	Fully Agree	Somewhat Agree
1	6	9
2	8	7
3	9	6
Mean	7.6	7.3

Table 3.7 central tendency



Central tendency bar chart of table 3.7

Chapter 4

Potential Learning through Animation

4.1 Introduction

The research has been extended further to reach another form of evaluation process to investigate the role of animation on learning. In this chapter, the essential factors that determine the potential learning through animation will be reviewed. We assess this work by using a set of open questionnaires which are different to the previous ones mentioned in Chapter 2, using the same set of the animated chemistry experiments used previously as shown in Figure 4.2 and sample of the questionnaire in Appendix (7), created earlier in 3DS Max, where statistical data will be collected from the evaluation. The statistical model and the methodology to lead this process will be discussed. A preliminary study of the reliability of the estimates is also going to be described. The highlight of this chapter lies in:

- (a) Determining the relative importance of animation in learning evaluation.
- (b) Proposing an experimental strategy for verifying and fitting a quantitative model to estimate the potential of animation as an educational aid.
- (c) Experimental results.

The quantitative method is found to fit closely to subjective ratings by student observers based on preliminary experimental results.

The main objective is to evaluate a quantitative metric that measures the potential use of animation in learning. A perceptual variation that can give the animator

some insight into how to work towards using animation as a tool and make it an essential ingredient for education in many subjects' areas needs to be implemented.

An overview of this chapter indicating the content discussed are illustrated in figure 4.1.

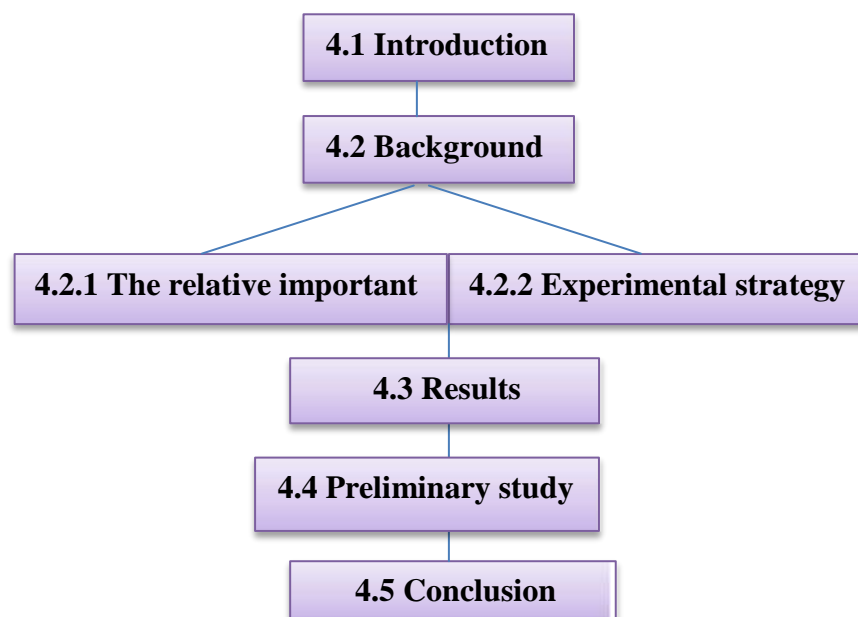


Figure 4.1: Overview of chapter 4 indicating the content discussed

4.2 Background

The highlight of this work lies in:

4.2.1 The relative importance of animation in learning evaluation.

One of many ways used to quantify the difference between values implied by an estimator and the true values of the potential use of animation being estimated is the advantages of using the **Mean Squared Error (MSE)**. MSE is a risk function, corresponding to the expected value of the squared error loss or quadratic loss; also it has the use of measuring the average of the squares of the "errors." The

error is the amount by which the value implied by the estimator differs from the quantity to be estimated, as shown in the below description.

From our example, we have a sample of size 3 *animated videos* from a population of 35 students: 17 female and 18 male, in addition to an extra 10 volunteer students were chosen randomly, 4 of which were female and 6 male collectively.

The usual estimator for the mean is the sample average demonstrated in table 4.1:

X Value		Error (Err) = (μ -X)	Error Squared (Err ²)	Total of 35 students
(Female)	17	-0.5	0.25	
(Male)	18	0.5	0.25	
Sum of Squared Error (SSE) =			0.5	

X Value		Error (Err) = (μ -X)	Error Squared (Err ²)	Total of 10 students
Female	4	-1	1	
Male	6	1	1	
Sum of Squared Error (SSE) =			2	

Table4.1: Students estimation

The formula used to calculate MSE is shown in table 4.2.

Formula : MSE = SSE / n where MSE = Mean Squared Error, SSE = Sum of Squared Error and n = Number of Population Number of Population (n) = 2 Mean (μ) = 17.5 Sum of Squared Error (SSE) = 0.5 Mean Squared Error (MSE) = 0.25	Formula : MSE = SSE / n where MSE = Mean Squared Error, SSE = Sum of Squared Error and n = Number of Population Number of Population (n) = 2 Mean (μ) = 5 Sum of Squared Error (SSE) = 2 Mean Squared Error (MSE) = 1
---	---

Table 4.2: Mean Squared Error (MSE)

	$\hat{\theta}$ = the unbiased estimator of the population mean $\bar{X} = \frac{1}{n} \sum_{i=1}^n (X_i)$	$MSE(\bar{X}) = E(\bar{X} - \mu)^2 = \left(\frac{\sigma}{\sqrt{n}}\right)^2$
--	--	--

4.2.2 Proposing an experimental strategy for verifying and fitting a quantitative model to estimate the potential of animation as an educational aid

There are many strategies available to provide the smooth transition of 3D character animation, an overview of some of the related factors that influence students learning using 3D character animation are:

1) Information Delivery Theory

This theory refers to where learning involves adding information to one's memory Mayer, 1996, in press [13]. According to this theory, the computer is a system for delivering information to learners. The instructional designer's role is to present information (i.e. as words or pictures, or both) and the student's role is to receive the information. For example, when an explanation presented in words (such as narration) the students can store the information in memory. Adding pictures (such as animation) should have no effect on what is learnt if the pictures contain the same information as the words. Thus, according to this information delivery theory, animation presentations should not result in better learning than other media presentations, however, if some students prefer visual presentations and others prefer verbal presentations, then animation media presentation would be effective in delivering information effectively to both kinds of students. In this approach, learners could select the delivery route they prefer. Thus, according to a lenient version of the information delivery theory, animation presentations should result in better learning than other media presentations.

2) Interactivity

This plays an important role in providing a mutual action between students, learning system, and learning material. Therefore, students will be able to learn faster, and have better attitudes toward learning when using interactive animation especially if the other techniques like audio and video are used.

3) Engagement

Interactive learning with live-action animation, simulation, video, audio, graphics, feedback, mobile advice, and questions and answers keep students interested and reinforce their skills, which encourage them to learn in their own pace through continual practice, which results in absorbing information to be integrated into daily performance.

4) Consistent

This theory will give students the opportunity to learn the same principles and skills. Also enforce getting and holding their attention to the important part of the topic for example, when computer animation is used to show invisible phenomena such as chemistry or physics interaction.

5) Immediate Feedback

Students will get immediate feedback from the animation system either by using the computer or animator / teacher comments that will enhance their skills and abilities. During the process of the animation, teachers can open free-discussion among learners, which will effect positively over the entire classroom. This theory has the advantages not only for students, but it's also useful to act on the learner's feedback to improve the animation system itself.

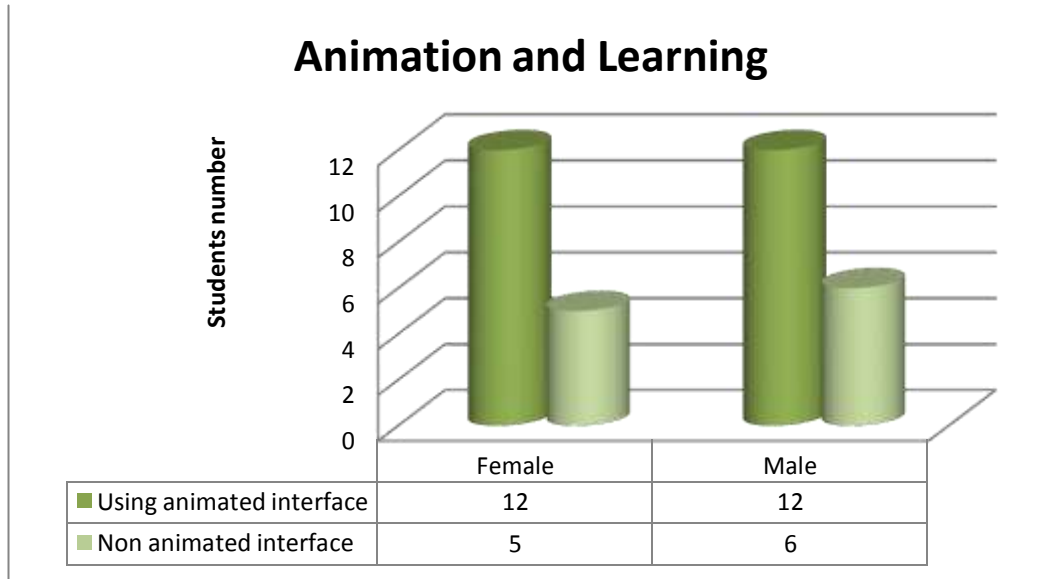
4.3 Experimental results

The animated chemistry experiments in this work were evaluated by 35 participants, science students, some of whom has some or little computer knowledge especially in the animation field. Three different animated chemical reaction (AVI) videos showed to them via a designed website followed by answering a questionnaire consisting of 15 questions as shown in Figure 4.2, 4.3, and Appendix (7). All evaluation experiments were performed on classroom computers, and the feedback was stored on their student area and was to be collected at the end of the lesson. The participating students were asked to answer the questionnaire independently, illustrating their preference of using animated videos in class to study their subject area, and rating the important role of the using animation as a learning aid demonstrated in Question 3 (*as good, very good, not bad, and excellent*).

From the experiments it was observed that results for the animated videos were very close to reflect the needs of performing subjects studied in class using animated interfaces, 5 females and 6 males didn't prefer the use of animated interface as shown in table 4.3 graph (4.1).

Gender	Using animated interface	Non animated interface
Female	12	5
Male	12	6

Table 4.3: student's feedback for the animated interface



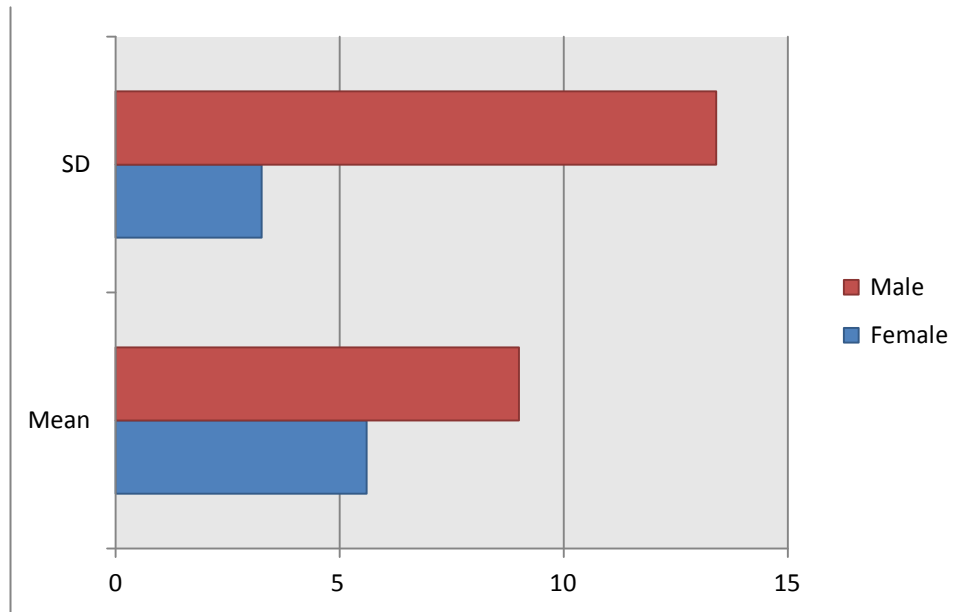
Graph 4.1

We also calculated the *standard deviation* for rating the animation among Female and Male students using the SD equation (4.1) below, which showed that SD for females (3.26) are lower than males which is 13.4 as demonstrated in table 4.4 and presented in graph (4.2).

$$SD = \sqrt{\frac{\sum N^2}{N-1}} \quad (4.1)$$

Gender	Rating				Mean	Standard Deviation (SD)
	Good	Very Good	Not Bad	Excellent		
Female	3	11	3		5.6	3.26
Male	6	12			9	13.4

Table 4.4: calculated the *standard deviation*



Graph (4.2) for table (4.4)



Figure 4.2 Animation Samples



Figure 4.3 Second Website

4.4 A preliminary study of reliability

Reliability of the user evaluations:

It is important to discuss issues relating the reliability of our perceptual evaluations. The reliability discussions are based on studies described by Guilford [14], that reliability “*increases with the number of judges.*” It was observed that the reliability of measurement depends on “self-correlation” where repeated sets of measurements are correlated to each other. Forming groups for self-correlation is however difficult and a time consuming task. A group of judges for self-correlation needs to have comparable judging behaviour, as we do not have groups of judges to measure self-correlation; we performed the other evaluation instead. In addition to the experimental results already described we conducted rating tasks with an additional 10 students 4 of whom were female and 6 male from the same group, after a time interval of about one week in between. The results obtained using the new group for the same three experiment animations are summarized in Tables 4.5 and 4.6.

Animation	Rating				
Video1 NA	Good		Very Good	Not bad	Excellent
	%	30	30	20	20
	Mean	0.3	0.3	0.2	0.2
Video2 Rb	%	60	20	20	0
	Mean	0.6	0.2	0.2	0.0
Video 3 K	%	40	50	01	0
	Mean	0.4	0.5	0.01	0.0

Table 4.5 Mean Users ‘Evaluations Quality for the animated videos for 10 students.

Gender	Rating				Standard Deviation(SD)
	Good	Very Good	Not Bad	Excellent	
Female		4			2.5
Male	2	4			2.6

Table 4.6 Standard Deviation of 10 Users’ evaluations for the 3 animations together

4.5 Conclusion

Using MSE (Mean Squared Error) method has got many advantages to our work these are:

- Determining the accuracy of the displayed quality of information with aid of animation.
- Perception of evaluation, especially when showing participants video animation to reflect how well it addressed their needs. This has enabled

students to visualise the key to scientific concepts through the use of animation.

- Discussing issues relating to the reliability of our perceptual evaluations. i.e. (reliability increases and improved with number of judges).
- Measure self-correlations.
- We have identified and assessed the importance of using animation for learning.
- We have established that learning with animation is effective, easier and useful.

We can conclude that the SD rating obtained from 35 students (Female and Male) regarding how good using animation in their studies was 3.26 and 13.4 respectively; while an extra 10 students (Female and Male) ratings were 2.5 and 2.6 respectively.

The MSE for this exercise was 0.25 for the first set of students and 1 for the other set of students.

The strategy to evaluate the related factors that influence learning using 3D character animation were addressed and considered during the creation of the animated experiments.

The quality of animation to present the requirement of the lesson objectives in our work was reasonably acceptable amongst male and female students.

Only a few students showed their dislike to use animation as a learning tool.

In summary from the above calculation, we can deduce that the methods studied in the previous chapters, and the feedback obtained from users has given the advantages of applying 3D animation great value, and opened another pathway to

learning another form of evaluation. As a continuation of evaluation methods highlighted in previous chapters for this thesis, the next chapter will lead the way to the visual assessment method or interview, where eliciting information by questioning methods will be introduced.

Chapter 5

Interview and Visual Assessment

5.1 Introduction

This chapter will discuss another form of evaluation as a continuation to the all evaluation methods for this thesis. The visual assessment method or interview is a form of eliciting information by questioning and is commonly referred to as a survey method. There are many such methods and the term survey has many meanings but for the purposes of this chapter, survey methods are defined as questionnaires, evaluation forms and structured interviews.

Visual assessment interviews are a long established instrument for data gathering and have been used as early as the 1890's. However, research about the efficacy of the different methods of surveying learners is relatively restrain and in particular, when students are asked to contribute opinions, as is the case in self-reported research studies that examine the validity and reliability of the respondents are. An overview of this chapter indicating the content discussed are illustrated in figure 5.1.

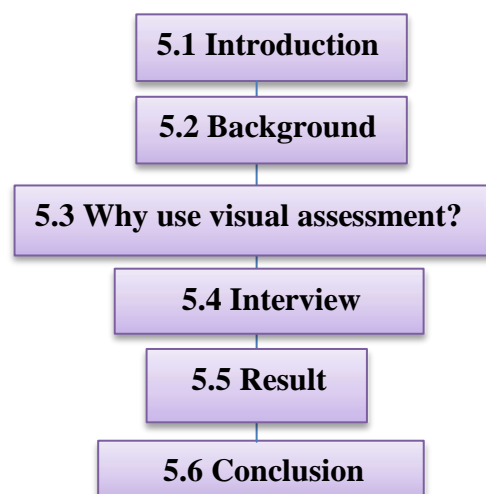


Figure 5.1: Overview of chapter 5 indicating the content discussed

5.2 Background

The aim of this evaluation question form is to evaluate the same 3D character animation used in the previous chapters, using the 3 different animated videos of chemistry experiments involving different variety of movement, realism, kinematic models and biped motions will help us to understand how useful using animation as a tool for learning.

The animated videos of chemistry experiments have been watched by 10 students from year 10 (SK group), and judged out of 20 marks as shown in table 5.1 along with the Spearman's coefficient of rank correlation for statistical evaluation.

The students were asked to watch, mark and give their initial and detailed general impression of using the animations as a tool for learning in their lesson.

Also they were given the opportunity to use the comments section in order to describe the visual observation, and identify the importance of using animation in learning.

The total mark has been set to be out of 20 marks.

Students No	Videos Initial impression		
	Experiment (1)	Experiment (2)	Experiment (3)
1	Reflected the requirement of the experiment.	Showed good modelling and explosion.	Clear reaction.
2	I Prefer to see cartoon figure to represent the character in the experiments to make the animation more appealing.	Each character, in this video showed connection to the event.	Good features and time length

3	It is an advantage to watch this video animation as it showed me the substance react and the consequences after.	Allowed me to be prepared for what I use in this experiment.	Good motivation to learn
4	Good setup	Good safety Reactions from the character	Attractive environment.
5	Simple and clear	Reactions from the character made aware of the danger	It is much more interesting to learn, especially when the animation shows attractive and colourful images flying around your screen instead of solving problems on plain black and white paper.
6	Animation shows how things come together and work together.	realistic models	real explosion
7	I have found that using animated video to do an experiments, is very difficult to inspire me while trying to imagine things like atoms and molecules for example.	Good representation	Character didn't in depth how to be safe using equipment.
8	This interactive animation takes less time to learn complex things.	Very enjoyable to learn difficult things	Close to real life
9	Entertaining and easy	It did offers perfect support for the experiment we doing.	Using this animation is quick to get the instruction and holding my attention.

10	Good inspection for learning especially for a complex experiment.	It easy to repeat these experiments using videos animation as much time as I want without injury occurs.	Plausible and practical to use.
Student No.	Videos General impression		
	Experiment (1)	Experiment (2)	Experiment (3)
1	Very clear facial expression on the characters, which made me interested to watch the video and learn from.	The fire or the explosion didn't reflect real explosion	Need sound effect into the video.
2	The character in video1 didn't show a lot of reaction to the metal reacts with water. Therefore I prefer not to use animated video to learn from.	Clear modelling and texturing. But animation is not for me	The character movement in video2 and his impression was real. Again no learning through animation for me.
3	Lots of details in the videos to make you aware of the chemical danger, animation is the best tools for learning I think.	Need more texturing details to the character.	Clear realism in this video especially it like been done outdoor in real life. This is useful to learn as student.
4	Computer animation also allows instructors to do things that would be extremely hard to do in real life.	The video animations showed good time dependent behaviour.	Taught me some Skills and ability Improvement.
5	After watching these video I found education is a lot easier when information presented via computer animation than normal classroom lesson.	I found using Computer animation it helps in my decision making.	The animation video gave me the abilities to perform my task without any risk.

6	It gave me the idea for preparing my equipment.	Computer animation videos allow me to learn-by-viewing.	I like to use animation in my learning but unfortunately it doesn't take into consideration different levels of knowledge within a group or class.
7	Good to use but it does not reflect all the required information.	The animation didn't give me clear picture about the experiments.	It doesn't solve all enquiries about the animation.
8	It's good to use, but some Teachers cannot help with the animation	Quite liked the layout.	Very useful.
9	I can do the experiment without using this video	I can work fine without using any kind of animation	Useful but not for me.
10	I liked the character walking away from danger	Good texturing.	Short video. Animation is the tool for me.

Table 5.1: Students evaluation

5.3 Why use visual assessment?

The learning Objectives of using this method are highlighted as follows:

- Students will be able to identify the functional difficulties associated with each category of the animation and list their potential initial and general impressions. This has been illustrated in table 5.1.
- They will be able to make general predictions on the presented information.
- They will be able to identify the quality of the animation presented to them and refer to any un-wanted artefacts. This has been obtained from student's feedback.

- They will be able to improve students' observational Skills. The results of this work have reflected this step.
- They will be able to develop good relationships for discussion to broaden their knowledge among themselves and with teacher.

The above evaluation of students impressions were quite useful for assessing the efficiency and re-targetting how useful and important using animation as a learning tool is, although it wasn't enough to solve all queries and couldn't differentiate between student levels of knowledge. For the aesthetic aspects of the animation, a visual evaluation was required.

5.4 Interview

The second part of this evaluation was commenced by performing an interview session with students. The students were asked to view the videos and comment on, if these videos are useful to use as a learning tool, and if it gives them a guidance tool to support their study before performing any chemical experiment in their practical session and presence of visible disadvantages. The aims and objectives, information to be gathered, and what results we would like to achieve was identified before the beginning of the exercise, in addition to enlighten the students with explanation regarding some animation hardware and software to whom did not have the knowledge or have not used animation before. Students were informed about the venue, how the interviews would be conducted via their school emails. Evaluation questions forms shown in table 5.2 were provided to students after viewing the experiments.

Questions	Comments
<p>1. How did the 3D animation for the chemistry reaction videos facilitate your learning?</p> <p>2. What is your perception of using 3D character animation as learning tools?</p> <p>3. Do Animations Make Learning Faster and easier?</p>	<p>1. Videos are relatively short. Maybe required sound to reflect the reactions. Animation is an excellent tool aid to learn.</p> <p>2. Very useful to use although required more realism and face reaction. Learning becomes a lot easier and more Interactive to watch live-actions.</p> <p>3. Made me aware of the any danger, more interaction with the content and can't wait to see the results.</p> <p>4. I would not depend on using this animation for my chemistry work, although I liked the realism showed in the video, therefore animation will not be used as part of my learning process.</p> <p>5. The animation videos help me learn complex things, enjoy the lesson more and motivate me more to learn.</p> <p>6. Small amount of hazardous shown in the first two videos. But Rb video (3) showed quite clear danger and it was very useful to use this animation before applying the real thing in real life.</p> <p>7. Using animation in Chemistry can teach you how chemicals can be used in a productive manner, and what chemical reactions have the potential to do. The three videos demonstrated that although it lacks sound. Animation is tools I use a lot in my learning.</p> <p>8. Watching the videos before performing the experiment gave me a good guide to use the equipment safely and understand the chemical reaction. That is why good animation is required and video 2&3 showed that very well. Animation is good and fast for learning.</p> <p>9. By watching the videos and performing experiments, we can figure out what chemical react to others, how they react, and what can kill you. This animation gave us the chance to communicate with each other and interact more.</p> <p>10. I prefer to have some warning before doing the experiment, watching these videos helped me to understand the reaction of chemical composition on the skin, bones, and muscles. Therefore animation is good aid to learn and memorise the information fast.</p>

Table 5.2: Evaluation questions

5.5 Result

The results of the questioning can be highlighted as follows:

- Motion artefacts such as inadequate fast motion, insufficient emotions reflection etc. were not especially considered during the creation of the animation, but were pointed out as significant factors affecting the total impression from animations.
- Motion used for character based on pre-recorded motion capture did not show major visible signs of any undesired motion acts, penetration or flying of the characters feet with ground and so on.
- In the more detailed analysis section, most of the students noticed that the animation video in experiment (2) rubidium (Rb) with water reaction was a relatively fast motion, with respect of the explosion. While in experiment (1) the reaction did not reflect clearly the dispersion of the sodium with water reaction.

From the above highlighted results a statistical evaluation to the benefits of chemistry and 3D character animation was produce using Spearman's coefficient of rank correlation method to evaluate the need and the importance of using animation to enhance students learning.

The following data shows the gender (Male and Female) of the students with/without knowledge about animation of whom participated in the evaluation and of "how important it was to use animation as an aid for learning", and how this could reflect on their judgment. The judgments are set out of 20 marks for 10 students from SK group and are listed in table 5.3 graph (1).

Boys Judgements	Girls Judgements	Rank 1	Rank 2	d_i	d_i^2
17	19	4	5	-1	1
15	10	2	1	1	1
16	14	3	4	-1	1
11	13	1	3	-2	4
18	12	5	2	3	9

Table 5.3: Students judgment.

The *Spearman's coefficient of rank correlation* calculation took the following steps:

1. From table 5.3 we created the variable scores, their ranks, differences in ranks (d_i) and the differences in ranks squared (d_i^2) were conducted.
2. Add up (sum) the differences in ranks squared (d_i^2).

$$\begin{aligned}\sum d_i^2 &= 1 + 1 + 1 + 4 + 9 \\ &= 16\end{aligned}$$

3. Apply the following formula:

$$\rho = 1 - \frac{6 \sum d_i^2}{n(n^2 - 1)}$$

4. Substitute the above into the formula:

$$\rho = 1 - \frac{6 \times 16}{10(10)^2 - 1}$$

$$\rho = 1 - \frac{96}{990}$$

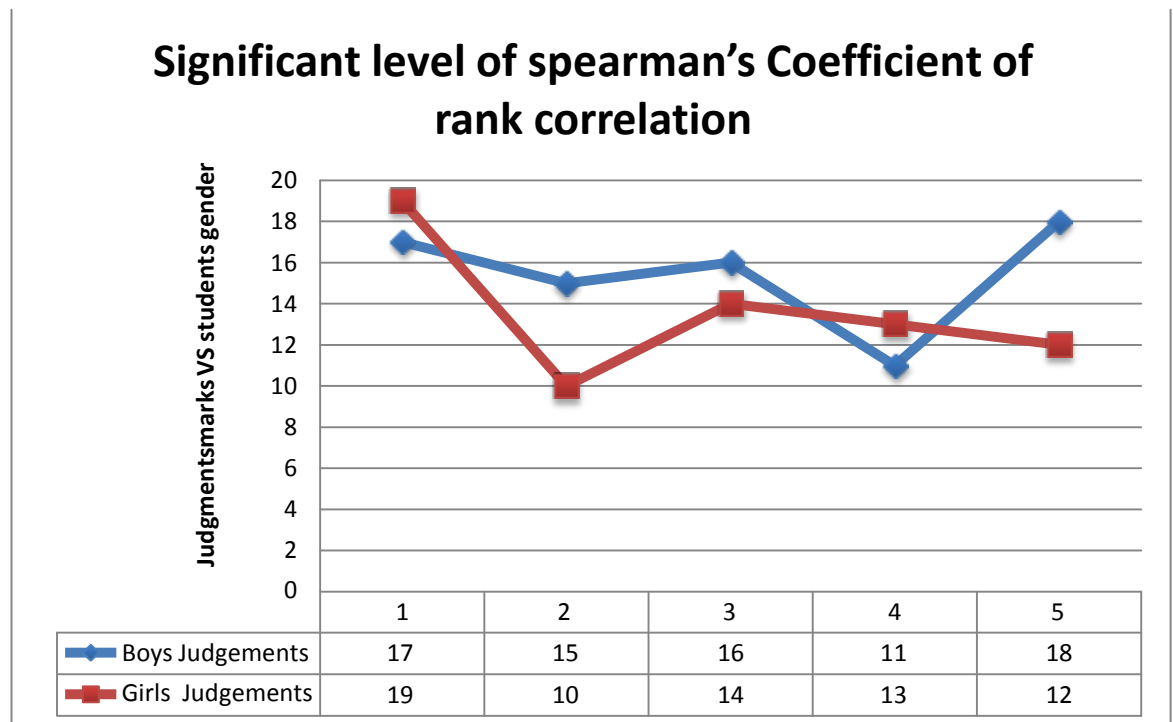
$$\rho = 0.9031$$

Our Null hypothesis statement for this experiment would be:

H_0 : There is no association between gender and judgment marks.

The above calculation indicated that there is a strong positive relationship between the ranks individuals which is found to be $p = 0.9031$, i.e. there is a strong relationship between high score assigned by both genders to show their preferences of using animation as tools to enhance their learning.

The achieved value of $p = 0.9031$ illustrated the significance test to investigating whether we can accept or reject the null hypothesis. If we set $\alpha = 0.05$, achieving a statistically significant Spearman rank-order correlation means that we can be sure that there is less than a 5% chance that the strength of the relationship we found happened by chance if the null hypothesis were true



Graph (1)

5.6 Conclusion

The response of this questioning were incommensurable. Some students were familiar with Computer Graphics (CG) and had the interest for viewing and identifying the importance of animation to enhance learning, while some other students did not know or had very little knowledge about CG and chose not to use animation as an aid for learning and left it unnoticed or did not comment at all. In most cases, some of the students were unable to notice any disadvantages of applying animation as part of their learning, infact we had more encouraging and more enthusiastic feedback to use animation. Other students found some problems using animation such as the videos were fast, and did not reflect the exact information, and limited help from teacher who had little or no experience in computer programming technology.

The results suggest that although the animation did not reflect a major artefact, some motion artefacts need to be addressed, corrected in order to reflect emotion and make it more realistic and indistinguishable from the real one. Other students found that using this type of animation gave them good preparation for their lesson in terms of preparing equipment and taking necessary precautions to limit any risks during the practical sessions, also good source of information for later exam preparation.

The above conclusion gave this work more enthusiasm to investigate and obtain more feedback from students to improve and advance the animation as a learning aid and concentrate more on reducing artefacts, and this will take this work to another set of evaluation to establish more facts regarding the use of animation.

Therefore the use of **SCAT** (Sam's Cognitive Ability Test) T test and Tukey's HSD Post Hoc evaluation techniques accompanied with multiple-choice, instructing the use of Wondershare Quiz Creator was essential for the next chapter to explore.

Chapter 6

Evaluation using T-Test

6.1 Introduction

Further important formats of evaluation have been carried out using different techniques such as the **SCAT** (Sam's Cognitive Ability Test) T test and Tukey's (Honestly Significant Difference) HSD Post Hoc techniques, accompanied with multiple-choice instructing the use of Wondershare **Quiz creator** shown in figure 6.3, 6.4.

The statistical test ***T-Test*** has been used to determine if two sets of data are significantly different from each other, and it can be applied when the test follows a normal distribution. The other techniques can be employed to look at the data after the experiment has concluded hence the meaning of the name **post-hoc analysis** (from Latin *post hoc*, "*after this*"). Or sometimes can be called critics data dredging to evoke the sense that "the more one looks the more likely something will be found".

The standard multiple-choice format has remained relatively unchanged for nearly 100 years, even over the past 25 years as multiple-choice tests have been computerised. We are going to introduce a multiple-choice format test that has the potential to improve a test's measurement along with other advantages. We summarise our research with my Academy students on course-level exams to demonstrate these benefits and to establish the Discrete-Option Multiple-Choice (DOMC) format as not only a viable way to measure skills and content knowledge, but an essential one.

An overview of this chapter indicating the content discussed are illustrated in figure 6.1.

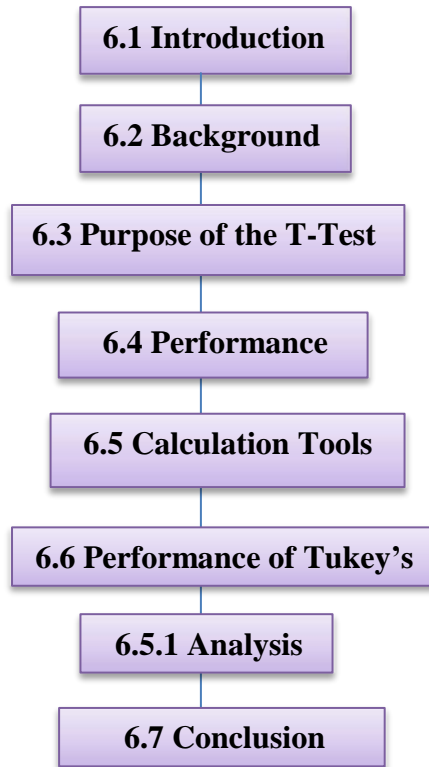


Figure 6.1: Overview of chapter 6 indicating the content discussed

6.2 Background

Tukey's HSD has been employed as a very handy test, to allow us further the research matter even after data has been collected and analysed. Tukey's test also known as the Tukey range test method and Tukey's honest significance test. Which refers to the Latin meaning post hoc, “after this”, consists of looking at the data—after the experiment has concluded for patterns that were not specified a priori or theoretically? This test can be used in conjunction with an ANOVA to find means that are significantly different from each other. The other purpose of Tukey's HSD test is to determine which groups in the sample differ and can clarify which groups among the sample in specific have significant differences.

The independent-measure T-Test allows us to evaluate the mean difference between two populations using the data from two separate samples. Thus, an independent-measures design can be used to test for mean differences between two distinct populations such as gender or between two different treatment conditions. Illustration of this meaning is shown in figure 6.2 below. While with Tukeys' HSD Post Hoc test the prediction is based on the assumption that students will learn most effectively with visual learning as opposed to non-visual at all, description of this theory is in the next section.

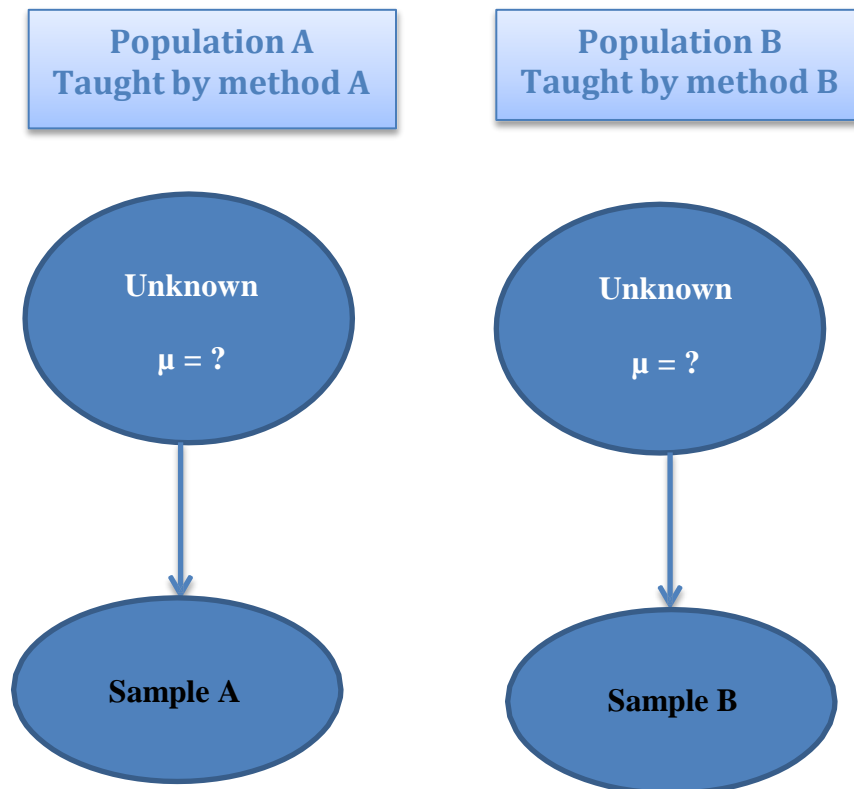


Figure 6.2 illustration T-Test methods

6.3 Purpose of the T-Test

The general purpose of the independent measures T-Test is to determine whether the sample mean difference obtained is a real difference between the two populations or simply the result of sampling error. If two samples are taken from the same population and are given exactly the same treatment, there still will be some difference between the sample means.

Therefore, we have asked the same group i.e. students from group SK Year 10 students mentioned in Chapter 5, sixteen of them who volunteered to help us carry out the T-Test. This time we have decided to use Video 1 (NA with water reaction) and Video 2(K with water reaction) to administer the **SCAT** (Sam's Cognitive Ability Test) to all participants. SAM sample completed a series of cognitive ability tests on visual observation, to establish whether learning is effective, fast, easier and more interactive using animation as part of the selection process for a video animation within a classroom. In this occasion, students completed a numerical reasoning test using multiple choice questions, with aid of **Wondershare Quiz creator** shown in figure 6.3, after watching the videos took place. Students were allowed to attempt the questions 3 times, below Sam's results are summarised in table 6.1.

X	$(X-M_x)^2$	Y	$(Y-M_y)^2$
5	0	7	9
7	4	2	4
5	0	4	0
3	4	6	4
5	0	5	1
3	4	4	0
4	1	2	4
8	9	2	4
$\sum X = 40$	$\sum (X-M_x)^2 = 22$	$\sum Y = 32$	$\sum (Y-M_y)^2 = 26$
$M_x = 5$	$S_x^2 = 3.1428$	$M_y = 4$	$S_y^2 = 3.7142$

Table 6.1: SCAT table

Where M = mean, n = number of scores per group, X, Y = individual scores

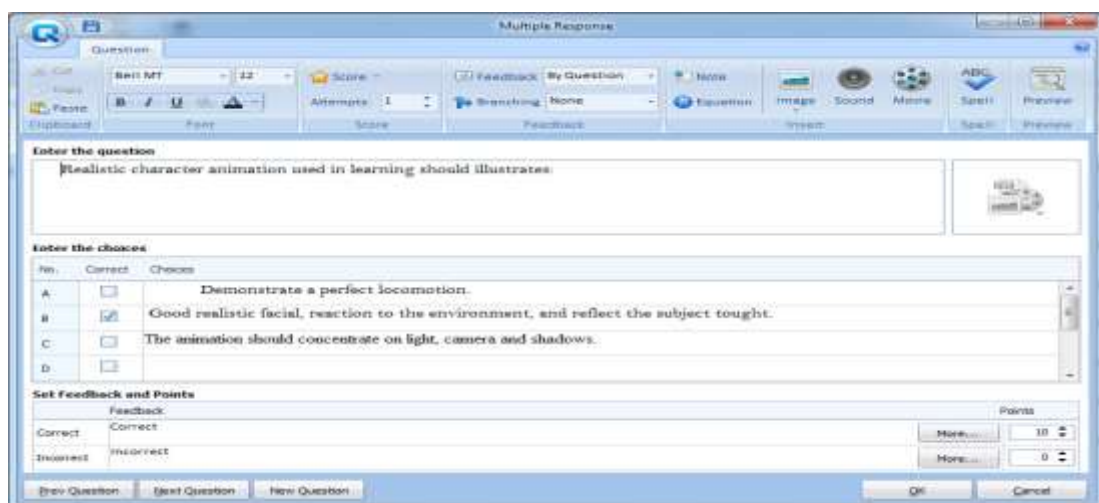
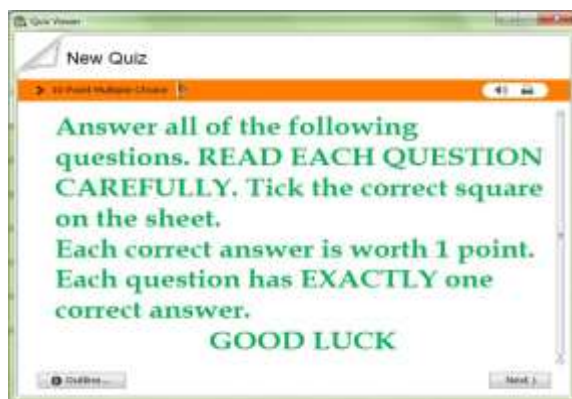


Figure 6.3: Wondershare Quiz (T-Test)

6.4 Performance

The results collected in table 6.1, regarding the numerical reasoning test indicate that we may be able to work effectively with numerical or statistical information of a relatively complex nature, but may need additional time when working with students during their lesson time, or information that is presented in a new format, or that students has no previous experience with animation processes.

6.5 Calculation Tools

The above T-Test measures the ability to make correct decisions or inferences from numerical data. The tasks set and the videos presented are highly relevant to evaluate animation as an aid for learning. Candidates may have many attempts, further to increase the relevance of the context, and choose the answers based on understanding and evaluation rather than solving a problem computationally.

By using the T-Test formula (6.1) we have:

$$S^2 = \frac{\sum (X - M)^2}{n - 1} \quad t = \frac{M_x - M_y}{\sqrt{\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}}} \quad (6.1)$$

Where M = mean, n = number of scores per group, X, Y = individual scores

Apply the results obtained in table (6.1) above into equation (6.1) to calculate t we

$$\text{get: } t = \frac{5 - 4}{\sqrt{\frac{3.1428}{8} + \frac{3.1742}{8}}} \quad t = 1.080$$

$$df = N - 2 \quad df = 16 - 2 \quad df = 14$$

6.6 Performance of Tukey's Test

For this section we have randomly selected 24 students from group KD Year 10 students in a chemistry lesson, and split them into three groups of eight. All students study a passage about the experiments that is going to take place as a practical task for 20 minutes with their teacher, followed by watching the animation videos. Those in Group 1 studied Video 1 with *Sodium (Na) and water* reaction. Those in Group 2 studied Video 2 with *Potassium (K) and water* reaction. Those in Group 3 studied Video 3 with *Rubidium (Rb) and water* reaction. After studying, all students took a 10 point multiple choice questions using **Wondershare Quiz creator** over the material. As shown in figure 6.4.

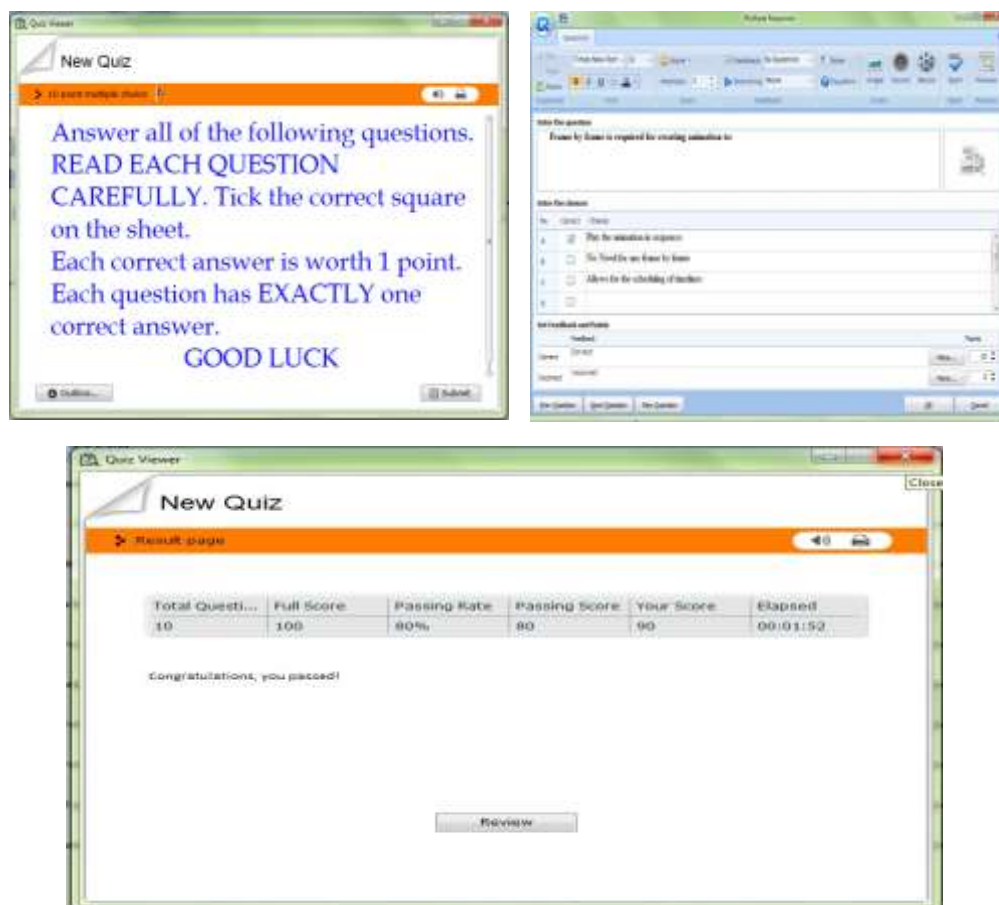


Figure 6.4: Wondershare Quiz

We began by conducting a one-way, between-subjects Analysis of Variance using the equations below. **The one-way Analysis of Variance (ANOVA)** is used with one categorical independent variable and one continuous variable. The *advantages* of carrying out this test is that an experimenter hypothesises that student in groups of three will debate and encourage each other in the discussion more effectively than learning in pairs or individually, also it will make the analysis more accurate. Therefore, as we have 3 groups the analysis goes through two steps:

First, we carry out an over-all F-Test to determine if there are any significant differences existing among any of the means. If this F-Test score is statistically significant, then we carry out a *second* step in which we compare sets of two means at a time in order to determine specifically, where the significance difference lies.

6.6.1 The one-way Analysis of Variance (ANOVA)

Our results might look something like the following:

$$SS_{Total} = \left(\sum X_1^2 + \sum X_2^2 + \sum X_3^2 \right) - \frac{(\sum X_1 + \sum X_2 + \dots + \sum X_r)^2}{N} \quad (1)$$

$$SS_{Among} = \left[\frac{(\sum X_1)^2}{n_1} + \frac{(\sum X_2)^2}{n_2} + \dots \right] - \frac{(\sum X_1 + \sum X_2 + \dots)^2}{N} \quad (2)$$

$$SS_{within} = SS_{total} - SS_{among} \quad (3)$$

$$df_{among} = r - 1 \quad df_{within} = N - r \quad (4)$$

$$MS_{among} = \frac{SS_{among}}{df_{among}} \quad MS_{within} = \frac{SS_{within}}{df_{within}} \quad F = \frac{MS_{among}}{MS_{within}} \quad (5)$$

X= individual observation

r = number of groups

N = total number of observations (all groups)

n = number of observations in group

We found that according to the F sig/probability table shown in appendix (9) with $df = (2, 21)$. F score was 3.4668 is statistically significant on the probability table with *degrees of freedom* and $p < .05$ demonstrated in table (6.2, 6.3 and 6.4):

Group of Students	Multiple-Choice scores							
Video1 with Sodium (NA) and water reaction	9	7	6	5	7	3	4	7
Video2 with Potassium (K) and water reaction	6	5	4	5	3	5	2	2
Video 3 with Rubidium (Rb) and water reaction	7	5	1	1	2	4	5	2

Table 6.2: Results test of the one-way Analysis of Variance (ANOVA)

X_1	X_1^2	X_2	X_2^2	X_3	X_3^2
9	81	8	64	9	81
8	64	9	81	6	36
7	49	9	81	8	64
8	64	10	100	6	36
9	81	7	49	7	49
10	100	7	49	10	100
9	81	6	16	9	81
8	64	9	16	8	64
$\sum X_1 = 68$	$\sum X_1^2 = 584$	$\sum X_2 = 65$	$\sum X_2^2 = 148$	$\sum X_3 = 63$	$\sum X_3^2 = 511$
$(\sum X_1)^2 = 4624$		$(\sum X_2)^2 = 4225$		$(\sum X_3)^2 = 3969$	
$M_1 = 8.5$		$M_2 = 8.125$		$M_3 = 7.875$	

Table 6.3: Results test of the one-way Analysis of Variance (ANOVA)

Source	SS	df	MS	F
Among	1.58	2	0.791	0.494
Within	33.75	21	1.60	

Table 6.4: Results test of the one-way Analysis of Variance (ANOVA)

$$\begin{aligned}
 SS_{\text{total}} &= (548 + 541 + 511) - \frac{(68 + 65 + 63)^2}{24} \\
 &= 1636 - 1600.66 \\
 \therefore SS_{\text{total}} &= 35.33
 \end{aligned}$$

$$\begin{aligned}
 SS_{\text{among}} &= \left[\frac{4624}{8} + \frac{4225}{8} + \frac{3969}{8} \right] - 1600.66 \\
 SS_{\text{among}} &= 1.58
 \end{aligned}$$

$$SS_{\text{within}} = 35.33 - 1.58 = 33.75$$

The relevant variables from ANOVA table are:

$$M = \frac{M_1 - M_2}{\sqrt{MS_{\text{within}} \left(\frac{1}{n} \right)}}$$

Where M = treatment/group mean

n = number per treatment/group

From table 4 we have:

$$MS_{\text{within}} = 1.60, M_1 = 8.5, M_2 = 8.125, M_3 = 7.875, df_{\text{within}} = 21, n = 8.$$

$$M_1 \text{ vs } M_2 = \frac{M_1 - M_2}{\sqrt{MS_{\text{within}} \left(\frac{1}{n} \right)}}$$

$$\text{Tukey's HSD (q)} = 0.8385$$

$$M_1 \text{ vs } M_3 = \frac{M_1 - M_3}{0.447} = 1.398$$

$$\text{Tukey's HSD (q)} = 1.398$$

$$M_2 \text{ vs } M_3 = \frac{M_2 - M_3}{0.447} = 0.559$$

Therefore the **Tukey's HSD (q) = 0.5590**

6.7 Conclusion

According to the Tukey's sig/probability table with degree of freedom $df = 14$, t must be at least 2.145 to reach $p < .05$, so this difference is **not** statistically significant. Therefore, we can conclude that this T-Test hypothesis was not confirmed, as did not find a significant difference between those who commented on Video 1 and Video 2 on cognitive test performance. The crucial value for t test is shown in Appendix (8).

According to the Tukey's sig/probability table, taking into account ($df_{\text{within}} = 21$ and treatments = 3), the mean comparison between means 1 and 3 is statistically significant, but not the other comparisons.

Our hypothesis was only partially supported by those who studied Video 1 and they performed significantly better on the test than those who studied Video 2, but they did not perform significantly better than those who studied Video 3.

From the above test we can summarise this evaluation that students did show their interest of using the video animation provided to them and how useful practising with animation before applying the actual practical test and made them realise that the danger of any chemical reaction is before put to practice, also what a good source of information for exams preparation. That gave this work the encouragement to move forward and use **social media browsing** so the students can participate, investigate and evaluate the usefulness of animations using new forms of representations which will be carried out in the next chapter.

Chapter 7

Comparing the enhancement and effectiveness' of 3D character animated videos (A, B, C) using social media browsing

7.1 Introduction

Flickr is one of the products of new “social media” sites, along with blogs, wikis and their group, that are transforming the Web to a participatory medium where the users are actively creating, evaluating and distributing information. Flickr’s interface is exceedingly simple. A user can upload images and videos to Flickr or view and comment on other users’ content. A user can annotate with tags, comments or submit it to a variety of special interest groups. Like many other social media sites. Flickr also allows users to designate others as “friends” or “contacts” and offers an interface to see in one place the latest information submitted by these friends. The friends’ lists form the social network for example yahoo backbone of Flickr. This section examines how people use Flickr: specifically, how they find new information to view. We claim that the social networks on Flickr facilitate new ways of interacting with information what we call social browsing. Rather than searching for images by keywords (tags) or subscribing to special interests groups, users can browse through the images and videos created by the presenter they had selected as being most interesting or relevant to them.

An overview of this chapter indicating the content discussed are illustrated in figure 7.1.

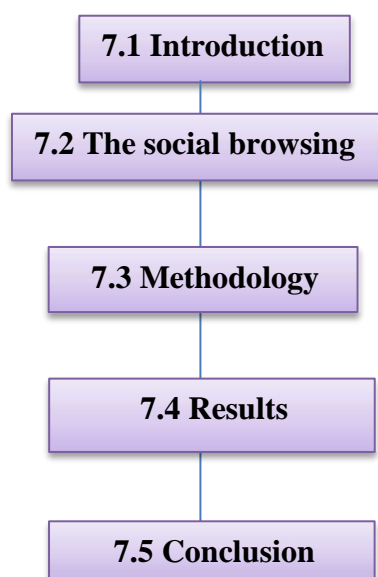


Figure 7.1: Overview of chapter 7 indicating the content discussed

7.2 The social browsing

How do students find new information on Flickr: Do they find them through groups, or by searching tags? Do they find them by browsing through the photo streams of their contacts? We believe that the latter effect, what we call social browsing, explains much of the activity generated by new images on Flickr. In the next section we will present a detailed study of the videos published on Flickr for the science student's figure 7.2, to explore the sets that help us evaluates the use of animation in learning.

7.3 Methodology

We are interested in comparing the effectiveness of 3D animated chemistry experiments created in 3DS max, to investigate and evaluate the usefulness and how animations influence learning as new forms of representations. For the

purpose of simplicity, we denote the three animated chemistry experiments videos (Rubidium (Rb) and water, Sodium (Na) and water, and Potassium (K) and water reaction) A, B, and C respectively. The data has been collected on a random sample of 18 science classes JLA school student's age between 14 to 17 years old, boys and girls, to view the animated videos which it has have been published on Flickr.com with introduction to the purpose of the videos, and simple guide to explain the requirement after viewing the videos such as entering age, score out of 80%, and a choice of the preferred video, to help us collecting our data.

The purpose of the study was to determine if the use of animation as learning tools depends on the variables: age, score, or personal choice based decision making or understanding to animation. This data refers to study based on how 3D character animation videos used as a learning aid is related to a number of explanatory variables. To model this, we have fitted a simple statistic, linear regression model to the 3D character animation. This is done by using (score) as an explanatory variable, but we may be able to refine the model by incorporating more explanatory variables such as: age, choice of video and score. It seems plausible that some of these variables play important roles in the determination of the animation used and the decision making. Table 7.1, and figure 7.2, shows some of the data obtained on 3D character animation from flickr.com.

7.4 Results

Sample data:

A samples of 3D Chemistry experiment animated videos designed using 3DS max.

Variable definitions:

- Response (y): a measure of 3D character animation video (how effective to convey the understanding of the subject using the video). Therefore the higher the *score*, the better indication that animation is a useful tool for learning.
- Potential predictor (x_1): *age* (in years) of the individual student.
- Potential predictor (x_2): 1 if student **choose** video A and 0, if student did not.
- Potential predictor (x_3): 1 if student **choose** video B and 0, if otherwise.

	X_2	X_3
A	1	0
B	0	1
C	0	0

We can apply these variables in our calculation, table 7.1 below will list the data transformation collected, and will be used to calculate the Linear Regression Equation (Y),

	Score y	Age x ₁	x ₂	x ₃	Video Choice
1	56	14	0	0	C
2	60	15	0	1	B
3	75	16	0	1	B
4	74	15	0	0	C
5	55	14	1	0	A
6	60	14	0	0	C
7	70	17	0	1	B
8	65	15	0	0	C
9	65	15	0	0	C
10	65	15	0	0	C
11	58	16	1	0	B
12	75	15	0	0	C
13	66	14	0	0	C
14	54	14	0	1	A
15	69	14	1	0	A
16	74	15	0	0	C
17	70	14	0	0	C
18	65	16	0	0	C
	Mean: 65.16	Mean: 14.94			

Students age between 14 to 17 years old boys and girls.
Score out of 80%

Table 7.1: 3D character animation usage data

Using table 7.1 above we can calculate the Linear Regression Equation (Y), the data transformation as shown in table 7.1A, 7.1B and a scatter plot of the data are shown in chart (7.1) and (7.2).

Diagnostic for Data Transformation					
R-Square	0.647	F-statistic	1.75	Mean (Y)	65.16
Mean (X1)	14.94	Variance	47.23	Variance(Y)	49.32
Mean : the first half	1.33	Mean of second half	-0.737	Its standard Error	1.77
Variance: the first half	32.46	Variance: of the second half	52.48	Its standard Error	26.61
First order serial correlation	0.0292	Second order serial correlation	-0.560	Its standard Error	0.23
Durbin-Watson statistic	1.86	Mean absolute errors	5.62	Its P-value	0.20
Correlation	0.314	Slope	2.35	intercept	30

Table 7.1A: data transformation

	Score	Age			
	y	x ₁	xy	x ²	y ²
	56	14	784	196	3136
	60	15	900	225	3600
	75	16	1200	256	5625
	74	15	1110	225	5476
	55	14	770	196	3025
	60	14	840	196	3600
	70	17	1190	289	4900
	65	15	975	225	4225
	65	15	975	225	4225
	65	15	975	225	4225
	58	16	928	256	3364
	75	15	1125	225	5625
	66	14	924	196	4356
	54	14	756	196	2916
	69	14	966	196	4761
	74	15	1110	225	5476
SUM	1041	238	15528	3552	68535
SQ SUM	1083681	56644		12616704	

Table 7.1B: data transformation.

Linear Regression Equation (Y):

$$Y = a + b_1X_1 + b_2X_2 + \dots + b_nX_n$$

Where,

a is the Y intercept point = 30

b₁, b₂, ... , b_n - Slope of X₁, X₂, ... , X_n respectively

The Fitted Model is: $Y = 30 + (2.305) X_1 + (2.35) X_2 + (2.35) X_3$

The variance can be calculated using:

$$variance S^2 = \sum \left[\frac{(x - mean)^2}{n - 1} \right]$$

Calculating the Correlation Coefficient

$$r = \frac{\sum (X - \bar{X})(y - \bar{y})}{\sqrt{[\sum (X - \bar{X})^2][\sum (y - \bar{y})^2]}}$$

Or

$$r = \frac{n \sum (xy) - \sum x \sum y}{\sqrt{[n \sum X^2 - (\sum X)^2][n \sum y^2 - (\sum y)^2]}}$$

Where r = sample correlation coefficient

n = Samples size

x = Value of the independent variable

y = Value of the dependent variable

This is to check if there is evidence of a linear relationship between animation and effectiveness at the .05 level of significance?

So the Hypotheses will be:

Hypotheses $H_0: \rho = 0$ (no correlation)

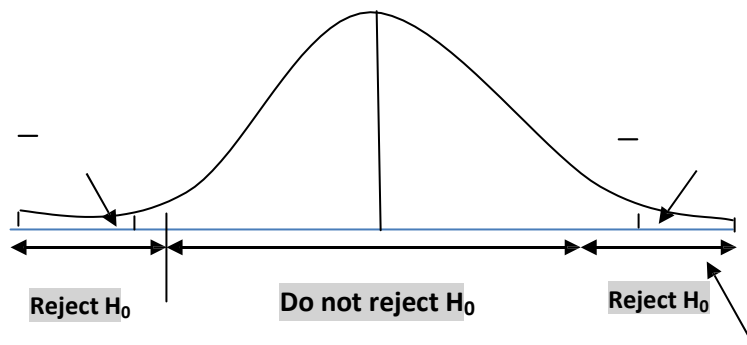
$H_A: \rho \neq 0$ (correlation exists)

Test statistic:

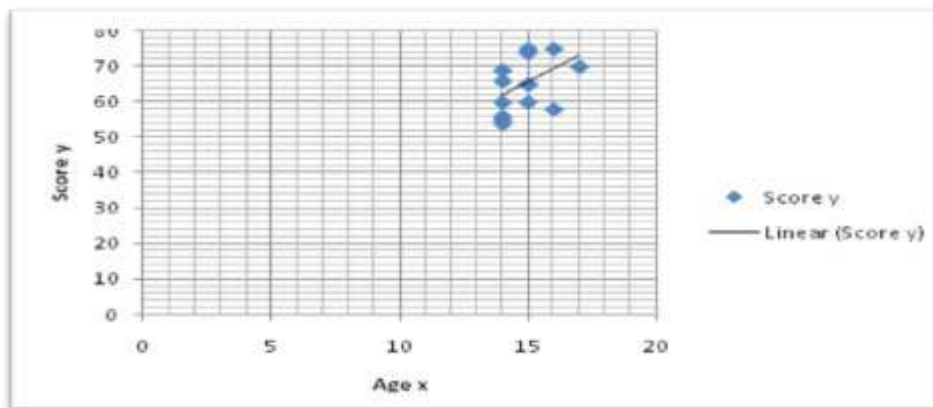
$$t = \frac{r}{\sqrt{\frac{1 - r^2}{n - 2}}} \quad (\text{With } n - 2 \text{ degrees of freedom})$$

$$t = 21.21$$

$$d.f. = n - 2 \Rightarrow 18 - 2 = 16$$



Decision: Reject H_0
Conclusion: There is evidence of a linear relationship at the 5% level of significance.



A scatter chart (7.1) Plot of the data with the scores on the y-axis and age on the x-axis

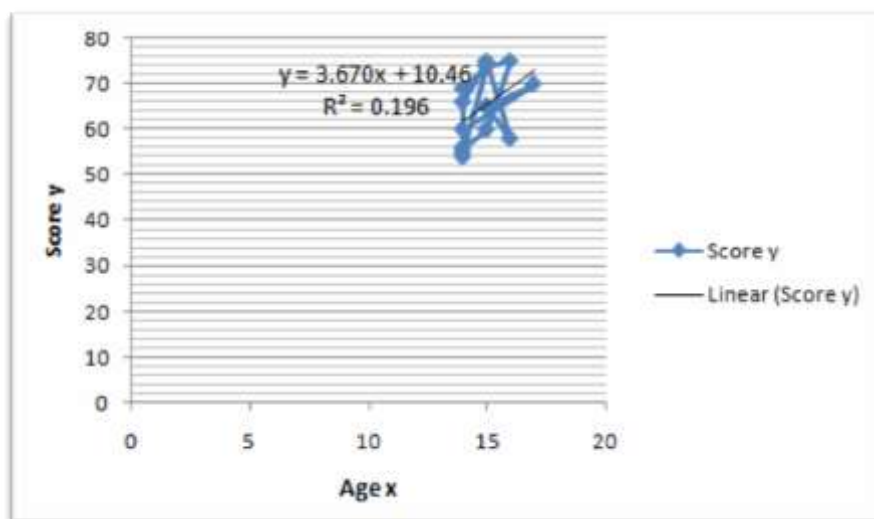


Chart (7.2) the slopes of the lines for the three videos

Non-parallel functions are the defining characteristic of plots of estimated models that contain interaction terms. We can note from chart (7.2), the estimated lines are *not* parallel and therefore we can conclude that the two variables age and score interact and correlate.

The results suggest that:

- The P -value for the t-test (21.21) estimates suggest that all of the slope parameters ($P < 0.001$) are significantly different from 0 i.e. 3.5272. See the crucial value table Appendix 10.
- 16% of the students preferred to use video A, 22% preferred Video B, and 61% preferred Video C.
- 39% students aged 15 had chosen video C, while 33% of students aged 14 chose Video B.
- 23% of the highest score (75-70%) was obtained from age 15 years.
16% of score (60-69) was obtained from age 14.
11% of score (58-56) was obtained from age 14.
One student of age 16, and 17 scored 70 and 75 respectively.

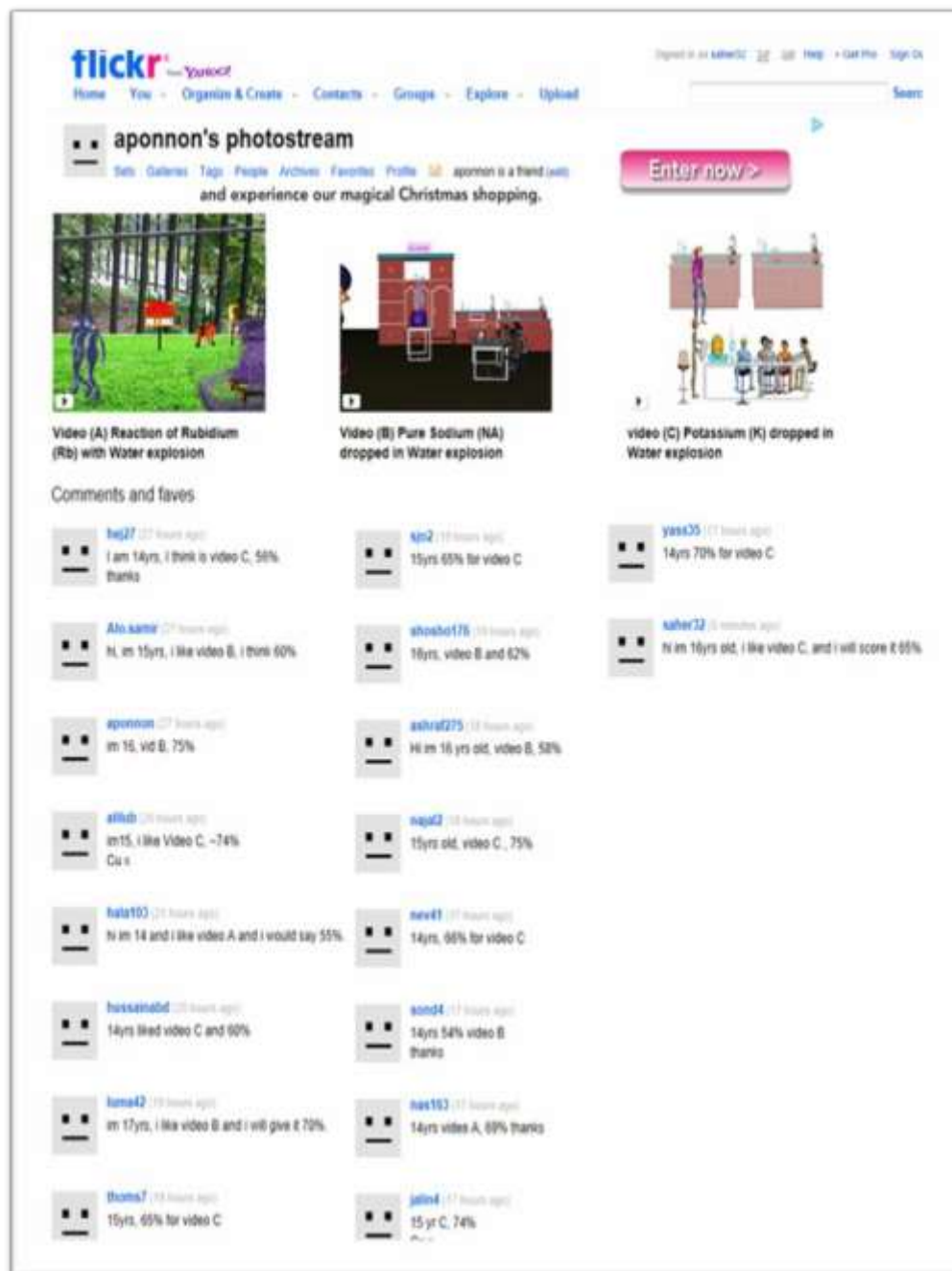


Figure7.2: Data obtained on 3D character animation from flickr.com.

7.4 Conclusion

This study was chosen as an objective to determine whether there are significant relationships between or amongst 3D character animation presented in AVI video creation to enhance learning and a number of independent variables. In terms of the statistical analysis, ANOVA, linear regressions were deemed to be the appropriate methodologies for testing the hypotheses of the study. The advantage of this method is to allow one to be able to include more than one independent variable in the model at the same time in order to determine the effect of each variable or to control for specific variables S. Perugini, 2004 [15]. According to that when the variables have been included in the ANOVA model, the results would indicate whether an individual or several independent variables contribute to the explanation in the variation of the dependent variable, therefore, if the variable was found to be significant then it could be concluded that the variable significantly contributes to the explanation in the variation of the dependent variable K.Lerman, 2007 [16].

The significance of the test is based on an F-statistic that is from the F-distribution Keuhl, 2000[17]. Therefore, if F-statistic exceeds this critical value then one would be able to conclude that there is a relationship between the independent and dependent variables. In our case this is true as $F\text{-statistic} = 1.75$.

The linear regression at the 0.05 significance level is sufficient evidence to reject the null hypothesis.

The score, age and choice of video are important factors in the evaluation of the quality, especially the video which was provided with instruction. Many students preferred to study their practical work with aid of using 3D character animation

prior to experiment with real things. This has indicated to us that the realism, colour, environment, texture and story board and information provided in the animation are more than adequate for students to be accepted, and understand the 3D animated experiment videos to be used as learning tools as those factors played an important role on the learning environment.

The metric for approximating subjective evaluation of 3D character animation was desirable useful method to evaluate the animation, and found to fit closely to subjective ratings by students observers based on preliminary experimental results. Therefore, the age and score showed to be interacted or correlated.

The use of social media browsing has encouraged this work to create and introduce different kind of animations techniques, and to involve multimedia technology to produce narrative story animations, games, quizzes and many more in order to display, interact, attract and convey useful education information through animation use. This will direct the way for students to learn and use animation in multimedia application and advance current technology devices in the next chapter.

Chapter 8

Multimedia Animation and Learning

8.1 Introduction

One of the most important keys that education technology development has made available is new forms of representations, such as animation, multimedia, and virtual reality. Each new representation is initially greeted with enthusiasm and then, as research on how it impacts the processes and outcomes of learning produces mixed results, this enthusiasm wanes.

In this chapter, I will apply a broad definition of animation used by Bétrancourt & Tversky 2001[18], animation is considered to be a “series of frames so each frame appears as an alternation of the previous one”, in time or represent invisible processes such as the movement of molecules, algorithm animation which has been included in educational technologies with increasing frequency since the early 1980s. Their availability and sophistication continues to grow as software for their creation and hardware for their implementation develops.

Therefore, in this work we have took the approach of multimedia technology to utilise the animation when there is a need to show learners something not easily seen in the real world, such the movement of atoms in a gas chemical animation e.g., Hydrogen bonding showed in Figure 8.2, or the shifting movements of the continents Geological Animation (as animated in Sangin, Molinari, Dillenbourg, Rebetez, & Bétrancourt, 2006 [19], see Figure 8.2.

One of the reasons animations are now found so widely is that many people believe that animations can help students to understand complex ideas more easily

in an interactive and interesting way. However, the reasons that are cited for this beneficial effect tend to vary considerably. Rieber, 1991[20] believed that animations can help students learn because they are especially motivating. Alternatively, others believe there are specific computational properties of animations that match the cognitive demands of a learning task Tversky et al., 2002 [21]. However, other people view animations with much more suspicion and recommend limiting the use of animations. Often they tend to cite the difficulties that students can have in processing animation or in applying appropriate strategies e.g., Lowe, 2003[22]. Consequently, it is not surprising that research addressing whether animation aids students' understanding of dynamic phenomena has produced a positive impact, Kaiser, Profit, Whelan & Hecht, 1992; Rieber, 1991[20], negative Rieber, 1990 [23]; Schnotz, Böckheler & Grzondziel, 1999[24], and neutral results Price, 2002 [25]. Research on animation has varied a wide range of factors, such as outcome measures, participant populations and research environment Price, 2002[25] and of course, one reason for this variety of results is that animation is a general term that refers to very different forms of representation. There is relatively little in common between Geological Animation, Chemical animation, an Algorithm animation and an animation of the Cardiovascular system presented as an animated Quiz activity will be presented later on in this work which has been designed for the purpose of this work. Even within more traditional uses of animation, the display of dynamic physical processes - there are many ways that animations can be implemented. For example, Lowe 2003[22] identifies three variants of animation: *transformations*, in which the properties of objects such as size, shape and colour alter; *translation*,

in which objects move from one location to another; and *transitions*, in which objects disappear or appear. Ainsworth and Van Labeke 2004[26], argue that animations are a specific form of dynamic representation and that the term animation should not be used to refer to all forms of dynamic representation.

An overview of this chapter indicating the content discussed are illustrated in figure 8.1.

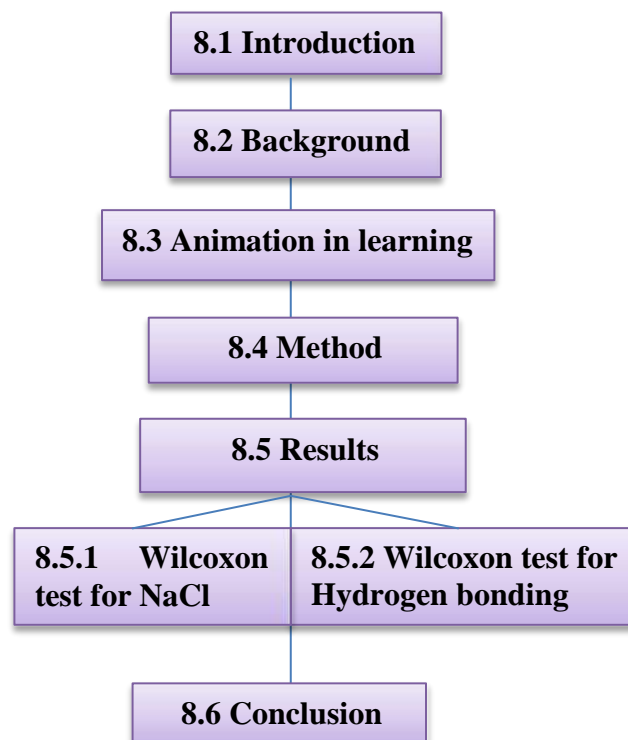


Figure 8.1: Overview of chapter 8 indicating the content discussed

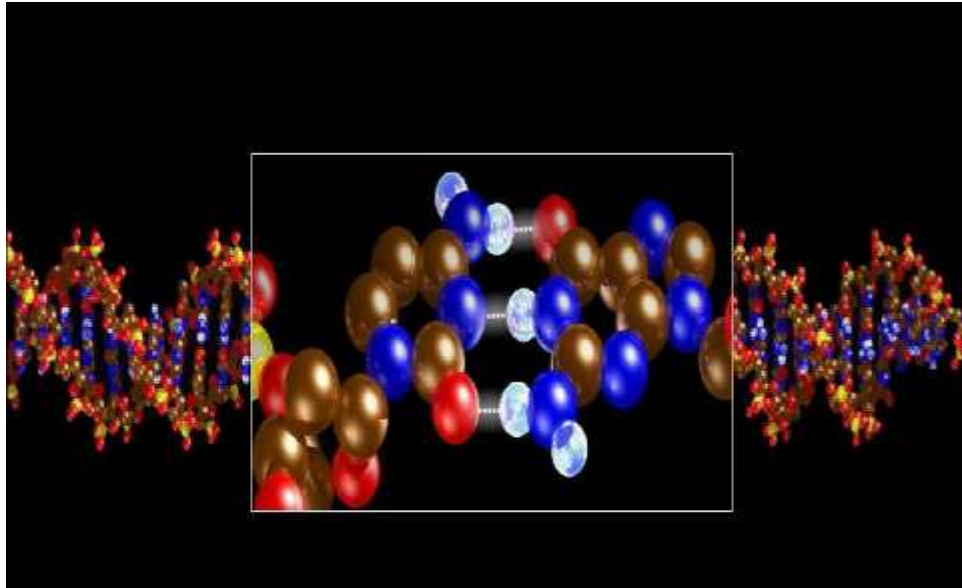


Figure 8.2 Chemical Animation e.g. of Hydrogen bonding

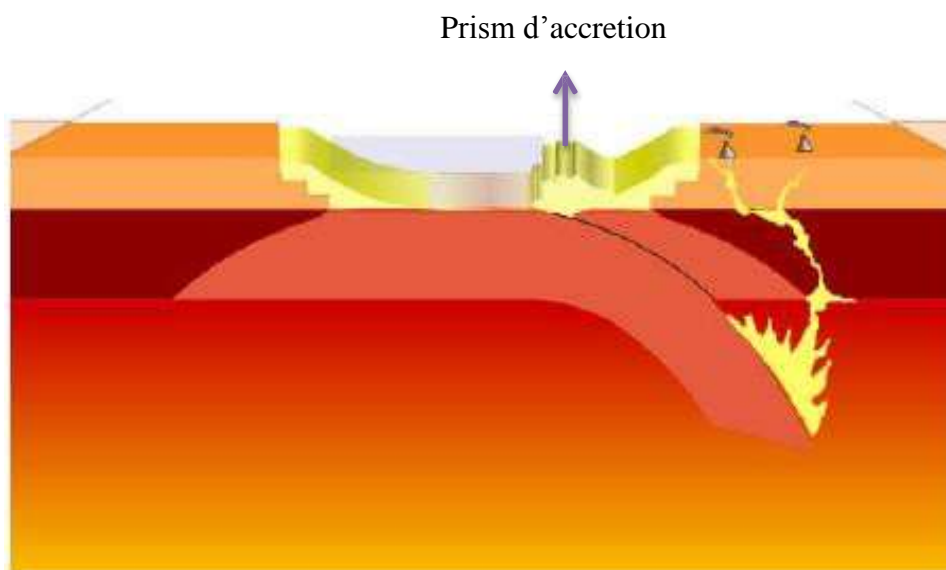


Figure 8.3 Geological Animation e.g. the shifting movements of the continents (as animated in Sangin, Molinari, Dillenbourg, Rebetez, & Bétrancourt, 2006).

8.2 Background

In this chapter I will introduce the Multimedia Animation (MM) approach as a beneficial tool for learning especially when the learning material demands visual movements. A number of animations consist of a chemistry experiments sample which has been created in Adobe Design Multimedia Flash CS6, to give a basic outline of using animation production as a guiding tool to help students understand their topic more effectively and interactively thus creating enjoyment. The target of choosing multimedia and animation is to allow students to gain knowledge and expertise in multimedia, graphics, film, broadcast and web media. The concept of this animation is to demonstrate a chemical reaction between Sodium (Na) and chloride (Cl), in a comical way, to convey the information required about the atomic structure and ionic bonding through the use of animation, and how sodium and chloride react with each other to produce the most useable item in our everyday use i.e. salt.

While the other animation concentrated on shining the light on how a slight positive charge of a hydrogen atom in a water molecule can attract an atom with a slight negative charge, such as the nitrogen in a molecule of ammonia. This forms a hydrogen bond between the two atoms. Clear basic instruction of why and how to use the animation had been given to students prior to performing the experiments. The instruction to use animation is illustrated in Appendix (11).

8.3 Animation in Learning

Animated pictures are used in multimedia environments to represent the dynamic aspects of complex subject matters in an explicit way Lowe, 2003[22]. Animations have two different positive functions in learning. *First*, they enable learners to perform more cognitive processing (enabling function) by providing them with additional information that cannot be displayed by static pictures. *Second*, they help students to build a dynamic mental representation by giving them an external support for simulating the behaviour of the system depicted. There have been many literatures on the use of animations in computer science related subjects in the past years. The intuition of computer scientists has led many to believe that animations must provide a learning benefit, but prior experimental studies dating back to the early 90s have provided mixed results.

8.4 Method

Participants were Year 10 science class, 20 students have been voluntarily chosen to answer questions about Sodium and chloride reaction and Hydrogen Bonding sample questions, using these animation samples which have been created in Adobe Flash CS6 to represent chemistry experiments shown in figure 8.4, and 8.5 below. A Question Format for both of the animation experiment samples are presented in Appendix (11A and 11B). A snippet of the ActionScript code to represent this animation is shown in Appendix (11D and 11E).

The scores for the questions were out of 100 points given to evaluate the story board and animation quality. This was then evaluated with aid of using **Wilcoxon test** statistical method and scores were collected.

The numbers of animation samples have been used for the purpose of determining if, in fact, improved learning actually occurred and which version of the animation produced the better outcome.



Figure 8.4: Sodium(Na) and chloride reaction sample animation

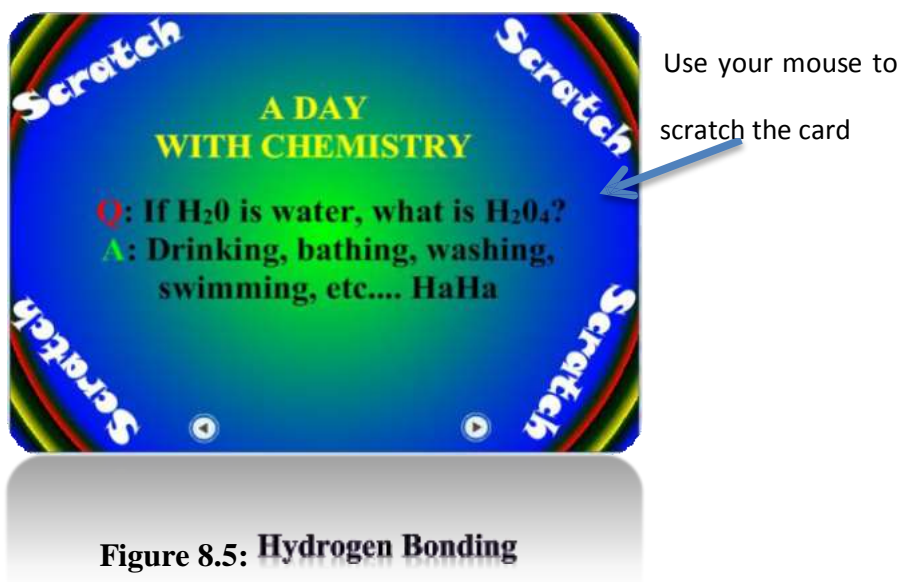


Figure 8.5: Hydrogen Bonding

8.5 Results

8.5.1 Wilcoxon test evaluation for Sodium (Na) and chloride (Cl) experiment

In order to evaluate the scores obtained from the students Wilcoxon test have been used on both animation samples. Below we show step by step explanations to this test. The **Wilcoxon signed-rank test** is a non-parametric statistical hypothesis test used when comparing two related samples, matched samples, or repeated measurements on a sample to assess whether their population mean ranks differ (i.e. it is a paired difference test).

The students' scores are presented in table 8.1.

Participants	Story Board	Quality	Difference (d)	Ranked difference
1	42	45	-3	9
2	40	40	0	ignore
3	38	40	-2	4
4	36	38	-2	4
5	40	47	-7	15.5
6	34	36	-2	4
7	46	48	-2	4
8	37	39	-2	4
9	30	45	-15	19
10	45	38	7	15.5
11	43	44	-2	4
12	34	42	-8	17
13	36	38	-2	4
14	31	35	-4	5.75
15	41	46	-5	13.5
16	33	37	-4	5.75
17	43	47	-3	9
18	30	39	-9	18
19	35	40	-5	13.5
20	45	48	-3	9
Median	37	40		

Table 8.1 Wilcoxon test students' scores.

(a) From the above results, we can calculate difference between each pair of scores.

(b) Rank these differences, ignoring any "0" differences and ignoring the sign of the difference (i.e. whether it is a positive or negative difference).

Ranking the differences has been calculated as follow:

Give the lowest rank to the smallest difference-score, ignoring whether it's a positive or negative difference. We note that there are two or more difference-scores which are the same; this is referring to a "tie" in our data:

Tied scores needs to:

- Get the average of the ranks that those scores would have obtained, had they been different from each other.
- Ignore the sign of the difference,

The lowest difference is -2 . The average of the ranks is 28 therefore, the average rank is $28/7 = 4$. This will be allocated to all of these scores.

- The next lowest difference-score is -3 , and ranked as 8, 9, and 10 add them up as the above to get the average rank to be 9

The same procedure has been followed to carry on to the last rank.

(c) Add together the ranks belonging to scores with a positive sign:

$$= 15.5.$$

(d) Add together the ranks belonging to scores with a negative sign:

$$= 163$$

(e) Whichever of these sums is smaller, is going to be our value of W. So,

$$W = 15.5.$$

(f) N is the number of differences (omitting “0” differences). We have $20 - 1 = 19$ differences. In our case we will only use N-1 as we have one difference which equals zero.

(g) By using the table of critical Wilcoxon values as shown in a shaded box in appendix (11C) With an N of 19, the critical value for a two-tailed test at the 0.05 significance level is 46.

With the Wilcoxon test, an obtained W is significant if it is LESS than or EQUAL to the critical value.

Our obtained value of 15.5 is smaller than 19, and so we can conclude that there is a significant difference between the scores obtained for the story board and the scores obtained for the quality.

8.5.2 Wilcoxon test for Hydrogen bonding experiment

The same procedure has been followed on the second animation where the same participants, used the question formatted presented in appendix (11B) to give their scores. The results are illustrated in table 8.2 as follow:

Participants	Story Board	Quality	Difference (d)	Ranked difference
1	40	42	-2	5.5
2	40	43	-3	8
3	38	40	-2	5.5
4	33	32	0	ignore
5	36	47	-11	18
6	38	39	-1	2.5
7	46	45	1	2.5
8	37	40	3	8
9	34	42	-8	16
10	45	41	4	11.5
11	43	47	-4	11.5
12	34	44	-10	17
13	36	33	3	8
14	31	32	-1	2.5
15	41	47	-6	15

16	33	37	-4	11.5
17	43	47	-4	11.5
18	30	42	-12	19
19	36	41	-5	14
20	46	45	-1	2.5
Median	37	42		

Table 8.2: The Hydrogen bonding experiment.

This has been carried out by giving the lowest rank to the smallest difference-score, ignoring whether it's a positive or negative difference. We note that there are two or more difference-scores which are the same; this is referring to a "tie" in our data:

Tied scores need to:

- Get the average of the ranks that those scores would have obtained, had they been different from each other.
- Ignore the sign of the difference,

The lowest difference is -1 . The average of the ranks is 10 therefore the average rank is $10/4 = 2.5$. This will be allocated to all of these scores.

The next lowest difference-score is -2 , and ranked as 5, 6, add them up as the above to get the average rank to be 5.5

The same procedure has been followed to carry on to the last rank.

(c) Add together the ranks belonging to scores with a positive sign:

$$2.5+8+11.5+8 = 30$$

(d) Add together the ranks belonging to scores with a negative sign:

$$5.5+8+5.5+18+2.5+16+11.5+17+2.5+15+11.5+11.5+19+14+2.5 = 160$$

(e) Whichever of these sums is the smaller, is our value of W. So, $W = 30$.

(f) N is the number of differences (omitting “0” differences). We have $20 - 1 = 19$ differences. In our case we will only use N-1 as we have one difference which equals zero.

(g) By using the table of critical Wilcoxon values as shown in a shaded box in appendix (11C) With an N of 19, the critical value for a two-tailed test at the 0.05 significance level is 46.

With the Wilcoxon test, an obtained W is significant if it is LESS than or EQUAL to the critical value.

Our obtained value of 30 is larger than 19, and so we can conclude that there is no significant difference between the scores obtained for the story board and the scores obtained for the quality.

We would write this as follows.

"A Wilcoxon test showed that the scored points for the story board was not significantly represented with the quality of the animation as a whole unit, ($W(19) = 30, p > .05$, two tailed test)."

This was a two-tailed test, because we were merely predicting that there would be some kind of unclear representation between the story board and the quality of the animation. Had we been able to make a more specific prediction *in advance of collecting the data*, e.g. that the story board will not give a clear picture about the topic studied in the animation through the quality of the video produced, i.e. the topic will not fully be understood by students using this kind of animation or clearly witnessing the hydrogen bonding through animation, then we could have used another measure such as ***directional*** or a ***one-tailed test***. This is more likely to be statistically significant, but only if the difference goes in the predicted

direction. From the table presented in Appendix (11C) we can detect that the value of N at 19, a value of 46 for our obtained W would be significant at the .05 level for a two-tailed test, but at the .05 level for a one tailed test are 53.

8.6 Conclusion

- We can conclude that a Wilcoxon test showed the scored points for the story board of the sodium (Na) and chloride (Cl) experiment was significantly represented with the quality of the animation as a whole unit, (W (19) = 46, $p > .05$, two tailed test)."

This was a two-tailed test, because we were merely predicting that there would be some kind of different interpretation between the story board and the quality of the animation. Had we been able to make a more specific prediction *in advance of collecting the data*, e.g. that the story board will not give 100% full clear picture about the topic studied in the animation through the quality of the video produced, in addition things can be seen such as molecule reactions through animation and not through eye sight, therefore, another measure which was needed to be used was ***directional*** or a ***one-tailed test***. This is more likely to be statistically significant, but only if the difference goes in the predicted direction. From table 8.1, we can detect that the value of N at 19, a value of 46 for our obtained W would be significant at the .05 level for a two-tailed test, but at the .05 level for a one tailed test are 53.

- Using the Wilcoxon test statistic evaluation **W** has showed us that it works significantly with the smaller of the rank totals. The SMALLER the rank

taking into account the number of participants, then is less likely to have occurred by chance. A table of critical values of W Appendix (11C) shows how likely it is to obtain a particular value of W purely by chance.

- Wilcoxon test is unusual in this respect: normally, the BIGGER the test statistic, the less likely it is to have occurred by chance.
- Findings of the experiment conducted showed that there was a significant advantage of using animation to generate better recall knowledge amongst the students.
- Students indicated a positive attitude towards using the animation as a learning tool.

We conclude from the work done in this chapter that student learned about how animation has brought many virtual characters and stories to life which made lessons a lot easier to understand and retrieve information quicker. This study then expands its wing further to exploit evaluation and develops an educational computer quiz, games etc. This approach has also accomplished positive effects and influences on students' learning and applying what they learnt from the previous animated experiments. Using these activities should attract pupils' attention and motivate them. Also they should positively influence pupils' emotions, attitudes and beliefs linked with subjects studied.

Chapter 9

Educational Chemistry Words Guessing Game

9.1 Introduction

This study furthers the evaluation to develop an educational computer quiz, to explore the positive effects and influences on students' learning and applying what they learnt from the previous two animated experiments. Using these activities should attract pupils' attention and motivate them. Also they should positively influence pupils' emotions, attitudes and beliefs linked with subjects studied.

This chapter will introduce an entertainment quiz, a game activity, in a form of a chemistry guessing game, where students will be able to guess the words learnt throughout the lesson. This game was provided to the same students who have used the first two experiments (Sodium (Na) and chloride reaction sample animation and Hydrogen Bonding) shown in chapter 8, as a plenary activity, shown in figure 9.2, along with instructions of how to use the game. Instant feedback will be given to students participating in the game such “sorry you are hanged” and the characters body will be displayed on the hanging post, with “would you like to try again” message displayed at the bottom of the screen. After the game is finished by students they will be able to complete a short evaluation form (paper format) to score the video in the range 1 to 5. (1= poor, 5= excellent), and total score out of 30 points, see Appendix 12. The ActionScript (the flash code) of this animation is illustrated in Appendix 12; the animation was evaluated using the Chi-Squared method.

An overview of this chapter indicating the content discussed is illustrated in figure 9.1.

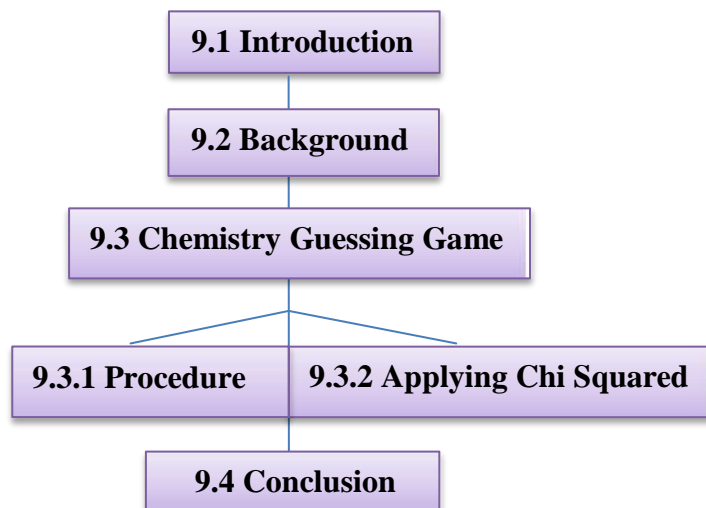


Figure 9.1: Overview of chapter 9 indicating the content discussed

9.2 Background

In this section we will be investigating the use of Chi Square Test to evaluate the educational guessing game in Chemistry. A **Chi-Squared Test**, also referred to as χ^2 **Test**, is any statistical hypothesis test in which the sampling distribution of the test statistic is a Chi-Squared distribution when the null hypothesis is true, or any in which this is *asymptotically* true, meaning that the sampling distribution (if the null hypothesis is true) can be made to approximate a chi-squared distribution as closely as desired by making the sample size large enough.



Enter button

Figure 9.2 Chemistry Guessing Game

9.3 Chemistry Guessing Game applying Chi-Square

9.3.1 Chemistry Guessing Game Procedure

A sample group of Year 10 Science students was selected to play the animated educational guessing game, during the plenary session of the lesson; the purpose of the game is to reinforce what they have learnt during this lesson.

The aim of using an animated game was to help these students with their learning and preparation for their exams, in a more interesting approach towards study in addition to evaluate whether the animation used in the previous experiments has played an important role in their learning. Each member will be able to play the animated guessing game which contains chemical terms only, and evaluate the game. The students kindly completed the evaluation form, which specifically asked about whether the animation offered knowledge to the topic, was the animation easy to perform, the quality of it, and if the animation achieved the objectives. This evaluation form is provided in Appendix 12. The total number of students participated in the evaluation process were 30 from both genders. The total score rewarded to evaluate the game was 30 points of scale of 1 to 5, (1being

low and 5 being excellent score). The guessing game has been designed and animated using Adobe Flash CS6.

9.3.2 Applying Chi-Squared

In many situations, *contingency table* can be used to investigate the dependency between attributes. This dealt with by using a contingency table and the χ^2 distribution.

By using this test (including Yates' correction) at the 5% significance level to determine whether using animation as useful tools for learning and a helpful guide for exams preparation to any subject area is independent of gender of students.

The gender of participants is independent on the use of animation.

Table 9.3 will demonstrate the figures obtained from the evaluation form.

Gender	Learning & preparation	Easy to use	Quality	achieve the objectives	Total
Male	3	4	5	4	16
Female	4	3	4	3	14
Total	7	7	9	7	30

Table 9.1: [2 x 4 contingency table of observed values].

Using $h \times k$ contingency table where (h represent the rows, k columns). This is to illustrate the convention that any entry with expected frequency of 5 or less should be eliminated by combining categories together;

Applying χ^2 test at 5% significance level to test whether gender is independent on the use of animation. We should be able to combine learning and preparation

which achieve the objectives, as both entities have a common factor which is learning.

Table 9.1, presents the expected frequency for students and (learning and preparation) is:

$$\frac{7 \times 16}{30} = 3.7 \quad \frac{7 \times 14}{30} = 3.2$$

Gender	Learning & preparation/ achieve the objectives	Easy to use	Quality	Total
Male	7	4	5	16
Female	7	3	4	14
Total	14	7	9	30

Since this less than frequency of 5, combine learning and preparation with achieve the objectives this will give us:

The hypotheses H_0 : students and animation use are independent

The hypotheses H_1 : students and animation use are dependent

The number of degrees of freedom:

No. of degree of freedom = $(h-1) \times (k-1)$

Where in our case $h = 2$, $k = 3$ therefore the $d_f = 2$ and the critical value of X^2 is 5.99

The **expected frequency** and Learning/preparation achieve the objectives for **male** and **female** student are calculated as shown below and represented in table 9.2:

$$\frac{16 \times 14}{30} = 7.4 \quad \text{And for female } \frac{14 \times 14}{30} = 6.5 \dots\dots\dots\text{so on}$$

Gender	Learning & preparation/ achieve the objectives	Easy to use	Quality	Total
Male	7.4	3.7	4.8	16
Female	6.5	3.2	4.2	14
Total	14	7	9	30

Table 9.2: The expected frequency

To calculate the X^2 we have:

O_i	E_i	$O_i - E_i$	$\frac{(O_i - E_i)^2}{E_i}$
7	7.4	0.4	0.054
4	3.7	0.3	0.0065
5	4.8	0.2	0.083
7	6.5	0.5	0.038
3	3.2	0.2	0.125
4	4.2	0.2	0.022

To calculate $X^2 = \sum \frac{(O_i - E_i)^2}{E_i}$

We have the critical value = $0.473 < 5.99$

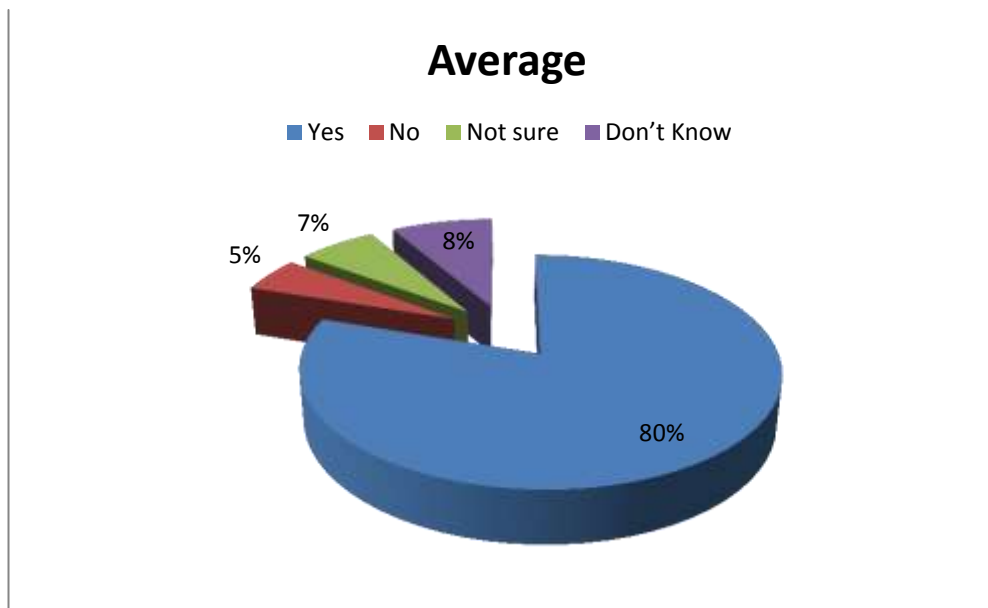
After the evaluation and students' performance in this game, a **Media Project check list form** has been given to students to provide us with their vital feedback after watching and participating in the animated samples as shown in Appendix 12. This task has taken the following steps:

The sample group consisted of 20 students of girls and boys. After watching the three animated sequences (Animation 1: Sodium Na⁺ Chloride Cl reaction; Animation 2: Hydrogen bonding and Animation 3: Day in Chemistry which is the animated words guessing game) a check list was distributed to this group to obtain their feedback.

The average outcome of their feedback was presented in table 9.3 with its Pie chart 9.1.

Question	Yes	No	Not Sure	Don't Know
Q1	18	1		1
Q2	17		1	2
Q3	19			1
Q4	20			
Q5	17	2		1
Q6	18			2
Q7	17	1	2	
Q8	20			
Q9	16		2	2
Q10	17			3
Q11	19	1		
Q12	15	1		4
Q13	19		1	
Q14	17			3
Q15	18	1		1
Q16	18		1	1
Q17	19	1		
Q18	16		2	2
Q19	17		1	2
Q20	18	1		1
Average	17.75	1.125	1.42857	1.857142857
Question	Yes	No	Not sure	Don't Know
Average	17.75	1.125	1.43	1.86

Table 9.3: Outcome of student's feedback



Pie chart (9.1)

9.4 Conclusion

We can conclude this as follow:

- The Chi-Squared Test would allow us to determine if our observations were consistent with this hypothesis, or if in fact there was a correlation between gender and animation. We can conclude that there is no dependency between gender of the students and the use of animation; therefore, the animation is quite useful for both.
- The use of technologies and online gaming is well documented as an effective tool for learning and the students in this study reflected a very good level of knowledge in the animated guessing game after participating in the other animated experiments.

The results of this chapter reflected student's attraction to learn through animation, they showed a positive attitude and interest towards learning the subject using similar methods and in particular gaming methods. This has pushed this work to take an extra step to demonstrate the effects of Multimedia Animation in Learning for the next chapter.

Chapter 10

The Effects of Multimedia Animation in Learning

10.1 Introduction

The last decade has led to an increase in use of computer technologies and hence animation in multimedia learning materials across all levels of education. According to Mayer, 2001 [27], multimedia learning is learning from words and pictures and multimedia instructional message or multimedia instructional presentation (or multimedia instruction) is the presentation involving words and pictures that is intended to foster learning. Based on various studies by researchers Khalili & Shashaani 1994[28]; Wan Fatimah & Halimah 2005, Faridah & Halimah 2008 [29] the effects of multimedia on learning suggest that multimedia can improve learning performance, irrespective of subject matter, but specifically Mathematics, Sciences and Languages. In other studies Seel & Schenk 2003 [30]; Adamczyk et al. 2009[31], which have compared learning during non-multimedia-based and multimedia based learning, have reported improved learning with the use of animation in multimedia technology. An overview of this chapter indicating the content discussed are illustrated in figure 10.1.

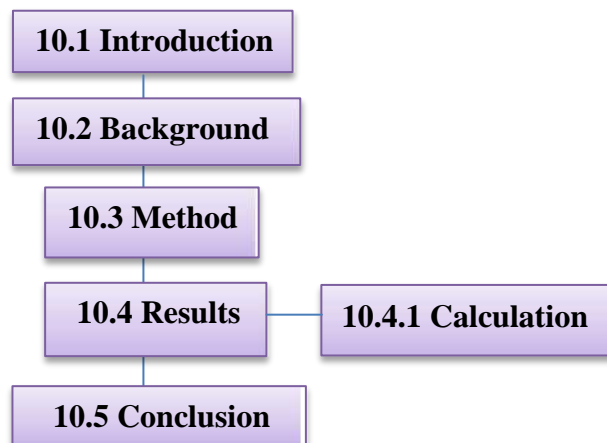


Figure 10.1: Overview of chapter 10 indicating the content discussed

10.2 Background

Due to the encouraging results we have obtained from this research, we have been approached by teachers in our academy to further this multimedia animation project and apply it in another science subject in this case Biology. Within Biology, it is being used to demonstrate one of the main topics in the syllabus; the human heart and the identification of the different parts of the heart and its role in the circulation of blood in the human body. Using computer based multimedia material offers different means of supporting information representation and enriches students' educational experience within the academy.

Therefore, a flash animated quiz has been created to provide help and support for the biology students and make their study more engaging and useful for retrieving the relative information required for the subject studied at the same time. A sample of this quiz is shown in figure 10.2 below with a correct and incorrect message. The ActionScript code behind this animation is shown in Appendix (13).

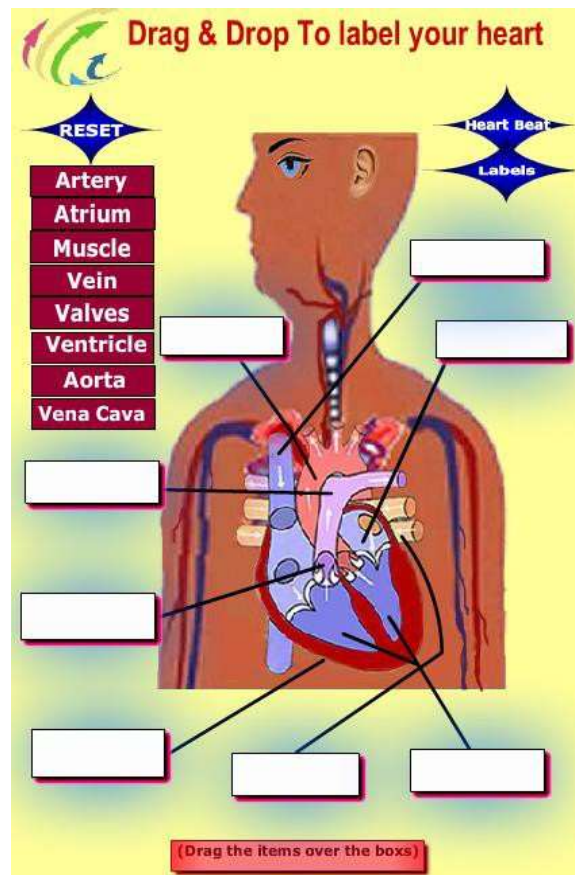


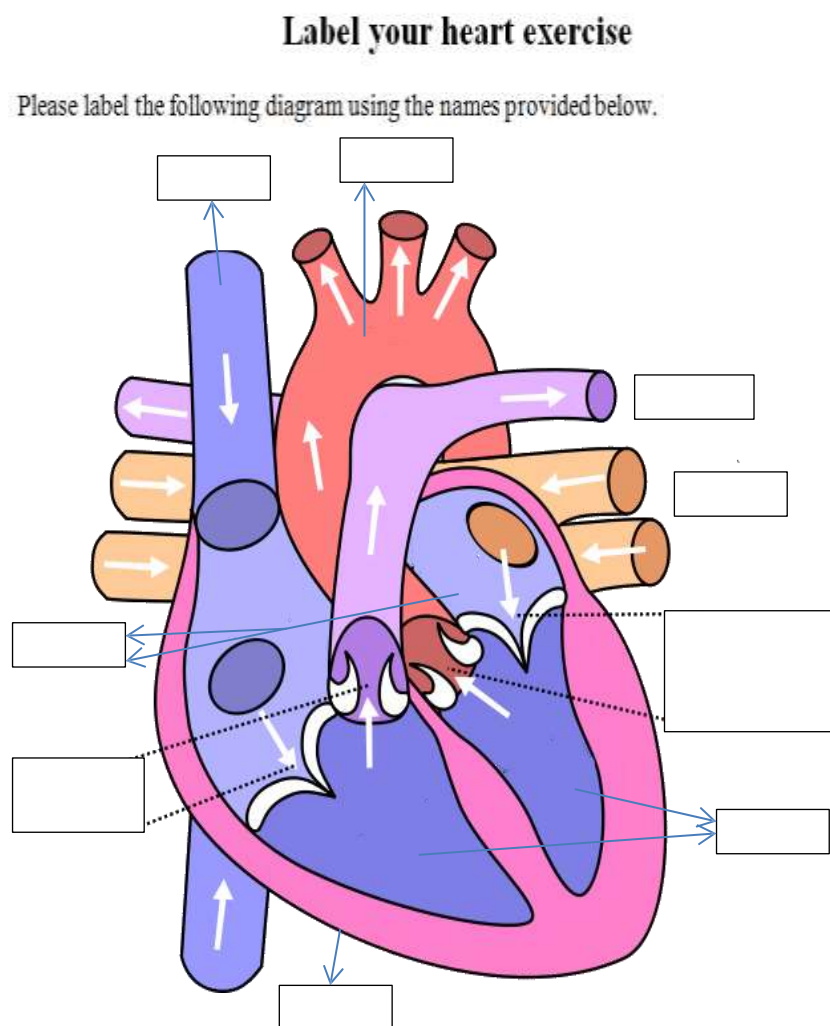
Figure 10.2: Labelling Human heart.

10.3 Method

The sample animation was exported as a flash animation *Shock Wave Flash* format (SWF) or **Future Wave Software**. The animation itself takes the format of a navigation search or drag and drop. The example was created as a demonstration for a biology lesson and to test its effectiveness for students in year 10. 12 students were involved in comparative test using the animation experiment and non-animated exercises presented in manual task session in order to compare the correct labelling of human heart diagram in the two different formats. This procedure will determine if there is a difference between boys and girls correct labelling and biology test with and without the use of animation hence our variability of the evaluation test.

The non-animated exercise was handed to students in a paper format with a diagram of the heart which they were required to label after the lesson, a diagram of which is shown in figure 10.3 also presented in Appendix (13) for a clearer picture.

The same task was given in an animated format to students who were required to label the diagram shown in figure 10.2, followed by evaluation using **Friedman Test**.



Key Words

Artery, Atrium, Muscle, Vein, Valves, Aorta, Vena Cava.

Figure 10.3: Heart paper format exercise

10.4 Result

The Friedman test evaluation was carried out in this work to see if there were differences in the score based on the biology test. Where:

Friedman test is a non-parametric randomized block analysis of variance. This is to say it is a non-parametric version of a one way ANOVA with repeated measures. This means while a simple ANOVA test requires the assumptions of a normal distribution and equal variances (of the residuals); the Friedman test is free from those restrictions. The price of this parametric freedom is the loss of power (of Friedman's test compared to the parametric ANOVA versions).

The null hypothesis: The distributions of the ranks of each type of score are the same.

The Friedman Test is a version of the Repeated-Measures ANOVA that can be performed on ordinal (ranked) data; therefore, Ordinal data collection has to be conducted and obtained from our students. Table 10.1 below will illustrate this.

Using alpha $\alpha = 0.05$.

Student Number		Animated Diagram		Un- animated Biology test
		Boys labelling	Girls labelling	
1	Boys	6	7	4
2		5	4	6
3		6	6	7
4		7	5	8
5		6	8	5
6	Girls	4	3	3
7		5	6	2
8		7	8	4
9		6	4	6
11		2	4	7
12		3	7	8

Table 10.1: ordinal data for Friedman test

10.4.1 Calculation:

1. Define the Null and Alternative Hypotheses:

H_0 ; there is no difference between the three conditions.

H_1 ; there is a difference between the three conditions.

2. Calculate Degrees of Freedom

$df = k - 1$, where k = number of groups

$$df = 3 - 1 = 2$$

3. State Decision Rule

We look up our critical value in the Chi-Square Table presented in appendix (13)

and find a critical value of ± 5.99 .

If X^2 is greater than 5.99, reject the null hypothesis.

	Animated Diagram		Un- animated Biology test	Animated Diagram		Un- animated Biology test
	Boys labelling	Girls labelling		Boys labelling	Girls labelling	
1	6	7	4	2	3	1
2	5	4	6	2	1	3
3	6	6	3	1.5	1.5	1
4	7	5	4	3	2	1
5	6	8	2	2	3	1
6	4	3	3	3	1.5	1.5
7	5	6	2	2	3	1
8	7	8	4	2	3	1
9	6	4	6	2.5	1	2.5
10	2	4	3	1	3	2
11	3	7	5	1	3	2
12	6	8	5	2	3	1

4. A Chi-Square value is then calculated using the sums of the ranks of each group by applying the Friedman test formula:

$$X^2 = \frac{12}{nk(K+1)} \sum R^2 - 3n(k+1)$$

Where:

k = number of columns.

n = number of rows.

R² = sum of the ranks in column.

	Animated Diagram		Un-animated Biology test
	Boys labelling	Girls labelling	
Sum of ranks	2.0	2.4	1.5
(Sum of ranks) ²	4	5.76	2.25
No. of Columns, K	3		
No. of Rows, n	12		
ΣR ²	12.01		
12/nk(K+1)	0.083		
3n(K+1)	144		
X ²	-142.8		

$$P = 0.0754$$

If n is sufficiently large, the sampling distribution of chi-square (csq_r) = 5.17 is a close approximation of the sampling distribution of chi-square with $df = k-1$.

With k = 3 and

$$df = 2.$$

The significance of X^2 may then be looked up in tables.

The critical value of X^2 for 3 columns and 12 rows at $\alpha = 5\%$ is 7.5.

Thus $X^2 > \text{critical value}$ so we can reject H_0 and accept H_1 .

We can conclude that the animation had significant effect on students learning and showed how well it reflected on their study while with the written task students did not score high results.

Chart (9.1) shows the total data collection of student score with and without animation.

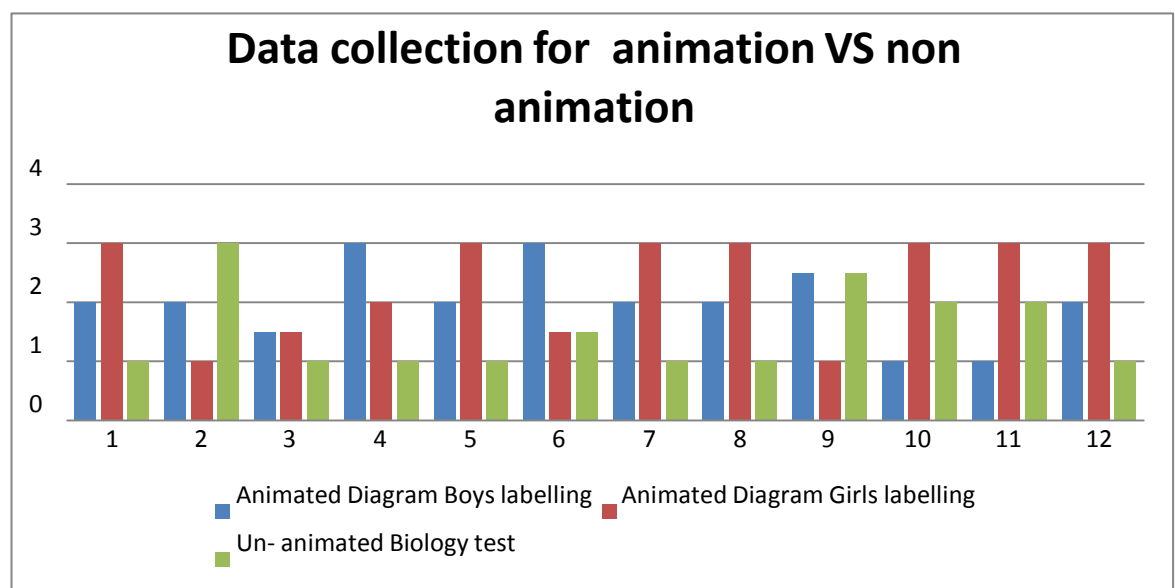


Chart 10.1 Total data collection.

10.5 Conclusion

We can conclude from using this method that Friedman test has many advantages these are:

- Since the Friedman test ranks the values in each row, it is not affected by sources of variability explained above (difference between boys and girls correct labelling and biology test with and without the use of animation), that equally affect all values in a row since that factor won't change the ranks within the row hence Friedman test meaning and the test hypotheses.
- The test created for this task controls experimental variability between subjects, thus increasing the power of the test.
- The rank transformation behaved as a rule which was more versatile than using rank randomisation tests.
- The animation test had significant effect on students test results and showed how well they performed in regards to the information stored through their observation to the animation, which in effect would help them later on in their study. From the written test we concluded that students did not score high results, and found the task relatively slow, less interesting and not interactive enough.
- Friedman test has slight disadvantages which lie in: the test does not make a distribution assumption, and it does not work as distribution assumption. Also it is not as powerful as the ANOVA test used in the previous chapters.
- We also concluded from this work that multimedia learning occurs when students are ready to accept and build mental representations from words

and pictures that are presented to them (e.g., printed text and illustrations or narration and animation). The promise of multimedia learning is that students can learn more deeply from well-designed multimedia messages consisting of animated words and pictures than from more traditional modes of communication involving words alone.

This will direct this work to present this multimedia animation in a different environment and take advantage of the new advanced digital technology such as air for android in the next chapter.

Chapter 11

Using Air for Android in Education and learning

11.1 Introduction

Android is a great operating system with a lot of great features and apps for education. Most students have Android phones, with a few having iPhones. Android phones make up more than 50% of the smartphone market, so it is very widespread, and its open nature has further encouraged a large community of developers and enthusiasts to use the open source code as a foundation for community-driven projects, which add new features for users.

With the increased pace of life as well as shrinking time, people, in (particular students) need everything in the palm of their hands, everything happening with a touch. Hence, it all boils down to one point, which system provides the best applications? In this chapter we will make use of this new technology to adventure the world of studying and learning using digital media, and mobile technology such as Android mobile phones, Quizzes, Games, and interactive activities for lessons these are, designed with aid of Adobe Flash CS6, and will be published using Air for Android phone and tablet such as **Samsung Galaxy SIII** where students can use it to read works and browse through stages of the animation displayed by a simple click on the buttons or touch the screen to open a new page with a selection of useful written information for their learning, as shown in figure 11.2.

An overview of this chapter indicating the content discussed are illustrated in figure 11.1.

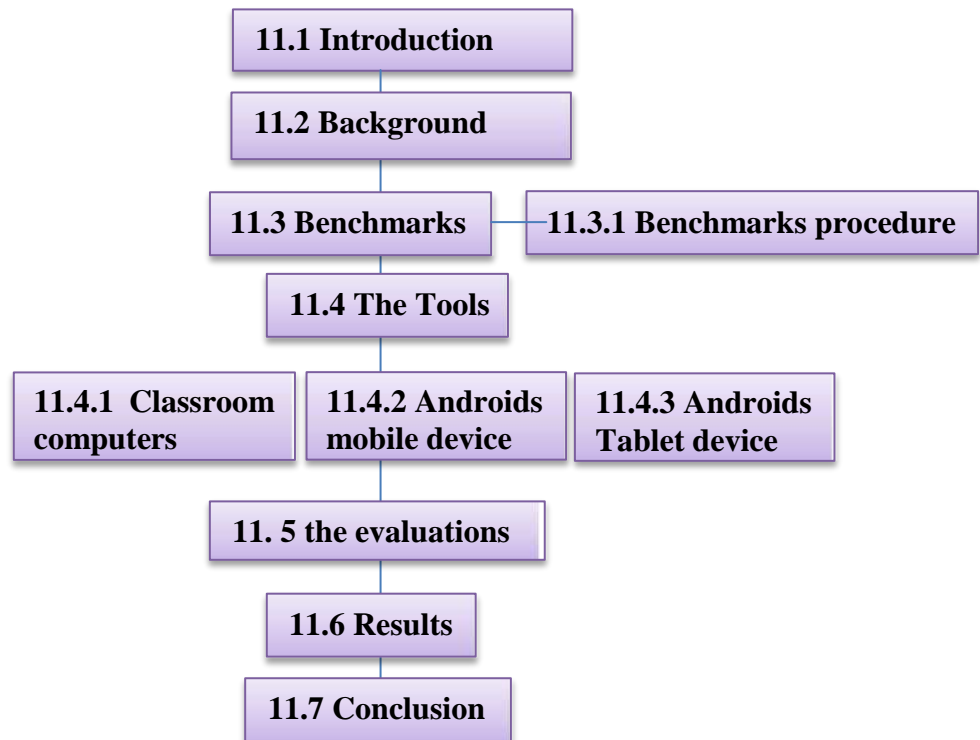


Figure 11.1: Overview of chapter 11 indicating the content discussed

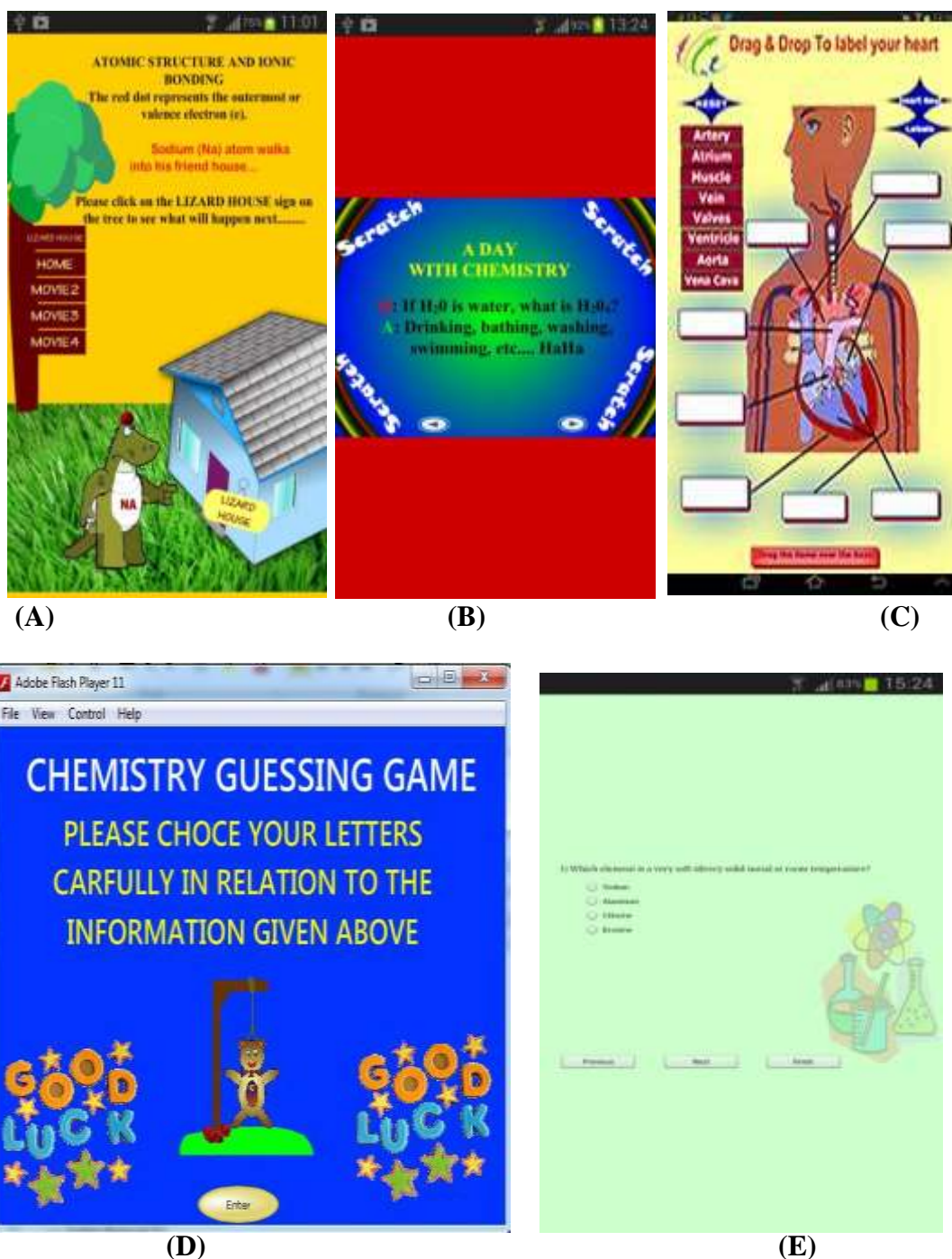


Figure 11.2 Animation Samples Published on Air for Android. (A) represent text format scratch card, (B) animated storyboard, (C) Drag and Drop Quiz, (D) Guessing Game, (E) Multiple choice questions.

11.2 Background

Due to the demand of using animation as a part of student's education and the increased interest in animation this not only happens with our finding results but also through students and teachers demand to increase the use of animation in many subject areas.

Our study has been expanded to take further interest of producing animation Quizzes, and interactive activities samples for science lessons using Android devices.

A mixed of Chemistry experiments and one biology heart explanation exercise has been designed for students group of year 10 in a comic narrative story to demonstrate Ionic Bonding when a METAL and a NON-METAL join together in a chemical reaction such as Sodium (*METAL*) and Chlorine (*NON-METAL*), Hydrogen bonding as a Scratch card text format, Guessing chemical term game, followed by Multiple choice questions, and Drag and Drop Quiz type format all designed and published in the same format and shown in figure 11.2 (A, B, C, D , E), the ActionScript used behind this animations are presented in appendix (14). The purpose of this exercise is not only lie in evaluating and benchmarks the value of using these animation as a tool for learning but also their influence on the students learning, but also to investigate which the best methods for helping students learning. The term "benchmark" was explained to students as an evaluation methods sample.

Toolkits of these benchmarks includes: class computer, and mobile technology devices.

11.3 Method

We have developed a set of 5 *benchmark tasks*. These benchmarks are designed to be representative of a range of animation learning styles such as Comic, animation with storyboard, etc. and they compare which is the best method, which reflects on the quality of the animation and would be more beneficial and influence the learning process. The animations have been displayed on about 3 different toolkits on different platforms in classroom these are classroom Computers/ laptops, Android mobile phone, and Android tablet. The students' questionnaire suggests that by implementing the benchmarks, they are learning the strengths and weaknesses of using a variety of a different kind of animation technique and methods. Implementations of the benchmarks by a number of more advanced toolkit students and animators suggest that the benchmarks also do a good job of identifying the effectiveness of the animation and toolkits for different kinds of activities, and point out deficiencies in the toolkits which presents these animations. Thus, benchmarks seem to be very useful both for learning and for evaluating user requirements and their needs. In addition, the students will be able to learn the features, strengths and weaknesses of different up-to-date modern technology toolkits. The benchmarks are also useful for toolkit and for researchers to evaluate using different toolkits.

However, the students complained that they did not learn enough about *different* toolkits, and wanted to see how toolkits differed, and the strengths and weaknesses of each.

The students have been divided into 3 groups each group individually performed their task as one of their tasks. These were revised and combined to result in a set

of five benchmarks which test a range of using different kinds of animated methods such as comic and storyboard, text format animated as a scratch card, Drag and Drop quiz, Guessing word Game, and animated multiple choice questions presented on different devices. At the end of the session the students been presented with a questionnaire form to evaluate their benchmark. As shown in figure 11.2(A, B, C, D, E). All implementation was only allocated the lesson time duration period, and most of the groups were able to stay on task and learn how to operate the new devices toolkit. The groups report that the benchmarks were of the appropriate difficulty related to the topics they were studying, and that they are learning a lot about the various devises.

11.3 The Benchmarks

The goals for the benchmarks it should be implementable in lesson duration by the science group which they are studying both subjects Chemistry and Biology for their academic year. The benchmarks have been set to cover the range of the animation methods we have produced for the purpose of helping students learning, that will describe which is the best method of animation which can be used to help students learning and to be specific enough so that all implementations of a benchmark would be alike in all essential details, and finally that the benchmarks would be fun and useful to implement.

11.3.1 Benchmarks Procedure

The *first task* in this exercise was for each student to independently specify a benchmark that met the goals listed already. After the initial benchmarks were graded, we formed 3 groups of 5 students and combined the benchmarks that addressed the same styles of animation methods. The benchmarks consisted of 5 animation styles: **1)** comic narrative story, **2)** Scratch card text format, **3)** Drag and Drop Quiz, **4)** Guessing game, **5)** multiple choice questions. (And of course, a number of other benchmarks should be added to cover other kinds of animation methods).

1. Comic Narrative Story

The comic narrative story benchmark is a simple example demonstrating the most essential item in our daily life which the ionic bonding between metal and a non-metal join together in a chemical reaction such like sodium (*metal*) and chlorine (*non-metal*) to form salt, for chemistry experiment animation. Students should read and follow the instructions provided on the top of the screen, by using the mouse or stylus pen to click the buttons situated on the tree and follow the movie clips figure 11.2(A).

In these tasks, reading the information is quite valuable for students to understand the chemical reaction before any practical work can take place. Often a sound to indicate each action in the movie clip will be added, but for the purpose of the difficult class the sound was terminated.

Aspects of this style occur commonly in comic animation style and the rules of the animation are demonstrated with each individual key frame.

In summary, this benchmark tests:

- Following the information provided and clicking the buttons with the mouse or stylus pen to view the actions.
- Invoking different actions depending on next instructional move.
- Providing the final results of the chemical reaction operation in a nice comical way to see what will happen with the bonding of the metal.
- Loading and viewing different pages as many times as the students require.

2. Scratch card text format benchmark

This benchmark will allow students to click and drag the mouse / stylus pen in any direction to reveal the image below, like a real scratch card. This animation uses masks to create the scratch card effect, which required an additional images and information to be discovered in order to display the final results figure 11.2 (B).

This benchmark tests several aspects these are:

- The ability to create an interesting and anticipating structured set of cards with various animations stages which make students willing wanting to know what is going to happen next.
- How hard it is to specify complex dependencies between the atoms of the forms.
- The ability to view and understand the concept of the atomic bonding, in this case the hydrogen bonding.
- The ease at which animation structures can be used in multiple parts to show things that cannot be seen in real life, but can through animation.

- Support for going backwards / forwards button, and symbols to move from scene to scene.

This benchmark pretends to illustrate the charge of an atom and how would they attract each other to form a molecule such as Ammonia, the strength, weakens and how the bond can be twisted to form a structure and behaviour of DNA, Water, proteins and many other substances. The behaviour of the DNA is demonstrated in an animated feature.

3. Drag and Drop Quiz

The animated quiz is simple to use, it is representative of tasks for which the students should position and drag an object that represents a section of the demonstrated diagram. In this task the special relationships of the team picked are significant, and the objects can be manipulated with the mouse or stylus. The terms have fixed positions on the main stage, and the act of placing other terms into them will triggers some behaviour (for example, dragging a term into a different position will bounce back or stay in the correct position), therefore, a feedback message was important to be installed to indicate what will happen.

In summary, this benchmark tests:

- Dragging objects with the mouse or stylus pen.
- Invoking different actions depending on where the objects are dropped (“drag and drop”).
- Providing feedback message about the operation that will happen if the terms are dropped.
- Maintaining and changing the colour of the terms if they dropped in the correct position.

- Loading and resetting a new quiz.

This application will present a clip containing 8 terms representing main section of the heart diagram figure 11.2 (C). The students can move them around the stage in any direction and try to fit them in the correct place, so that they can be arranged to display the right parts of the displayed figure with a showing feedback message. The terms can also be dragged over the main stage area before the mouse button or the stylus pen is released and if it is not placed in the right section then they will bounce back to their original place.

4. Guessing game

This benchmark uses guessing words with a shaped as teddy's body for any incorrect letter presented game setting. It is designed to test:

- How well the toolkit handles animations and other behaviours.
- How easy it is to create new objects dynamically at run time and to display objects showing student's feedback.
- Having two pages to demonstrate starting game and the actual game page concentrated to focus the benchmark on interaction with animation.
- Having two buttons to inform students the entering page and having a second try to play the game again.

To focus the benchmark on interaction with animation, we have simplified the game by adding feedback messages for students' performance.

The main stage of the game showed stands where part of the characters body will be displayed for any incorrect letters, and a dotted line generated randomly to present certain words to be discovered by the students. If students have managed

to guess the chemical term, then “well done!! Would you like another go?” feedback message will be presented, otherwise any wrong guessed letter will be replaced by part of the teddy characters body to be hanged on the presented stand, until all parts of the body are hanged followed by a “sorry you are hanged” feedback message with a question if the student have the desire to start the game again. Figure 11.2(D) shows an example screen.

5. Multiple choice questions

This is a simple text presentation in which students may read one question at a time and select the right answer from the options provided. The interface styles include a main stage where the questions appear with the multi answers, and various buttons (Previous, Next and Finish). This benchmark is presented on classroom computers, mobile android phones tablet. Figure 11.2 (E) shows an example screen.

The main feature that makes this benchmark more than just the animated text quiz is supplied by the lesson topic requirement. The answer can be selected by pressing on the radio buttons situated next to the multiple answers with the aid of using the mouse or stylus pen. The intention of this is to investigate the knowledge that students gain during the lesson using this type of animation production. The buttons illustrated at the bottom of the stage will give indication to the students to preview the previous question, or next question if they are confident enough of their answers, while the finish button will act as a terminator to the task. The function of the ***Previous*** button tells students “This is it the first question, there are no previous ones” if it has been misused or pressed by accident, also will act as play back to present the previous question. The ***Next***

button will display the next page as the name suggested, and will demonstrate “Please answer the current question before continuing” feedback if the button been hit twice by mistake. Once the whole questions have been attempted “That's all the questions! Click Finish to Score, or Previous to go back” message will be displayed to take the next action, i.e. hitting the finishing button. The ***Finish*** button will terminate displaying questions as a last station with a display to students’ scores results for example “You answered 4 correct out of 8 questions Good Try!!” feedback.

In summary, this benchmark tests:

- Support the animation for the clarity of the questions.
- Support for functions and instructions from using the buttons displayed in the animation.
- Support lessons-specific requirements, and student needs.

Most of the above animation samples been presented on classroom computers, mobile android phones and tablet apart from the guessing game which were not compatible with android devices at the time the devices were available to students and to our research.

11.4 The Tools

The science class students have so far used 4 different tools. Figure 11.3 summarizes all the tools and benchmarks used by the class.

The first group performed their task by selecting the five benchmarks; they had to choose an available tool, like Classroom computers, (most used Computers or laptops). The second group picked the Android mobile phone to perform 4 of the benchmarks, except the guessing words game has to be performed on the class PC

due to the compatibility of the program. The last group used the Android tablet, for the 4 benchmarks and for the Guessing game had to be performed using the PC for the same reason. At the end of the session an android tablet was chosen to be used for performing the chosen benchmark by all students. The Android tablet was chosen because it is a modern research toolkit that incorporates many features that can be used in advanced new digital media technology toolkits, support for the Adobe Air which is used to design the animation samples for the purpose of this research, good resolution, slim, lightweight, portable, user-friendly, and the advantages of touchscreen or using stylus pen. In addition, we have requested students to perform the guessing game and the multiple choice question as a manual written work, the results were not in favour and students preferred the use of the advanced new toolkits. As a result, “students” have used 3 tools to implement the task.

The comments generated as a result of these implementations were (very useful and easy to learn the topic presenting the animation on these devices) in addition they highlighted of the strengths and weaknesses of the various tools. Although the excitement of using new tools overwhelmed the main subject, students managed to keep calm and concentrated on the task at hand.

The following are some observations about the tools that were used to implement the benchmarks: **Android mobile phone Android tablet Classroom computers.**

11.4.1 Classroom Computers

All groups of students used the classroom computer and laptops, and selected the animation sample guessing word game to prototype the benchmarks. Most students found it to be very easy to perform and learnt the concept of animation presenting as our students are used to operating it. The resulting performance was fine, acceptable and not time consuming. Except for students who wanted to use the mobile and tablet only. The lack of sound, flexibility in resizing objects, was a highlighted limitation.

11.4.2 Androids mobile device

The second group have benchmarked 4 of the animations sample using the new technology Androids mobile which has been published as Air for Android. The students found using this device quite interesting, easy, fun, and mobile, although some of the limitations were found such as the writing and the images which were too small, and could not rotate the animations horizontally; although the animations main stages size were set to fit the screen size of the mobile device, and the sensitivity of the touch screen was a feature of the device. The overall results were good.

11.4.3 Androids tablet device

The third group found the tablet a good tool to use for benchmark for the 4 animation samples. They were clear, easy, fun, interesting and well advanced to use. The outcome results were very good.

Screen shots of the animation samples presented on the tablet is shown in figure 11.3.



Figure 11.3: 4 Screen shots of the animation samples presented on the tablet

11.5 The evaluations

After implementing the benchmarks, the students kindly filled out questionnaires in Appendix 14, which asks about the animations method, the toolkit and the benchmark.

The answers from the students show that they got a very good understanding of the various toolkits from the quick implementation of the benchmarks. They were able to identify the strengths and weaknesses of the animation methods, and were able to evaluate what kinds of methods would be most appropriate to help and influence their learning process.

Table 11.1 to table 11.4 shows a summary of the numerical results obtained from the students respectively.

This shows that the students were mostly able to identify their needs through comparing the type of animation they would like to use as an aid for their learning and exams preparation.

Given this quite small sample, it is probably not appropriate to use these numbers as a way to compare animation methods, since the individual differences among the students preference, the demand of using animation as a tool for studying, and the desire to explore new technology may vary among students. Also, it is important to note that all of these methods are subjective to personal choice and some students might answer the questions in favour of the teachers which in effects could reflected on the benchmarking results. Still, some trends are interesting:

- The *Comic Narrative Story* method benchmark seems to be very interesting for the students as they can relate this method to a concept or content in their topic can expand their knowledge as they go through the process knowing all the theoretical content steps, and they can produce something visual to deepen their overall understanding. Also it can engage students in active cooperative learning, and uses a range of multiple intelligences.
- Most students found **text format animation** very useful to use as it can be used to visualize a dynamic phenomenon or process which cannot be readily seen by the eye or science setting (e.g. DNA), so students can produce a visual product which shows the content; i.e. it has the potential to expand their understanding of topics through visualization of content.
- A number of students found the *Quiz* method is fun to do, further students' knowledge and adds benefits to student knowledge when compared to static/textbook graphics or diagrams. Also it helps students to maintain focus and develop essential problem-solving skills. Students have found the animated quiz engaging and exciting.
- Comparing the different animation methods students always found that animated *Games* are exciting, enjoyable and useful to learn from. And it acts as methods for soaking up information. Also students can increase their collaboration, creativity and communication.

This *Multiple choice questions* method show mixed overview as some students showed some interest and found it useful to store information especially for exams, and others found it boring. Students had received full credit for having

guessed correctly. This element of chance added an interesting dimension to our testing method.

11.6 Results

The evaluation of animation methods was processed by year 10 students' opinions. 15 students been splits into 3 groups, and have benchmark five different animation methods through the Multi-Point Rating (1-5) Questionnaire from fully Agree to fully disagree individually and collectively collected the results. Sample of rating Questionnaire presented in Appendix 14. The questionnaire results are shown in table 11.1below:

Students Number	Animation methods					Chosen Method
	Comic	Text format	Games	Quiz	Multiple choice	
1	1	4	1	1	4	Comic
2	1	4	1	1	4	Comic
3	1	4	1	3	1	Games
4	1	2	1	3	1	Games
5	1	2	1	4	1	Text format
6	4	1	1	4	3	Games
7	4	1	4	4	1	Quiz
8	4	1	4	1	1	Games
9	1	1	3	1	1	Quiz
10	4	1	3	1	1	Quiz
11	4	1	1	4	4	Comic
12	4	1	1	4	4	Multiple choice
13	1	4	1	4	4	Quiz
14	1	1	4	1	4	Text format
15	1	4	4	1	4	Games

Table 11.1 Questionnaire results

The calculated average results for the whole group are illustrated in table 11.2.

Methods	Fully Agree	Strongly Agree	Strongly Disagree	Unsure
Comic	9	6		
Text format	8	5	2	
Games	9	4		2
Quiz	7	6		2
Multiple choice	7	7		1

Table 11.2 average results for the whole group.

The average results for the 3 groups are shown in table 11.3.

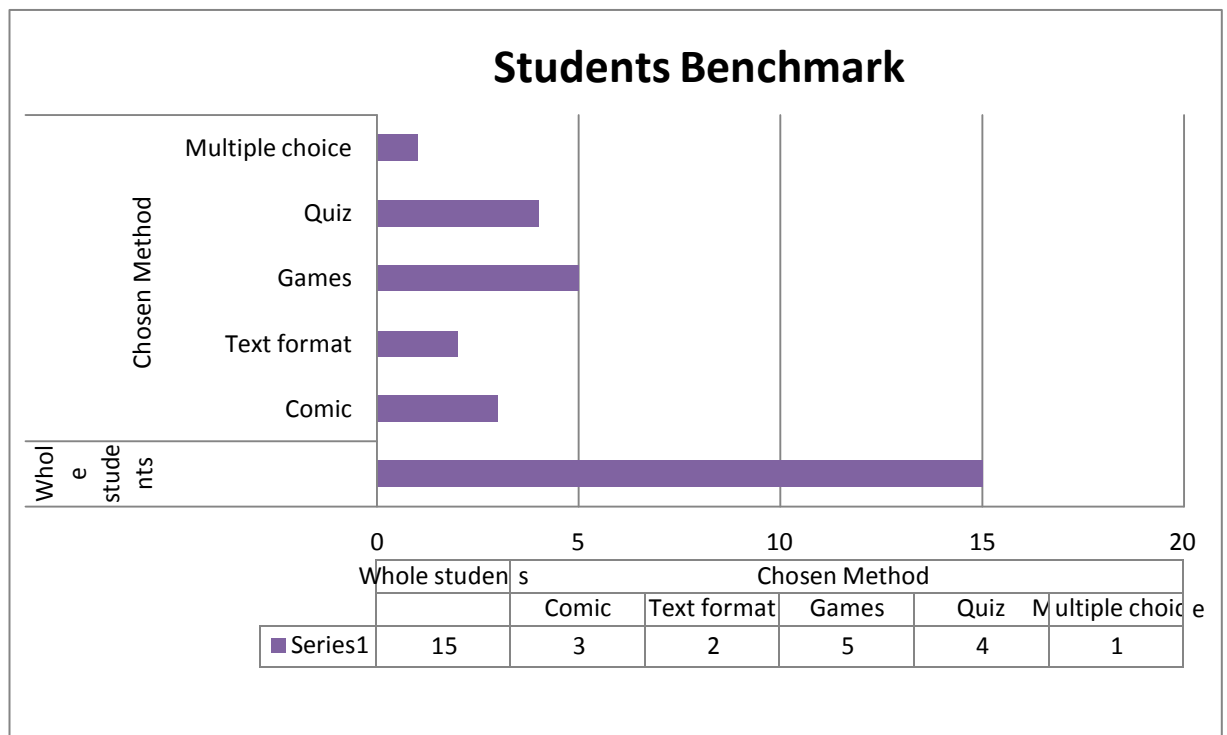
Groups	Methods	Fully Agree	Strongly Agree		Strongly Disagree		Unsure
Group 1	Comic	4	1				
	Text format	8	3		2		
	Games	5	2				2
	Quiz	2	1				3
	Multiple choice	3	2				
Group 2	Comic	2	3				
	Text format	5					
	Games	1					
	Quiz	3					2
	Multiple choice	4					1
Group 3	Comic	3	2				
	Text format	3	2				
	Games	3	3				
	Quiz	2	3				
	Multiple choice		5				

Table 11.3: Results for the 3 groups

The chosen Methods by the students are shown in table 11.4 and graph 11.1.

Whole students	Chosen Method				
	Comic	Text format	Games	Quiz	Multiple choice
15	3	2	5	4	1

Table 11.4 chosen Methods by the students.



Graph 11.1 students benchmark

11.7 Conclusion

We can conclude from these benchmarks that this method does not cover all types of animation methods, and it can mainly measure the learnability and suitability of the tools for small applications. This leaves out issues of structure, design, analysis, and performance that become more important for large applications. However, we feel that all methods used were very useful interactive and fun to use with the aid of the new technology.

The analyses by the students suggest that games and Quiz animated methods were the most adequate to use for learning and help student retrieve their information by forming visual images.

Implementations of the benchmarks by a number of more advanced toolkit students and animator suggest that the benchmarks also do a good job of identifying the effectiveness of the animation and toolkits for different kinds of activities, and pointing out deficiencies in the toolkits which presents these animations.

Using the benchmarks for learning, some students preferred to use the animation only on digital media devices rather than text book work.

Students found the process fun, and useful. It deepened their knowledge and added benefits to their knowledge when compared to static/textbook graphics or diagrams. Also it helps them to maintain focus and develop essential problem-solving skills. Students have found the animated quiz engaging and exciting.

Comparing the different animation methods students have found that animated **Games** are exciting, enjoyable and useful to learn from. And it acts as a method for soaking up information. Also students can increase their collaboration, creativity and communication.

Student also commented on the quality of the animation and how well structured, presented, attractive and useful it was to use as a guide before performing and facing any unpredictable danger which might occur dealing with chemical reaction or any other phenomena constructed during a practical session in different subject area.

Chapter 12

Summary

In this dissertation, I have presented a unified framework to measure and evaluate the important aspects of animation, and to derive practical results from the data obtained. The key research problems addressed by our work are summarised below, followed by a brief listing of our contributions:

1. The objective of the thesis was to design and improve quality of animations by taking audience perceptions and their rating levels of satisfaction into account which has been achieved through all the animations created for the purpose of this research.
2. How does one provide a comparative study of different methods applied to improve the quality of character animation? The solutions that have been adopted in computer animation, which have been coming from robotics or other areas such as biomechanics, or simulation different skinning techniques applied on a character during animation, which will lead the way for animation to be used as an essential tools, and another approach to aid future learning and education which has been achieved and reflected in chapter 2.

This work has followed the following steps, in addition in highlighting the intrinsic advantages and limitations of each approach, these steps are:

1. Methods based on kinematic animation.
2. Interactive edition of either captured or synthetic motions
3. Incorporate dynamics constraints in the generation of motion or to use dynamics simulation.

4. Character animation techniques.

3. How does one explore the use of different animation approaches that can be applied on 3D character animation such as rig construction, weight, skinning and many other approaches? These methods have been applied on the design of 3D character animation created for the purpose of this work.

How does one make comparisons between some methods and techniques that have been used in the development of character animation such as Skeletal Subspace Deformation (SSD) and Multi-Weight Enveloping (MWE). The latter has served the design of the animation tremendously to avoid any unnecessary artefacts and give the character more definition.

4. To review the recent advanced method techniques used for character animation, motion editing that enables the control of complex animations by interactive blending, improving and tuning artificial or captured motions, for the present and future work.

5. The thesis has highlighted the advantages, limitation, application, evaluation and use of techniques and methods followed in character animation.

6. The long term goal for this research was to achieve real-time detailed realistic rendering character animation. We have achieved this by constructing some important visible features, attractive to a variety of users, despite few showing artefacts. The results of the animation content shows detail of 3D modelling, texturing and rendering in all the animation samples created for this work.

7. The next research steps for the animation framework was the attempt of targeting non-professionals and novice users, to represent social information

support teaching, and simulation by creating a dynamic animation and control environment such as *Particle Systems*.

8. The *Particle Systems* has been used in a variety of applications in this work ranging from modelling fire, texturing and others. Because of its complexity and artefacts of reflecting these effects on an avatar, to generate realistic results, this has become my ultimate goal in this research in heading towards improving quality of character animation, since it will provide benefit in many ways:

- 1) Creating realistic animation operations in real time,
- 2) Adapting easily to different environments,
- 3) Increasing skill, imagination, and knowledge about physics-based animation, especially in the field of education, computer games and other sectors.

9. The goal to improve and reach good realistic character animation, free from any major artefacts, was generated from respondents feedback regarding various animations have been created for the purpose of this exercise, through quantitative method to validate the animation quality such as questionnaires surveys, moderation session, etc.

10. The work has introduced a realistic 3D character animation to demonstrate the purpose of using entertaining and interactive useful animations for learners where sensitivity, accuracy, reaction, dynamic environment, and any special effects were considered. In addition, methods of validation were implemented to make each task more effective and error-free.

11. This research took the step towards discussing validation of 3D character animation demonstrating chemistry experiments in the classroom, and to establish how learners respond to animation in a science environment, particularly in chemistry or biology lessons. The main question was addressed to be: “How students from both genders respond to animation in their learning environment? And how beneficial and influential animation can be to them?”

12. The study has presented evidence of statistical validity based on Likert Scale and many other statistical evaluations and techniques for the developed animation represented the science experiments to support education and teaching.

13. The research has been extended further to reach another form of evaluation process to investigate the role of animation on learning, including the essential factors that determine the potential learning through animation was reviewed and described as the follow:

- a) Determining the relative importance of animation in learning.
- b) Proposing an experimental strategy for verifying and fitting a quantitative model to estimate the potential of animation as an educational aid.
- c) Concluding an analysing any experimental results.

14. Students had to identify the quality of the animation presented to them and refer to any unwanted artefacts to help them improve their observational skills. They had developed good relationships for discussion in broadening their knowledge amongst themselves and with the teacher.

Further important format of evaluation for this work has been carried out using different techniques such as the **SCAT** (Sam's Cognitive Ability Test) **T-Test** and **Tukey's HSD Post Hoc** techniques. This test has been applied to determine if the

sets of data obtained was significantly different from each other, and it can be applied when the test follow a normal distribution. The other techniques have been employed to look at the data after the experiment has concluded hence the meaning of the name *post-hoc analysis* (from Latin *post hoc*, "after this"), or sometimes can be called *Critics Data Dredging* to evoke the sense that "the more one looks the more likely something will be found".

Other statistical evaluation were employed was the *one-way Analysis of Variance* (ANOVA) which is used with one categorical independent variable and one continuous variable. The advantages of carrying out this test is to establish how students in groups will be encouraged in holding debates with each other, in discussing more effectively reflecting their understanding and learning, both in pairs and individually; also how this procedure will make the analysis more accurate.

15. How does one evaluate the enhancement and effectiveness of 3D character animation using social media browsing such as *Flickr*? And how students find new information using this technique. Also to investigate and evaluate the usefulness and how animations influence learning as new forms of representation. The purpose of the study was to determine if the use of animation as learning tools depends on the variable age of students and score, or their personal choice-based decision making in understanding of animation. The data collected referred to a study on how 3D character animation videos used as learning aid is related to a number of explanatory variables. A fitted simple statistics linear regression model to the 3D character animation was created to model this approach. We have used (score) as an explanatory variable, and refined the model by incorporating

more explanatory variables such as, age, choice of video and scoring. It seems plausible that some of these variables played important roles in the determination of the animation used and in decision making.

In our research, we have created animated videos messages, consisting of narrated animations that explain different chemical reactions: what could these reactions produce, as a dynamic environment and what are the dangers, if they didn't handle with care or without supervision from a teacher. The messages has been displayed as a form of story and explanation text in some of the experiments which was short and focused, ranging from 24-30 frame per second (FPS). For example, the multimedia instructional message for Sodium Na and water consists of an animation that depicts the steps with formation produced at the end of the reaction e.g., $\text{Cl} + \text{H}_2\text{O}$ form Salt (NaCl), Potassium $\text{K} + \text{H}_2\text{O}$ results in purple some and produce fire, and a corresponding narration that describes the steps in a text format. We have tested the students' understanding by asking them to use the websites provided, whereby they follow the instructions and write answers to a series of questions regarding the science subject they have learnt previously, saving the answers in a suitable folder.

The work focused on the 3D character animation used in learning to evaluate the potential advantages of using animation towards aiding students' learning, as well as improving their memory, through such tasks as animated games, quizzes, and multiple choice animated tasks).

The research of animation and learning evaluation involved human perceptions implemented by showing a number of images or videos at various simplified stages to reflect how well students analysed the animation and whether it

addressed their needs. Also, this implementation utilized and entertained the idea of using an animation which simulated to students something not easily seen in the real world, such the movement of atoms in a gas for their science lesson.

The criteria used to evaluate quality in various areas were strategically planned to provide opportunities for students to identify which type of animations could influence the learning.

The presented investigation showed in this thesis aimed to use animation and its methods to serve students' learning and make the education process more interesting, beneficial and easy to use.

In order to fulfil the objectives of this study, we used different evaluation methods (both qualitative and quantitative) for data collection. These methods are set out in the table provided in the conclusion chapter.

The Quantitative Method defines counts or frequencies, rates or percentages, and other statistical methods. These methods are usually objective and require the use of standardised measures so that various perspectives and experiences can fit into a limited number of predetermined responses; these methods are usually easier to summarise and compare than qualitative methods.

The main advantages of applying the quantitative method includes, easy administration, conducive to large number of questions, large samples yields, is easier to summarise, and is more widely accepted as a form of evidence, especially for our task in finding out students' learning effectiveness. Although this method reflects some limitation since data may not be as rich or as detailed as qualitative methods. Survey or written questionnaires may be difficult for some participants, thus may not provide all the information needed for interpretations of

data findings, and the large amounts of data may require a more sophisticated analysis approach.

Whilst with the *Qualitative Method*, data collection methods shown in table (12.1) result in descriptions of the main problems, which can provide narrative descriptions of users' thoughts and opinions about their experiences, attitudes and benefits. The main advantages are: it can capture more depth and provide insights into "why" and "how" of attitudes and behaviours, clarify quantitative data and sometimes puts it into the context of users' experiences. This makes quantitative data easier to understand, provides more detail and explains what the nature of problem means to the participants involved.

The disadvantages of these methods are: it's time consuming to capture and analyse; the data is more subjective and maybe more difficult to summarise and compare systematically; it is generally viewed as less reliable because qualitative data is more subjective than quantitative methods, and may yield smaller sample sizes.

Data collection method	
•	Questionnaire
•	Interviews
•	Observations chick list
•	Social browsing
•	Multiple choice questions
•	Moderation session
•	Benchmarking
•	Statistical evaluation
•	Websites

Table 12.1: Data collection methods

The advantages and limitation for the techniques used in evaluating the work shown in table 12.2:

Techniques used for evaluation	Strengths	Weaknesses
F-test	Has F-distribution under the null hypothesis. Identify the model best fits. We do not need to pre-specify which treatments are to be compared. Can be used to determine if there is a relationship between the independent and dependent variables.	F-test reject the null hypothesis, we do not know which treatments can be said to be significantly different from the others.
Likert Scale	Simple to construct Likely to produce a highly reliable scale Easy to read and complete for participants	Central tendency bias, therefore, participants may avoid extreme response categories Acquiescence bias, the students may agree with statements in order to please the experimenter. Social desirability bias. Lack of reproducibility. Validity may be difficult to demonstrate i.e. is the affirmative been set to measure what it has been set out to measure.
Spearman's coefficient of rank correlation	It assesses how well the relationship between two variables can be described. The data correlation between (+, or -1) if there are no repeated data values.	Repeated measure is required to predict the performance, i.e. prediction will improve from trial to trial.
ANOVA	Allow testing more than 2 means, effective as durable as they are. ANOVA test assumes three things: -The population sample must be normal -The observations must be independent in each sample -The population samples are selected from have equal variance. Allows including more than independent variable in the model at the same time in order to determine the effect of each variable or to control for specific variables. The most useful technique in the field of statistical inference.	The null hypotheses of all groups are simply random samples of the same population. This implies that all treatments have the same effect (perhaps none). Rejecting the null hypothesis implies that different treatments result in altered effects. ANOVA is difficult to teach, particularly for complex experiments.

Tukey's HSD Post Hoc (t-test)	<p>Compares the means of every treatment to the means of every other treatment.</p> <p>It has the ability to find significance with a small sample.</p> <p>Identifies any difference between two means that is greater than the expected standard error.</p> <p>The observations being tested are independent.</p>	<p>Specific arrangement of comparing the mean needs to be applied e.g. largest mean compared to be the smallest mean, and then the largest mean with the next smallest, etc., can't not be done at random.</p>
ANOVA, linear regressions	<p>Allows including more than independent variable in the model at the same time in order to determine the effect of each variable, or to control for specific variables.</p>	<p>Time consuming and the regression approach require more work.</p>
Wilcoxon test	<p>It's a nonparametric test.</p> <p>Can be used to test population parameters when the variable is not normally distributed.</p> <p>Can be used when the data are nominal or ordinal.</p> <p>Test hypotheses that do not involve population parameters.</p> <p>Computations are easy.</p> <p>Easy to understand.</p>	<p>Less sensitive than their parametric counterparts when the assumptions of the parametric methods are met.</p> <p>Therefore, larger differences are needed before the null hypothesis can be rejected.</p> <p>Tend to use less information than the parametric tests. E.g. the sign test requires the researcher to determine only whether the data values are above or below the median, not how much above or below the median of each value is.</p> <p>Less efficient.</p>
Chi-squared	<p>Accepting or rejecting the hypothesis.</p>	<p>Depending on rough estimate of confidence; it accepts weaker, less accurate data as input than parametric tests.</p> <p>Its limitations are also its strengths; because chi square is more 'forgiving' in the data it will accept.</p>
Friedman test	<p>It's a non-parametric test.</p> <p>Requires smaller samples and less work.</p> <p>Friedman tests ask whether the rankings are the same for all levels.</p> <p>Free from ANOVA restrictions.</p>	<p>Requires repeated-Measures therefore, prefer the ordinal (ranked) data most of the time.</p> <p>It does not work as distribution assumption. Also it is not as powerful as the ANOVA.</p>

Table 12.2: Techniques used for evaluation

Chapter 13

13.1 Conclusion

It seems reasonable to assume that providing visualisation of what “really” happens in a dynamic system will facilitate learners’ comprehension of the functioning of the system. Our overall research approach is to address the quality and evaluate the importance and under-explored areas of animation. The methods I presented reduce the complexity by exploiting number of animated models representing different kind of animation aspects such representation includes the use of simplified dynamic environment, realistic character and the influence of animation on learning.

In this chapter, I summarise the main results of this dissertation and discuss potential future research directions.

I have presented a description and studied the issues associated with character animation, to demonstrate realistic character movement throughout the animation process. An improvement and correction to any artefacts in the animations presented for this work was necessary especially in the area of modelling, realism, and adding some dynamic system character animation in order to apply modification to validate the animation quality.

The use of real-time inverse / forward kinematic (IK, FK) to adapt existing motion has showed the advantage of reducing visual artefacts and interpolates the movement of the character in a straight line, while FK has given an arc motions similar to natural movements, these techniques have given this work real dynamic achievements in terms of its application including editing key-frame postures, producing interactive animation, and generating motion such as reaching and

walking as achieved in Videos(1,10, 14,15) Appendix (1), therefore the quality of the motion depends on the quality of the model.

Our research took a new direction to reach methods that differ from other approaches taken before, as it introduced usefulness results, good achievements for students to learn through using animation, and published in most new current digital media technology in addition to the statistical evaluation to the outcome. We can conclude that applying statistical validity based on statistical evaluation such as **Likert Scale** for the developed animation representing the Chemistry experiment Chapter (2), the applied technique was helpful, simple to construct, produced highly reliable scale and easy to complete for participants.

Other statistical quantitative evaluation method such as **Mean Squared Error (MSE)** was applied and found to fit closely to subjective ratings by student observers based on preliminary experimental results Chapter (3). We can also find from applying this method that we can determine the potential learning through animation, and the relative importance of animation in learning. We can conclude from using MSE the accuracy of the displayed quality information with aid of animation and the perception evaluation, especially when showing participants video animations to reflect how well it addressed their needs, enabling student to visualise key scientific concepts, the way of discussing issues relating to the reliability of our perceptual evaluations i.e. reliability increased and improved with the number of judges, identifying and assessing the importance of using animation. Establishing whether learning with animation is effective, easier or

useful was also determined; only a few students showed their dislike to use animation as a learning tool.

The overall response from students who participated using questionnaires or any kind of evaluation took place in this work were incommensurable. Some students we found were familiar with Computer Graphics (CG) and had the interest of viewing and identifying the importance of animation towards enhancing learning; some other students did not know or had very little knowledge about CG and chose not to use animation as an aid for learning and left it unnoticed, or did not comment at all. In most cases, some of the students were unable to notice any disadvantages of applying animation as part of their learning discussed in Chapter (4). In fact we had more encouraging and more enthusiastic feedback for use of animation as good prepreparation for their lessons, in terms of preparing equipment and taking necessary precautions to limit any risks during the practical sessions. The feedback also informed us that the animations provided a good source of information for later exam preparation. Other students found some problems using animation such as the videos were fast and did not reflect the exact information.

In some of our evaluation such like Tukey's HSD, our hypothesis was only partially supported for students who studied the animated videos, Video 1 presented in Chapter (5), and they performed significantly better from those who studied Video 2, but they did not perform significantly better than those who studied Video 3. Therefore, we can conclude that students' answers were based on understanding the science subject rather than solving a problem computationally.

In this study student from year 10 has been chosen to participate in our data collection was related to the fact that year 10 students can identify a project idea on their own and can conduct the project and report on it without much assistance. They can also use the scientific method to make predictions about the world around them and to construct experiments to test their predictions.

The study also included the use of social media sites such as Flickr.com, which are the leading edge in the “social web revolution”. This was chosen as an objective to determine whether there are significant relationships between or amongst 3D character animation presented in AVI video creation presented in Chapter (6) to enhance learning and a number of independent variables. In terms of the statistical analysis, ANOVA, linear regressions were deemed to be the appropriate methodologies for testing the hypotheses of the study. We can conclude that many students preferred to study their practical work with the aid of using 3D character animation prior to experiment with real things. This has indicated to us that the realism, colour, environment, texture, storyboard and information provided in the animation are more than adequate for students to accept and understand the 3D animated experiment videos to be used as learning tools as those factors played an important role on the learning environment.

The metric for approximating subjective evaluation of 3D character animation was the desirable method to evaluate the animation, and found to fit closely to subjective ratings by student observers based on preliminary experimental results. Therefore, the age and score showed to be interacted or correlated.

The work took another evaluation approach which represented the use of multimedia technology to utilise the animation when there was a need to show

learners something not easily apparent in the real world, such as the movement of atoms in a gas chemical animation (e.g., Hydrogen bonding) addressed in Chapter (7), which demonstrated that the animations were found helpful to students to understand complex ideas more easily and in an interactive and interesting way. The result of this beneficial approach using Wilcoxon Evaluation showed that the scored points for the storyboard of the sodium (Na) and chloride (Cl) animated experiment sample, was significantly represented with high quality animation. Also the results showed that there was a significant advantage of using animation to generate better recall knowledge amongst the students.

Students indicated a positive attitude towards using the animation as a learning tool.

This study furthers the evaluation to develop an educational computer quiz illustrated in Chapter (8), to explore the positive effects and influences on students' learning, and applying what they learnt from the previous animated experiments. Using these activities has attracted students' attention and motivated them, positively influencing their emotions, attitudes and beliefs linked with subjects studied. Evaluation of this work was done using

Chi-Squared Test which allowed us to determine if our observations were consistent with the hypothesis or whether there was a correlation between gender and animation. We can conclude that there is no dependency between gender of the students and the use of animation, therefore, the animation is beneficial and useful for both.

Another good approach which was used in this work was the use of computer based multimedia material showed in Chapter (9), which offered different means

of supporting information representations and provided the basic ingredient for learning and improving students' performance. We can conclude that students reflected a very good level of knowledge in the animated guessing game after participating in the other animated experiments.

The work progressed to take advantage of using the new digital media technology to present the animation samples and to encourage students not just only using animation for their learning, but also in using the new technology to enhance the learning process. With aid of "Air for Android" devices presented in Chapter (10). This work took further strides in investigating and creating useful benchmarks. The answers from the students showed they displayed a very good understanding of the various toolkits from the quick implementation of the benchmarks; they were able to identify the strengths and weaknesses of the animation methods and were able to evaluate what kind of methods would be most appropriate to help and influence their learning process. Using benchmark methods does not cover all types of animation and it can mainly measure the learnability and suitability of the tools for small applications. This leaves out issues of structure, design, analysis and performance that become more important for large applications. However, we feel that *all* methods used were very useful, interactive and fun to use with aid of the new technology.

Comparing the different animation methods, students have found that animated *games* are exciting, enjoyable and useful to learn from: aiding in absorbing information. Also, students demonstrated increased levels of confidence, collaboration, creativity and communication.

13.2 Future work

In the design of the methods presented in this dissertation, I have made a number of assumptions and sometimes restricted the scope of my evaluation for the sake of performance or ease of implementation, especially when dealing with students of young age and trying to fit within requirement of the lessons. Some of these restrictions were relaxed in the course of my research, such as number of tests and different methods for evaluation, especially for the first chapter. Although this chapter was evaluated by users from all walks of life, it did offer some potential solutions for improving the quality of 3D character animation, therefore more effort and time is needed to accomplish this tasks.

Our long term goal for this research is to achieve real-time, detailed realistic rendering character animation. We have achieved this by constructing some important visible features, attractive to a variety of users, despite few showing artefacts. The results of animation contents show detail of 3D modelling, texturing and rendering. The *studying result*, targeted both genders and professions of candidates, had different level of standard deviation (S.D for male was 2.44 which is higher than female S.D = 1.82, and F. test of 0.11 and within-group degrees of freedom $f_w = 6$) as a first task of the research process.

The most ambitious attempts to achieve, as the research progressed for the animation framework will be targeting non-professionals and novice users, to represent social information support teaching, and simulation by creating a dynamic animation and control environment such as particle systems.

- **Particle systems** used in a variety of applications ranging from modelling fire, texturing, etc. and because of its complexity, and artefacts of

reflecting these effects on an avatar to generate realistic results. This has become my ultimate goal for this research to head towards improving quality of character animation, since it will provide benefit in many ways:

1) creates realistic animation operates in real time; 2) adapts easily to different environments; 3) increases skill, imagination, and knowledge about physic-based animation especially in the field of education, computer games etc.

- The goal to improve and reach a good realistic character animation, free from any major artefacts, was generated from respondents' feedback regarding various animations, which I had created for the purpose of this research. Another quantitative method to validate the animation samples such as questionnaire survey, moderation session, interviews, benchmarks, and many others were carried out.
- We met our objectives by presenting various computer animations, containing different techniques, such as, blend-shape method, FK&IK, rigged animation, reactor and dynamic systems based deformation. The aforementioned techniques were utilised on the three different chemistry experiment videos. The physics based modelling was applied on the 'multimedia text format animation' and 3D body modelling performance, narrative animations, games, quizzes and animated multiple choice questions. Although some artefacts occurred, applying these methods, especially dynamic systems based deformation, FK&IK, and rigged animation methods which clearly showed the undesired results in Videos(5, 6, and 7), whereas the rest of the animation worked fine. For

each technique and methods described, we compared the similarities, differences, strength and weakness. Animations were rated by viewers via questionnaires and other feedback and evaluation methods, as showed in the summary chapter. The aim of this was to provide the audience with basic information that was displayed in the animation towards achieving our objectives of the research.

- Some quality features in the animation produced was not fully achieved such as pinching, slow rendering, losing textures, shown in Videos (2, 3, 5) therefore an account for subsurface light scattering, bump mapping was considered to be a requirement to overcome this unwanted realism for the 3D character, and thus to become an important target of improvement for next step of our research to be achieved.
- Later on, we have managed to overcome any undesired realism occurring on the 3D character animation, by paying particular attention to avoid pinching, slow rendering, and appealing texturing to reflect good skinning realism to the character. This can be witnessed on the new AVI videos addressed in Chapter (2), and also in the subsequent chapters. Increasing the skin layers and applying enveloping along with subsurface light scattering, bump mapping, with aid of latest versions of different software such as 3DS Max, Poser, and Motion Builder, which has played an important factor to improve the quality of the animation and showed an enormous difference to the appearance not only just for the 3D character, but also for the design of the environment the character sounded with i.e.

the lab equipment etc. This has fulfilled the target set to improve the quality of the animation produced for the purpose of this work.

- I have managed to integrate the work done and the techniques used in the first stage of the research and overcome any artefacts and unfavourable results regarding the design and the quality of the animation, with the current and new techniques together and create new real-time dynamic animation and control environment, such as particle systems. This has been performed with the aid of carrying out creating new character surrounding by particle and dynamic system, literature review, chemical experiments moderating session, questionnaires, surveys and interviewing a number of voluntary audiences which was achieved successfully.
- Overall the animations in this research achieved the objectives and it was effective in conveying ideas through the use of a variety of techniques.
- Our project intention was to employ dynamics systems on a chemistry experiment, to present good simulations and conceptual computer animations. Therefore, the experiment (demonstrated certain reaction such as burning metal object e.g. Sodium (Na) with water reaction, which involved fire and dynamics interacting within the environment), along with the reaction and behaviour of the character in the scene. This has allowed reviving the life shown in the experiments as a realistic simulation played as (MVI) video versions format was satisfactorily achieved. We have also enjoyed achieving realistic animation by employing the same principle of using dynamics system techniques, with aid of using Multimedia technology animation on the character. The aim of the

demonstrations was to illustrate the important aspects of chemistry (reaction types, dyes...) for everyday life, involves substances or equipment, hazardous or cause problems of disposal, and animating the character movements, emotions, reaction and decision making.

- The research has also enjoyed the achievement of enriching an instructive of education which intern made the education more educationally attractive and interesting to use. Our research intended to progress further and enjoy the advantages of using animation as a learning tool in the educational field, therefore, the use of creating multimedia animated samples consists of narrated animation, text format, games and multiple choice format that explains different chemical reactions, what could these reaction produce as a dynamic environment and what are their dangers if they weren't handled with care or without supervision from a teacher was created and achieved successfully. Short, focused, and up to the required point feedback messages in a form of story and explanation text in some of the experiment, losing games, bounce back words in some other experiments, and so on, were displayed to assist the user and achieved the objectives. The varieties of animations with feedback messages are shown in Chapter (10). A construction of the evaluation methods used for this research was aimed to assist a student's comprehension and involvement in different kinds of educational areas and mainly helping them with their learning and preparation for their exams. Presenting students with evaluation tools such as websites, questionnaires, multiple choice questions, interviews, check list evaluation and using new digital media

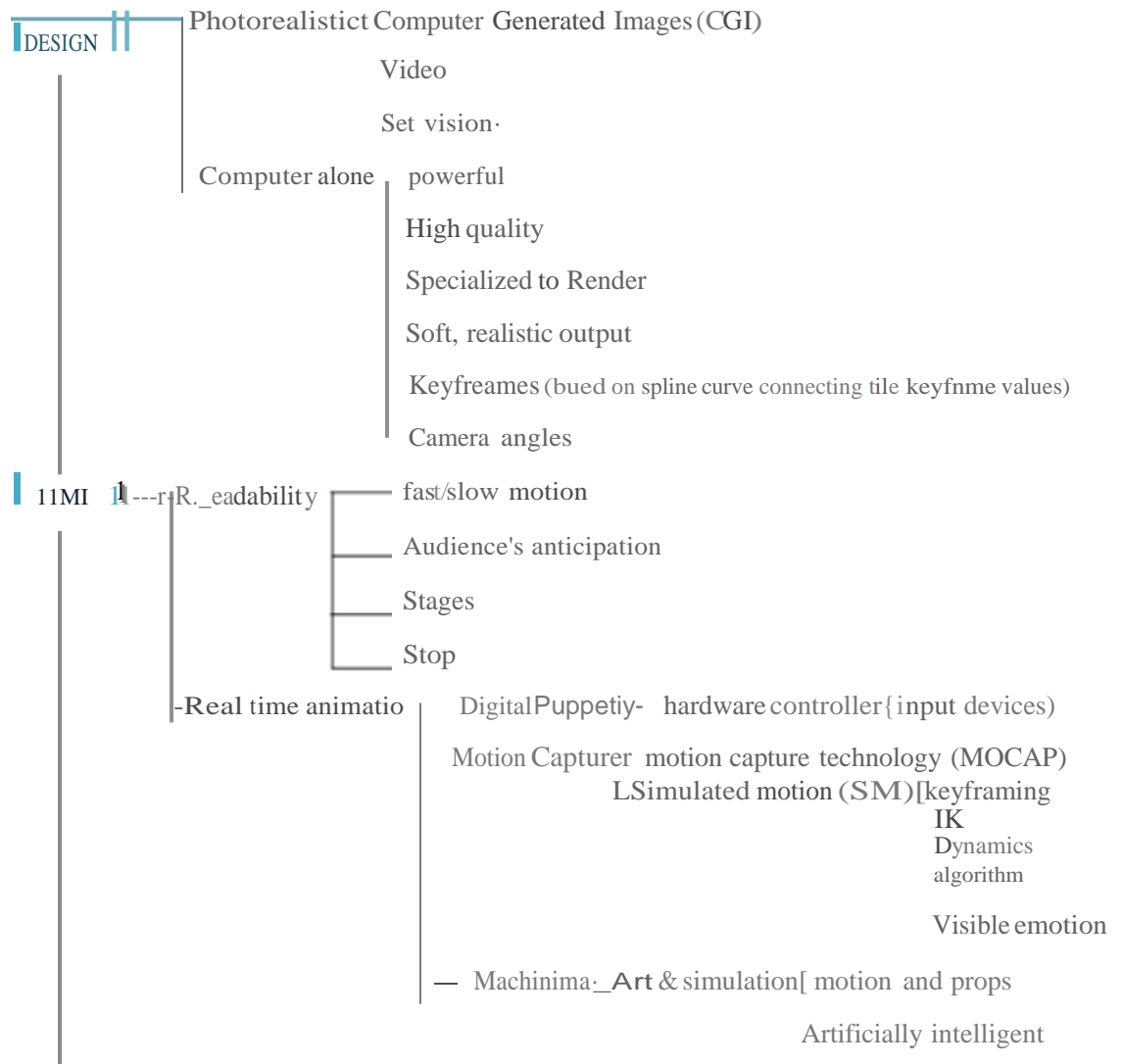
devices, such as mobile devices and tablets, has broadened students' knowledge and the objectives were achieved.

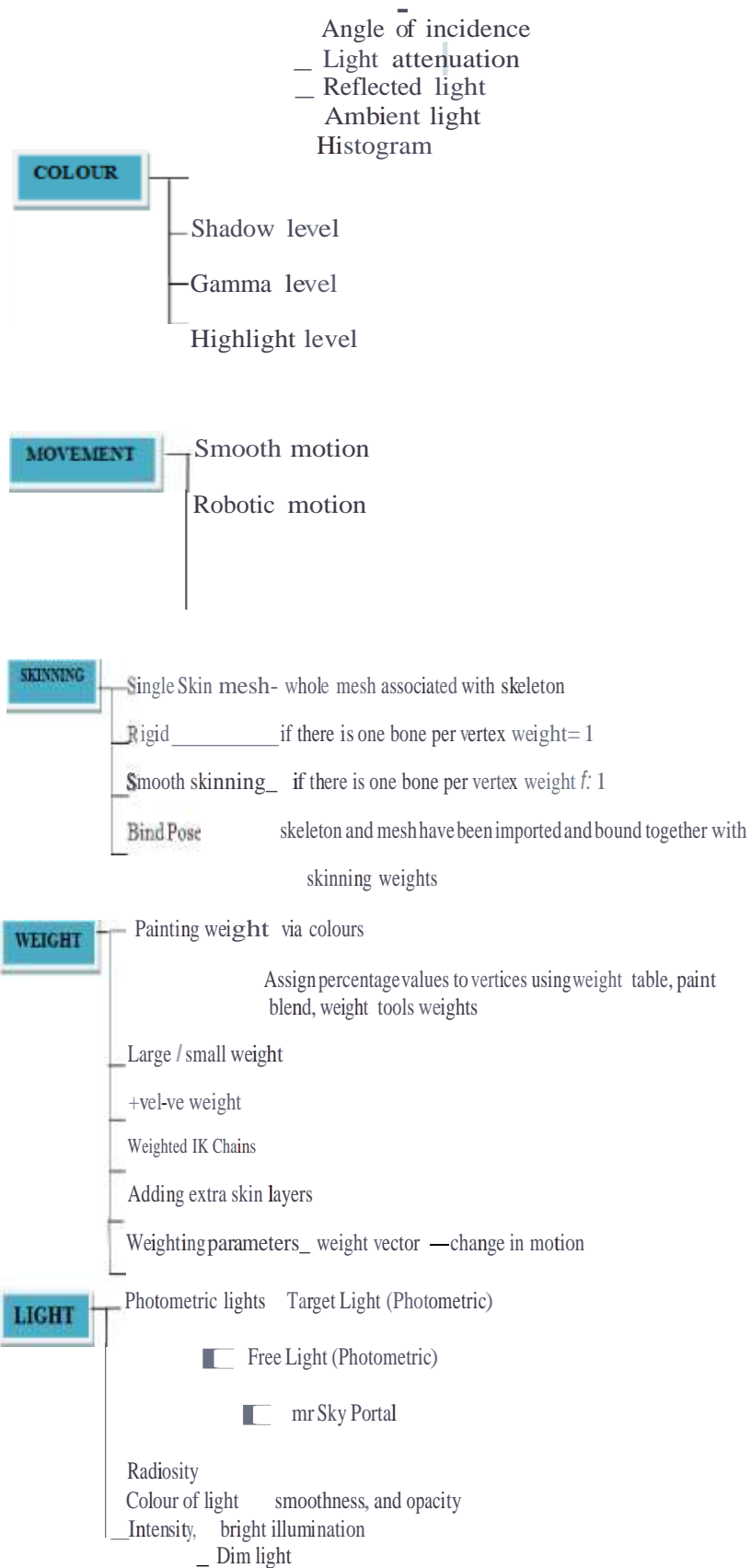
Together, all these techniques have provided new tools for understanding animation target and data structures, also understanding the perceptual issues related to them.

It is our hope, ambition and long-term goal that the fruits of the research produced by continuing research on animation and perception, will offer substantial benefits, in terms of pure knowledge, consolidating learning and aiding solutions for students' education which will drive and motivate us towards future directions in this research.

Appendices

Appendix (1) Design steps used in chapter (1):





Retargeting inverse kinematics

Dynamics
Biomechanics
SPEED weighting
Angle

-Normal motion-- physiological builds (individualisation) emotion

REALISM

Materials — natural materials Ambient colour

— Diffuse colour

Specular colour

Glossiness

Manufactured Materials [Synthetic colour
Plastics/porcelain glazes/ shiny material

Indoor and outdoor Lighting
Physical realism

Behaviour Modelling

SIMULATION

Physics simulation

Crowd simulation

Particle Motion (Wind, gravity...etc.)

AI simulation (sight, hearing, basic emotion, energy level, aggressiveness, etc.)

RENDERING

Batch rendering

1 Network rendering

SATISFACTION

Cost

Realism Quick Fantasy

Spirit within

Motion

Biomechanics

* set visions: different types of designing and rendering software to take CGI to the next level of realism, manipulating, breaking ground, to create technical skills to develop CGI.

•Machinima="Machine" and "Cinema" It started out with fans inter-cutting and over-dubbing screen captures from popular PC games, such as "World of War craft" or "Second Life", provide highly-configurable environments.

Appendix (2) Animation used in this Questionnaire.



Basketbal



Dancing
character



Funy Body



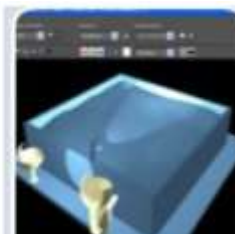
Helicopter



Poli



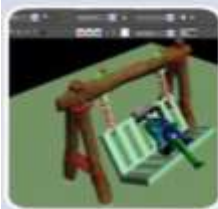
Rigged
animation



Water and light
reflection



Snooker
Momentum
and impact



Rotaion



Dancing



Movement
and speed



Reactor



Squatting



Walking on level
ground



Justin/physical
movement

Appendix(3) Screen shot of the website.



Page 1



Page2



Page3

Appendix (4) screen shots of Respondent answers.

Candidate:q1

-6.Should we use physically-based simulation to help compute realistic motions?

No.
because its computationally expensive, and need to use
yes, to facilitates the use of physically-based models by
animators. The main point is to give the animator a familiar
ace.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

the application which allow you to create real-time
interactive 3D content.
Also to create and render exceptionally rich & realistic
natural environments.

Candidate:q3

6.Should we use physically-based simulation to help compute realistic motions?

yes, and you can use rigid body simulation, and rain
effects in video 4.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

rendering which is used to draw complex 3D scenes from
simple primitives using it's many function calls.

Candidate:q4

6. Should we use physically-based simulation to help compute realistic motions?

based simulations, such as cellular automata, fluid dynamics (Harris 2004) for example, and cloth simulation. A common characteristic of these features is that the connectivity of the simulated elements--either particles or cells, which does not change during the simulation.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

A system with visualization applications (AVS), which is designed around the concept of software building blocks, or modules, which can be interconnected to form visualization applications. AVS has an advantage of allowing flow networks of existing modules to be interconnected, which can be used to create a visualization of a system.

Candidate:q5

6. Should we use physically-based simulation to help compute realistic motions?

yes, through out my study I learned as a student that, simulations are generated at interactive rates, even in the case of complex articulated objects. This facilitates the fine tuning of an animation sequence

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

Application that helps reducing any visible artifacts such as advanced ray casting, to create more realistic results at a speed that is one orders of magnitude slower.

J.J

Candidate: q7

6. Should we use physically-based simulation to help compute realistic motions?

Yes,
physically-based animation can offer collision detection
and response, deformation of the objects,
and realism of motion. And at the same time, keep the most
frequently-used and most convenient interface : key-frames
In addition, throughout the process, the animator

8. According to your experiences and knowledge, which render application that has a better use
and also producing good quality outcomes?

High quality of realism.

Candidate: q8

6. Should we use physically-based simulation to help compute realistic motions?

Yes, but you can combining the physical simulation of
objects, or contact situations, with trajectory control.
The user still need to defines key-frames to guide motion,
but does not have to consider the realism of motion, nor
the collisions that will take place.

8. According to your experiences and knowledge, which render application that has a better use
and also producing good quality outcomes?

The better use rendering application is to give a complete
real-time control over all elements of the 3D scene
including the characters, animations, morphs, cameras,
lights, textures, etc.

Candidate: q13

6. Should we use physically-based simulation to help compute realistic motions?

yes,
The physically-based simulation method creates smooth
deformations that preserve the fine structure of the original
motion.

8. According to your experiences and knowledge, which render application that has a better
use and also producing good quality outcomes?

Real-time rendering as it is very suitable for interactive
media, such as games and simulations, is calculated and
displayed in real time, and it show as much information as
possible at a reasonable time.

Candidate: q16

6. Should we use physically-based simulation to help compute realistic motions?

Yes,
The Physical simulation acts based on a specialized controller which is derived from parameters almost exclusively extracted from motion capture data, which makes use of inverse dynamics as an internal model to

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

Rendering applications which allows to utilize more easily the aggregate rendering power of a collection of commodity graphics accelerators housed in a cluster of workstations, without imposing a specific scalability algorithm that may not meet an application's needs.

candidate: q15

6. Should we use physically-based simulation to help compute realistic motions?

Yes,
I think it should combines human motion data and physically based simulation, to bring character animation into live i.e realism

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

Rendering methods that is specialized in polygon-based rendering.

Candidate: q18

6. Should we use physically-based simulation to help compute realistic motions?

yes, provide the expressive power of keyframing. Furthermore, the system should allow non-skilled users to create realistic animations easily with minimal training.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

Any rendering process that can be applied to achieve highest degree of photorealism at an acceptable minimum rendering speed example (24FPS), to successfully create the illusion of movement.

Candidate: q19

6. Should we use physically-based simulation to help compute realistic motions?

Yes
Animators can use dynamic character motion as well as applying physical simulation to produce relatively complex realistic motion.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

A software system that can be used for developing interactive scientific visualization applications quickly, with a minimum of programming effort.

Candidate: q20

6. Should we use physically-based simulation to help compute realistic motions?

Yes
in fact I am using physical simulation to drive the animation of my example (animation of breaking objects and collision-detection).

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

I have used Blender is open-source software for 3D modeling, animation, rendering, post-production, interactive creation and playback.

Candidate: q21

6. Should we use physically-based simulation to help compute realistic motions?

Yes, to facilitate the use of physically-based models by animators. The main point is to give the animator a familiar interface.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

The rendering with interface makes figure design, posing and animating fast and easy. Map facial photos, grow and style dynamic hair, and create dynamic cloth to add extraordinary realism to your figure.

Candidate: q22

6. Should we use physically-based simulation to help compute realistic motions?

Yes, while providing a simulation module which detects collisions, thus enhancing realism.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

The one that offers an exceptionally ergonomic interface at the same time as precise professional results.

Candidate: q23

6. Should we use physically-based simulation to help compute realistic motions?

Yes, The simulator will correct the trajectories and compute deformations according to each object's physical properties (such as mass, inertia, stiffness) as well as the collisions.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

From my experience rendering should allow you to perform dynamic motion, using revolutionary AI and biomechanics techniques.

Candidate: q24

6. Should we use physically-based simulation to help compute realistic motions?

Yes, physically based simulation helps animation that uses deformable models to simulate the behaviour of the solid or any other objects.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

Rendering should give's you high-quality character motions in real-time. In addition to complete control to direct your characters' actions by choosing a variety of adaptive AI behaviours.

Candidate: q27

6. Should we use physically-based simulation to help compute realistic motions?

Yes, very important feature as you can use it a variety of application such as water and clothing.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

High quality of realism.

Candidate: q28

6. Should we use physically-based simulation to help compute realistic motions?

Yes I do use it in my video games and training simulations, and physically simulated motion.

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

The better use rendering application is to give a complete real-time control over all elements of the 3D scene including the characters, animations, morphs, cameras, lights, textures, etc.

Appendix (5) Screenshots of Questionnaire Sample

Questions and answer's

1. What is your gender?

<input type="radio"/>	Male
<input type="radio"/>	Female

2. What is your occupation?

<input type="radio"/>	Student
<input type="radio"/>	Lecturer
<input type="radio"/>	Professionals
<input type="radio"/>	Others (please specify) <input type="text"/>

3. Have you ever created a 3D animation?

☐ C_

4. If you answered B to question 3, what links did you select?

<input type="radio"/>	Main Animation
<input type="radio"/>	Bone Construction
<input type="radio"/>	Kinematics
<input type="radio"/>	Control Objects

5. Which area in 3D character animation that you are interested at?

<input type="radio"/>	Modelling
<input type="radio"/>	Texturing
<input type="radio"/>	Animation
<input type="radio"/>	Rendering
<input type="radio"/>	Others <input type="text"/>

6. Should we use physically-based simulation to help compute realistic motions?

--

7. Which of the following lights is the easiest to control and produces the outcome that you wanted?

<input type="checkbox"/>	Target/ Spot light: easiest to control and produces the outcome that you wanted?
<input type="checkbox"/>	Free light: easy to control and the light spreads well on the objects
<input type="checkbox"/>	!!!sly portal
<input type="checkbox"/>	Others (please specify)

8. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes?

--

9. Can you identify any artefact on the animated model such as pinching problem etc.?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

10. Is the 360 degree rendering necessary for modelling and animating 3D object model?

<input type="checkbox"/>	Yes it's necessary to view the model in any direction
<input type="checkbox"/>	No, Realistic flexible motion, and good use of different locomotion.
<input type="checkbox"/>	Others (please specify)

11. Do you have any dissatisfaction to the 3D animation solution?

<input type="checkbox"/>	Yes, too expensive, long time for downloading, freeze every time the user try to play action replay.
<input type="checkbox"/>	Yes, it's not easy to use, and cost too much time (please specify the details if possible):
<input type="checkbox"/>	Yes
<input type="checkbox"/>	No, I'm satisfied

12. What does an animator have to do to give a Footsteps animation more personality?

13. Which type of animation would be suitable for the use sport movement animation in your experience?

14.. Is proper timing is critical to making ideas readable in animation?

15. What is your perception of perfect character animation?

10. What kind of distinguishing detail would you like to see in character animation?

11. Are the character actions in this animation believable, probable, or at least plausible?

<input type="radio"/>	Believable
<input type="radio"/>	Probable
<input type="radio"/>	Plausible
<input type="radio"/>	Least plausible

12. Please give 3-5 adjectives that describe the character/animation you would like to see in the design e.g. (cheerful, tough, intelligent, sloppy, etc.)

13. Is there a visual look or "style" you have in mind for the character(s)? (If so, please give examples)

14. Do you prefer to watch animation process as a comic or animation?

<input type="radio"/>	Comic
<input type="radio"/>	animation

15. What kind of final image quality do you expect to see in character animation?

22. From your personal experience do you think subjects performed better with animated interfaces based on realistic rather than abstract images?

☐ !Animated realistic image

☐ !Abstract images

23. Do you think character animation should only be used in games, or should it be used in any other applications?

☐ Character animation should only be used in games

☐ Other application

24. What do you consider an "important" difference in satisfaction ratings that you'd like to be able to detect in character animation?

25. Would you like computer animation and illustrate activities been used in Education?

☐ -----

26. What improvement would you like to witness when using a map in games/computer animation?

27. What type of environment would you like to see in computer animation that could influence the perception of a virtual character's affective state and personality?

28. Do you think specific lighting causes a particular perception effect on the character animations?

29. Does bright lighting make a character more likely to be perceived as more agreeable and why?

30. Would you prefer to see audio and special effects included in animation production techniques to enhance their quality? Please comment.

31. What quality expectations in 3D animation do you expect the animator to provide on character motion?



32. What are some of the most challenging aspects of character animation?



33. What are the similarities between modern animation works in comparison with animation from the past?



34. What is the biggest myth about character animation?



35. What are the most critical quality factors in computer animation?

--

36. What are some of the exciting aspects of character animation?

--

37. What is your favourite part about working with character animation?

--

38. Does the character's in the animation you chose flow well from one movement to another?

r

39. Which area would you like to see the improvement on the 3d character animation? Please give brief comment **if** you wish. Is it in: Education, Gaming, industry, medical field, military.....etc?

r	Education
r	Gaming
r	Sport
r	Entertainment

40. Which area in 3D character animation that you are interested at?

<input type="radio"/>	Animation
<input type="radio"/>	Modelling
<input type="radio"/>	Design
<input type="radio"/>	Texturing, colour and light

41. In a short animation, what kind of theme do you like most? (You may choose 2)

--

42. Which one do you prefer: (a) full action and exciting animation moves from the beginning or (b) short animation which focused more on story and put a few action animations in some parts of it?

43. For a short 3D animation, do you prefer human characters or non-human characters?

<input type="radio"/>	Human
<input type="radio"/>	Non human

44. According to your experiences and knowledge, which render application that has a better use and also producing good quality outcomes? Maya software, 3ds max ...etc.

<input type="radio"/>	Maya software.
<input type="radio"/>	3DS Max
<input type="radio"/>	Blender
<input type="radio"/>	Other:

45. Which of type of Lights easiest for you to visualise and produces the outcome that you wanted?

- ☒ Spot Light
- ☒ Directional Light
- ☒ Ambient Light
- ☒ Area Light

46. \What are the strengths and weaknesses have you noticed in 3D character animation?



47. \What has been your favourite subject seeing character animation been used so far?

- ☒ Action
- ☒ Comedy
- ☒ Horror
- ☒ Romance

48. What would you recommend to an aspiring animator to be good at?



49. Does the character in the animation you chose look balanced throughout the action?

50. What feature would you like to add to the quality of future character animation?

51. Rate the animations that appear in the website, based on their features and quality.

<input type="radio"/>	Good
<input type="radio"/>	Very Good
<input type="radio"/>	Bad
<input type="radio"/>	Excellent

Appendix 6

Questionnaire sample of Likert Scale for NA, K, and RB Videos

Potassium (K) dropped in Water explosion

The After-Scenario Questionnaire (ASQ)

For each of the statements below, please tick the rating of your choice.

	Fully Agree	Somewhat Disagree	Unsure	Somewhat Agree	Fully Disagree
1. Using this video animation is quite effectively to complete and perform the Sodium in Water experiment tasks scenario under supervision.	1	2	3	4	5
2. The animation gave clear reflection of the danger and the chemical reaction of the (Alkali metals) with water explosion during the experiment.	1	2	3	4	5
3. The environment and apparatus set in the animation video was clear and reflected realism.	1	2	3	4	5
4. How do you evaluate this animation					
Very Good	1	2	3	4	5
Good	1	2	3	4	5
Bad	1	2	3	4	5
Excellent	1	2	3	4	5

Questionnaire sample

Potassium (K) dropped in Water explosion

The After-Scenario Questionnaire (ASQ)

For each of the statements below, please tick the rating of your choice.

	Fully Agree	Somewhat Disagree	Unsure	Somewhat Agree	Fully Disagree
1. Using this video animation is quite effectively to complete and perform the Potassium in Water experiment tasks scenario under supervision.	1	2	3	4	5
2. The animation gave clear reflection of the danger and the chemical reaction of the (Alkali metals) with water explosion during the experiment.	1	2	3	4	5
3. The environment and apparatus set in the animation video was clear and reflected realism.	1	2	3	4	5
4. How do you evaluate this animation					
Very Good	1	2	3	4	5
Good	1	2	3	4	5
Poor	1	2	3	4	5
Excellent	1	2	3	4	5

Rubidium (Rb) dropped in Water explosion

The After-Scenario Questionnaire (ASQ)

For each of the statements below, please tick the rating of your choice.

	Fully Agree	Somewhat Disagree	Unsure	Somewhat Agree	Fully Disagree
1. Using this video animation is quite effectively to complete and perform the Rubidium in Water experiment tasks scenario under supervision.	1	2	3	4	5
2. The animation gave clear reflection of the danger and the chemical reaction of the (Alkali metals) with water explosion during the experiment.	1	2	3	4	5
3. The environment and apparatus set in the animation video was clear and reflected realism.	1	2	3	4	5
4. How do you evaluate this animation					
Very Good	1	2	3	4	5
Good	1	2	3	4	5
Poor	1	2	3	4	5
Excellent	1	2	3	4	5

Website used



Website1 sample used with (NA, K, Rb videos)

Appendix 7

Questions and answers based on animated Chemistry experiment videos

1. What is your gender?

<input type="checkbox"/>	Male
<input type="checkbox"/>	Female

2. Do you prefer to use 3D animation as a source of learning?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

3. Rate the animations that appear in the website, based on the important role of the using animation as a learning aid.

<input type="checkbox"/>	Good
<input type="checkbox"/>	Very Good
<input type="checkbox"/>	Not Bad
<input type="checkbox"/>	Excellent

4. Do you think that there is an increasing or decreasing demand for animation in education?

<input type="checkbox"/>	Increase demand
<input type="checkbox"/>	Decrease demand

5. Can you identify any artefact on the animated videos in terms of quality?

<input type="checkbox"/>	Yes, Please comment:
<input type="checkbox"/>	No

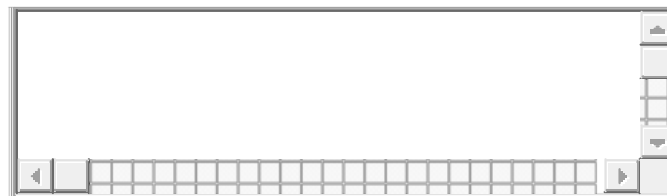
6. What is your perception of perfect character animation?



7. Are the character actions in this animation believable, probable, or at least plausible?

<input type="checkbox"/>	Believable
<input type="checkbox"/>	Probable
<input type="checkbox"/>	Plausible
<input type="checkbox"/>	Least plausible

8. What sorts of animation quality do you expect to see in character animation?



9. From your personal experience do you think illustrating subjects activities performed better with animated interfaces?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

10. What quality expectations do you expect see on character motion?



11. Does the character's in the animation you chose flow well from one movement to another?

<input type="checkbox"/>	Yes
<input type="checkbox"/>	No

12. What are the strengths and weaknesses in 3D character animation videos you have watched?

13. What has been your favourite subject seeing character animation been used at?

<input type="checkbox"/>	Chemistry
<input type="checkbox"/>	ICT
<input type="checkbox"/>	Biology
<input type="checkbox"/>	Physics

14. What feature/s would you like to add to the quality of future character animation?

15. Do you have any dissatisfaction with the 3D animation software used in education?

<input type="checkbox"/>	Yes, too expensive, long time for downloading, freeze every time the user try to play action replay.
<input type="checkbox"/>	Yes, it's not easy to use.
<input type="checkbox"/>	Yes
<input type="checkbox"/>	No, I'm satisfied

Appendix 8

Critical values of T in a ANOVA T-Test

Critical Values of t

$Df = N-2$ (N = total number of observations)

d.f.	probability (two tailed)		
	0.05	0.01	0.001
1	12.706	63.657	636.619
2	4.303	9.925	31.598
3	3.182	5.841	12.941
4	2.776	4.604	8.610
5	2.571	4.032	6.859
6	2.447	3.707	5.959
7	2.365	3.499	5.405
8	2.306	3.355	5.041
9	2.262	3.250	4.781
10	2.228	3.169	4.587
11	2.201	3.106	4.437
12	2.179	3.055	4.318
13	2.160	3.012	4.221
14	2.145	2.977	4.140
15	2.131	2.947	4.073
16	2.120	2.921	4.015
17	2.110	2.898	3.965
18	2.101	2.878	3.922
19	2.093	2.861	3.883
20	2.086	2.845	3.850
21	2.080	2.831	3.819
22	2.074	2.819	3.792
23	2.069	2.807	3.767
24	2.064	2.797	3.745
25	2.060	2.787	3.725
26	2.056	2.779	3.707
27	2.052	2.771	3.690
28	2.048	2.763	3.674
29	2.045	2.756	3.659
30	2.042	2.750	3.646
40	2.021	2.704	3.551
60	2.000	2.660	3.460
120	1.980	2.617	3.373
∞	1.960	2.576	3.291

Appendix 9

Critical Values for F ($p < .05$) ANOVA

df _{within}	df _{among}									
	1	2	3	4	5	6	7	8	9	10
1	161.4476	199.5000	215.7073	224.5832	230.1619	233.9860	236.7684	238.8827	240.5433	241.8817
2	18.5128	19.0000	19.1643	19.2468	19.2964	19.3295	19.3532	19.3710	19.3848	19.3959
3	10.1280	9.5521	9.2766	9.1172	9.0135	8.9406	8.8867	8.8452	8.8123	8.7855
4	7.7086	6.9443	6.5914	6.3882	6.2561	6.1631	6.0942	6.0410	5.9988	5.9644
5	6.6079	5.7861	5.4095	5.1922	5.0503	4.9503	4.8759	4.8183	4.7725	4.7351
6	5.9874	5.1433	4.7571	4.5337	4.3874	4.2839	4.2067	4.1468	4.0990	4.0600
7	5.5914	4.7374	4.3468	4.1203	3.9715	3.8660	3.7870	3.7257	3.6767	3.6365
8	5.3177	4.4590	4.0662	3.8379	3.6875	3.5806	3.5005	3.4381	3.3881	3.3472
9	5.1174	4.2565	3.8625	3.6331	3.4817	3.3738	3.2927	3.2296	3.1789	3.1373
10	4.9646	4.1028	3.7083	3.4780	3.3258	3.2172	3.1355	3.0717	3.0204	2.9782
11	4.8443	3.9823	3.5874	3.3567	3.2039	3.0946	3.0123	2.9480	2.8962	2.8536
12	4.7472	3.8853	3.4903	3.2592	3.1059	2.9961	2.9134	2.8486	2.7964	2.7534
13	4.6672	3.8056	3.4105	3.1791	3.0254	2.9153	2.8321	2.7669	2.7144	2.6710
14	4.6001	3.7389	3.3439	3.1122	2.9582	2.8477	2.7642	2.6987	2.6458	2.6022
15	4.5431	3.6823	3.2874	3.0556	2.9013	2.7905	2.7066	2.6408	2.5876	2.5437
16	4.4940	3.6337	3.2389	3.0069	2.8524	2.7413	2.6572	2.5911	2.5377	2.4935
17	4.4513	3.5915	3.1968	2.9647	2.8100	2.6987	2.6143	2.5480	2.4943	2.4499
18	4.4139	3.5546	3.1599	2.9277	2.7729	2.6613	2.5767	2.5102	2.4563	2.4117
19	4.3807	3.5219	3.1274	2.8951	2.7401	2.6283	2.5435	2.4768	2.4227	2.3779
20	4.3512	3.4928	3.0984	2.8661	2.7109	2.5990	2.5140	2.4471	2.3928	2.3479
21	4.3248	3.4668	3.0725	2.8401	2.6848	2.5727	2.4876	2.4205	2.3660	2.3210
22	4.3009	3.4434	3.0491	2.8167	2.6613	2.5491	2.4638	2.3965	2.3419	2.2967
23	4.2793	3.4221	3.0280	2.7955	2.6400	2.5277	2.4422	2.3748	2.3201	2.2747
24	4.2597	3.4028	3.0088	2.7763	2.6207	2.5082	2.4226	2.3551	2.3002	2.2547
25	4.2417	3.3852	2.9912	2.7587	2.6030	2.4904	2.4047	2.3371	2.2821	2.2365

26	4.2252	3.3690	2.9752	2.7426	2.5868	2.4741	2.3883	2.3205	2.2655	2.2197
27	4.2100	3.3541	2.9604	2.7278	2.5719	2.4591	2.3732	2.3053	2.2501	2.2043
28	4.1960	3.3404	2.9467	2.7141	2.5581	2.4453	2.3593	2.2913	2.2360	2.1900
29	4.1830	3.3277	2.9340	2.7014	2.5454	2.4324	2.3463	2.2783	2.2229	2.1768
30	4.1709	3.3158	2.9223	2.6896	2.5336	2.4205	2.3343	2.2662	2.2107	2.1646
40	4.0847	3.2317	2.8387	2.6060	2.4495	2.3359	2.2490	2.1802	2.1240	2.0772
60	4.0012	3.1504	2.7581	2.5252	2.3683	2.2541	2.1665	2.0970	2.0401	1.9926
120	3.9201	3.0718	2.6802	2.4472	2.2899	2.1750	2.0868	2.0164	1.9588	1.9105
inf	3.8415	2.9957	2.6049	2.3719	2.2141	2.0986	2.0096	1.9384	1.8799	1.8307

Appendix 10

T Values full Table

Critical t values (full table)

The columns are probabilities, and the rows degrees of freedoms. Each cell contains the critical value for that particular degrees of freedom and probability of Type I error (alpha α)

α is the probability of Type I error.

The t values are for the two tail test. The same t value is used for half the alpha value in a one tail test.

For example, at 20 degrees of freedom, the t value of 2.086 is critical for $\alpha=0.05$ (2 tail) and $\alpha=0.025$ (1 tail). With the same degrees of freedom, 1.725 is critical for $\alpha=0.1$ (2 tail) and $\alpha=0.05$ (1 tail).

17	1.7396	2.1098	2.5669	2.8983	3.2224	3.6458	3.9651
18	1.7341	2.1009	2.5524	2.8784	3.1966	3.6105	3.9216
19	1.7291	2.0930	2.5395	2.8609	3.1737	3.5794	3.8834
20	1.7247	2.0860	2.5280	2.8454	3.1534	3.5518	3.8495
α (1 tail)	0.05	0.025	0.01	0.005	0.0025	0.001	0.0005
α (2 tail)	0.1	0.05	0.02	0.01	0.005	0.002	0.001
df							
21	1.7207	2.0796	2.5176	2.8314	3.1352	3.5272	3.8193
22	1.7172	2.0739	2.5083	2.8188	3.1188	3.5050	3.7921
23	1.7139	2.0686	2.4998	2.8073	3.1040	3.4850	3.7676
24	1.7109	2.0639	2.4922	2.7970	3.0905	3.4668	3.7454
25	1.7081	2.0596	2.4851	2.7874	3.0782	3.4502	3.7251

Critical Values for Tukey's HSD (Q)

The critical values for q corresponding to $\alpha = .05$ (top) and $\alpha = .01$

(bottom)

df for Error Term	k= Number of Treatments								
	2	3	4	5	6	7	8	9	10
5	3.64 5.70	4.60 6.98	5.22 7.80	5.67 8.42	6.03 8.91	6.33 9.32	6.58 9.67	6.80 9.97	6.99 10.24
6	3.46 5.24	4.34 6.33	4.90 7.03	5.30 7.56	5.63 7.97	5.90 8.32	6.12 8.61	6.32 8.87	6.49 9.10
7	3.34 4.95	4.16 5.92	4.68 6.54	5.06 7.01	5.36 7.37	5.61 7.68	5.82 7.94	6.00 8.17	6.16 8.37
8	3.26 4.75	4.04 5.64	4.53 6.20	4.89 6.62	5.17 6.96	5.40 7.24	5.60 7.47	5.77 7.68	5.92 7.86
9	3.20 4.60	3.95 5.43	4.41 5.96	4.76 6.35	5.02 6.66	5.24 6.91	5.43 7.13	5.59 7.33	5.74 7.49
10	3.15 4.48	3.88 5.27	4.33 5.77	4.65 6.14	4.91 6.43	5.12 6.67	5.30 6.87	5.46 7.05	5.60 7.21
11	3.11 4.39	3.82 5.15	4.26 5.62	4.57 5.97	4.82 6.25	5.03 6.48	5.20 6.67	5.35 6.84	5.49 6.99
12	3.08 4.32	3.77 5.05	4.20 5.50	4.51 5.84	4.75 6.10	4.95 6.32	5.12 6.51	5.27 6.67	5.39 6.81
13	3.06 4.26	3.73 4.96	4.15 5.40	4.45 5.73	4.69 5.98	4.88 6.19	5.05 6.37	5.19 6.53	5.32 6.67
14	3.03 4.21	3.70 4.89	4.11 5.32	4.41 5.63	4.64 5.88	4.83 6.08	4.99 6.26	5.13 6.41	5.25 6.54
15	3.01 4.17	3.67 4.84	4.08 5.25	4.37 5.56	4.59 5.80	4.78 5.99	4.94 6.16	5.08 6.31	5.20 6.44
16	3.00 4.13	3.65 4.79	4.05 5.19	4.33 5.49	4.56 5.72	4.74 5.92	4.90 6.08	5.03 6.22	5.15 6.35
17	2.98 4.10	3.63 4.74	4.02 5.14	4.30 5.43	4.52 5.66	4.70 5.85	4.86 6.01	4.99 6.15	5.11 6.27
18	2.97 4.07	3.61 4.70	4.00 5.09	4.28 5.38	4.49 5.60	4.67 5.79	4.82 5.94	4.96 6.08	5.07 6.20
19	2.96 4.05	3.59 4.67	3.98 5.05	4.25 5.33	4.47 5.55	4.65 5.73	4.79 5.89	4.92 6.02	5.04 6.14
20	2.95 4.02	3.58 4.64	3.96 5.02	4.23 5.29	4.45 5.51	4.62 5.69	4.77 5.84	4.90 5.97	5.01 6.09
24	2.92 3.96	3.53 4.55	3.90 4.91	4.17 5.17	4.37 5.37	4.54 5.54	4.68 5.69	4.81 5.81	4.92 5.92
30	2.89 3.89	3.49 4.45	3.85 4.80	4.10 5.05	4.30 5.24	4.46 5.40	4.60 5.54	4.72 5.65	4.82 5.76
40	2.86 3.82	3.44 4.37	3.79 4.70	4.04 4.93	4.23 5.11	4.39 5.26	4.52 5.39	4.63 5.50	4.73 5.60
60	2.83 3.76	3.40 4.28	3.74 4.59	3.98 4.82	4.16 4.99	4.31 5.13	4.44 5.25	4.55 5.36	4.65 5.45
120	2.80 3.70	3.36 4.20	3.68 4.50	3.92 4.71	4.10 4.87	4.24 5.01	4.36 5.12	4.47 5.21	4.56 5.30
infinity	2.77 3.64	3.31 4.12	3.63 4.40	3.86 4.60	4.03 4.76	4.17 4.88	4.29 4.99	4.39 5.08	4.47 5.16

Appendix 11

What do you need to know about this animation?



Introduction

This animation consist of a short video which have been created in Flash CS6, and will give a basic outline of using animation production as a guiding tool to help you understand your topic more effectively, interactively and funny way of learning.

The concept of this video is to demonstrate a chemical reaction between Sodium (Na) and chloride (Cl), in a comical way, to convey the information required about the atomic structure and ionic bonding through the use of animation, and how sodium and chloride react with each other to produce the most usable item in our everyday use i.e. SALT.

Why use animation?

- Visually appealing and easy to recall what you have seen.
- It will maintain your attention.
- Effective and easy to follow, therefore, it help to learn the topic quicker than normal text format, also it will guide for your exams preparation.

How to use this video

- This video is straight forward to use read the first line
- Click on the lizard house button situated as a first button on the tree as a form of a rectangular shape, and watch your first movie.
- Click the movie 1, 2... to go to the next page.
- Click the home button to stop the animation.



Na + Cl sample (1) animation

WHAT DO YOU NEED TO KNOW ABOUT THIS ANIMATION?

HYDROGEN BONDING DAY WITH CHEMISTRY

Introduction

This animation consist of a short video which have been created in Flash CS6, and will give a basic outline of using animation production as a guiding tool to help understand your topic more effectively, interactively and funny way of learning.

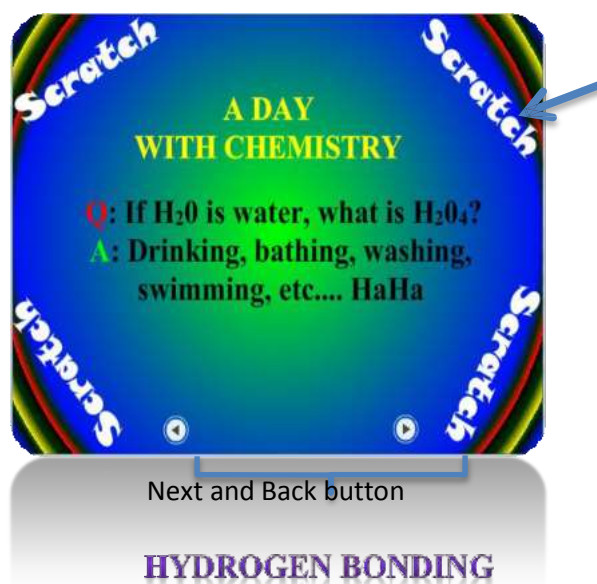
The concept of this video is to demonstrate how a slight positive charge of a hydrogen atom in a water molecule can attract an atom with a slight negative charge, such as the nitrogen in a molecule of ammonia. This forms a hydrogen bond between the two atoms.

Why using animation?

- Visually appealing and easy to recall what you have seen.
- It will maintain your attention.
- Effective and easy to follow, therefore, it help to learn the topic quicker than normal text format, also it will guide for your exams preparation.

How to use this video

- This video is straight forward to use start by scratching the first page and click on the play button to go to the next page.
- Read about hydrogen bonding and click on the next page.
- Next page will explain to you how hydrogen bonding involves in creating protein.
- The next page will demonstrate the DNA structure. More information is provided regarding this structure by clicking on read me button.
- Click the back button to stop the animation.



Appendix 11A

Question Format for the animation experiment samples

This animation samples been created in Adobe Flash CS6 to represent a chemistry experiments Sodium and chloride reaction.

Please read the questions below and score the content of the animation sample out of 100 points with respect to the story board and the quality of the animation.

Each question can only gain a maximum of 5 points.

Sodium and chloride reaction Questions

Questions	Story Board	Score
1	The video sample shows a clear reaction between CL and NA	
2	Offers support to your study	
3	The ability to portray the message about the given subject matter.	
4	The animation represent information clearly	
5	Possible use of theory learnt from video and apply in practice in the future	
6	Can link theory with other examples	
7	Exploring the possibilities of animation as a method of learning to develop student's skills and competencies.	
8	Did it expand my knowledge and education	
9	Learning using new method	
10	Did it answer your questions and meet your objectives	

Questions	Quality	Score
1	Did it capture your interest?	
2	Did the animation have interesting features	
3	Did the animation achieve the goals and objectives of the lesson	
4	Was the animation colourful, easy to understand and clear	
5	The transition of the character movement from one position to another.	
6	Were you able to understand chemical bonding from this animation	
7	The sample design is suitable for student who wishes to use animation as a tool in their study and professional work.	
8	The animation Reflected theory and practice	
9	Was the wording clear and concise	
10	Did the animation motivate you to learn further about the topic	

Total score out of 100 points: -----

Appendix 11B

Question Format for the animation experiment samples

This animation samples been created in Adobe Flash CS6 to represent a **Hydrogen Bonding**. Please read the questions below and score the content of the animation sample out of 100 points with respect to the story board and the quality of the animation.

Each question can only gain a maximum of 5 points.

Hydrogen Bonding Questions

Questions	Story Board	Score
1	The video sample shows a Hydrogen Bonding clearly	
2	Offers support to your study	
3	The ability to portray the message about the given subject matter.	
4	The animation represent information clearly	
5	Possible use of theory learnt from video and apply in practice in the future	
6	Can link theory with other examples	
7	Exploring the possibilities of animation as a method of learning to develop student's skills and competencies.	
8	Did it expand my knowledge and education	
9	Learning using new method	
10	Did it answer your questions and meet your objectives	

Questions	Quality	Score
1	Did it capture your interest?	
2	Did the animation have interesting features	
3	Did the animation achieve the goals and objectives of the lesson	
4	Was the animation colourful, easy to understand and clear	
5	The transition of the character movement from one position to another.	
6	Were you able to understand chemical bonding from this animation	
7	The sample design is suitable for student who wishes to use animation as a tool in their study and professional work.	
8	The animation Reflected theory and practice	
9	Was the wording clear and concise	
10	Did the animation motivate you to learn further about the topic	

Total score out of 100 points: -----

Appendix II C

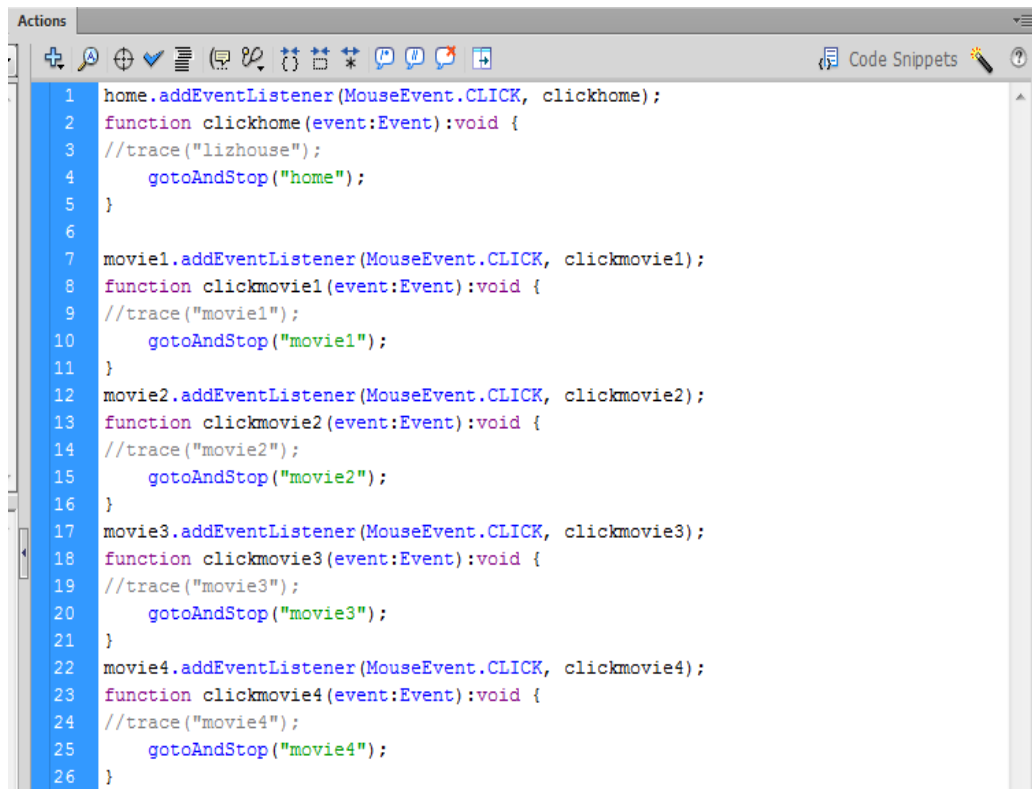
Critical Values of the Wilcoxon Signed Ranks Test

n	Two-Tailed Test		One-Tailed Test	
	$\alpha = .05$	$\alpha = .01$	$\alpha = .05$	$\alpha = .01$
5	--	--	0	--
6	0	--	2	--
7	2	--	3	0
8	3	0	5	1
9	5	1	8	3
10	8	3	10	5
11	10	5	13	7
12	13	7	17	9
13	17	9	21	12
14	21	12	25	15
15	25	15	30	19
16	29	19	35	23
17	34	23	41	27
18	40	27	47	32
19	46	32	53	37
20	52	37	60	43
21	58	42	67	49
22	65	48	75	55
23	73	54	83	62
24	81	61	91	69
25	89	68	100	76
26	98	75	110	84
27	107	83	119	92
28	116	91	130	101
29	126	100	140	110

Appendix 11D

Actionscript for Sodium and chloride reaction

The code to activate the buttons is shown below:



```
1 home.addEventListener(MouseEvent.CLICK, clickhome);
2 function clickhome(event:Event):void {
3     //trace("lizhouse");
4     gotoAndStop("home");
5 }
6
7 movie1.addEventListener(MouseEvent.CLICK, clickmovie1);
8 function clickmovie1(event:Event):void {
9     //trace("movie1");
10    gotoAndStop("movie1");
11 }
12 movie2.addEventListener(MouseEvent.CLICK, clickmovie2);
13 function clickmovie2(event:Event):void {
14     //trace("movie2");
15     gotoAndStop("movie2");
16 }
17 movie3.addEventListener(MouseEvent.CLICK, clickmovie3);
18 function clickmovie3(event:Event):void {
19     //trace("movie3");
20     gotoAndStop("movie3");
21 }
22 movie4.addEventListener(MouseEvent.CLICK, clickmovie4);
23 function clickmovie4(event:Event):void {
24     //trace("movie4");
25     gotoAndStop("movie4");
26 }
```

A stop action been added to the action layer to stop the scene playing continuously is shown below.

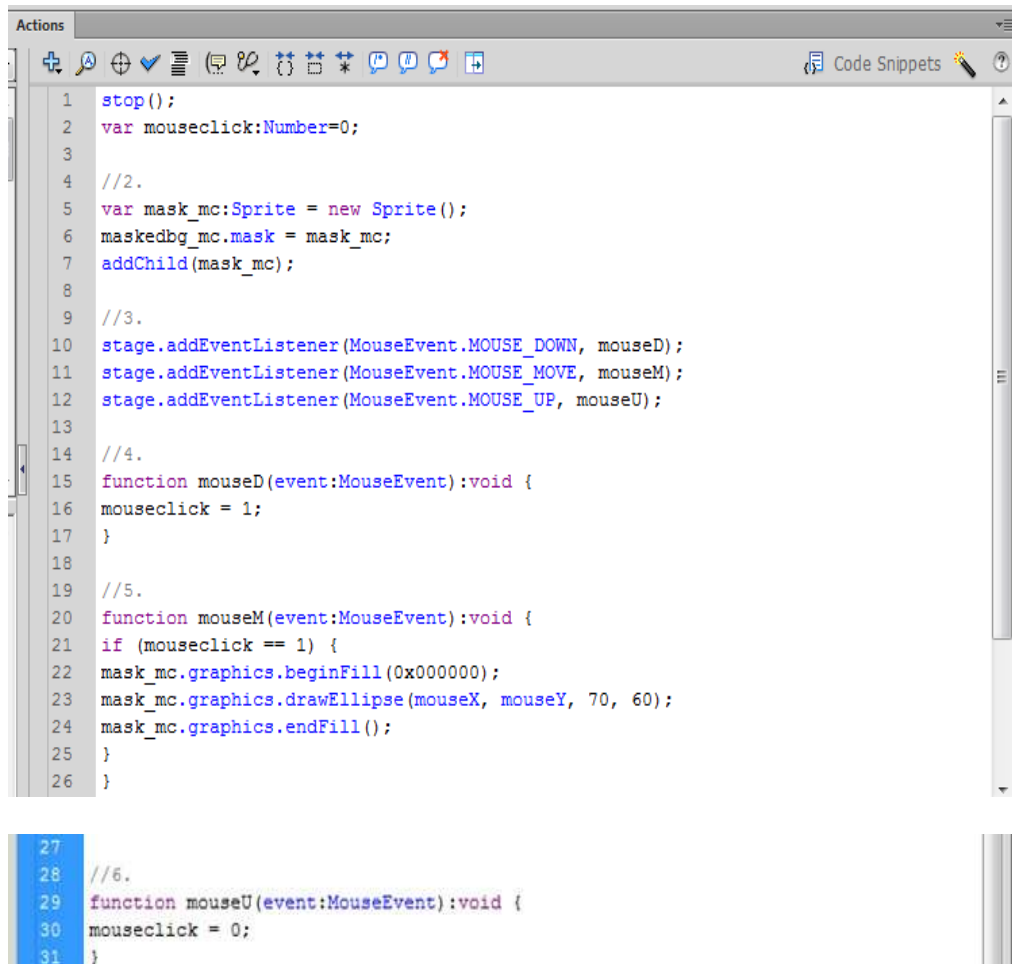


```
1 stop()
```

Appendix 11E

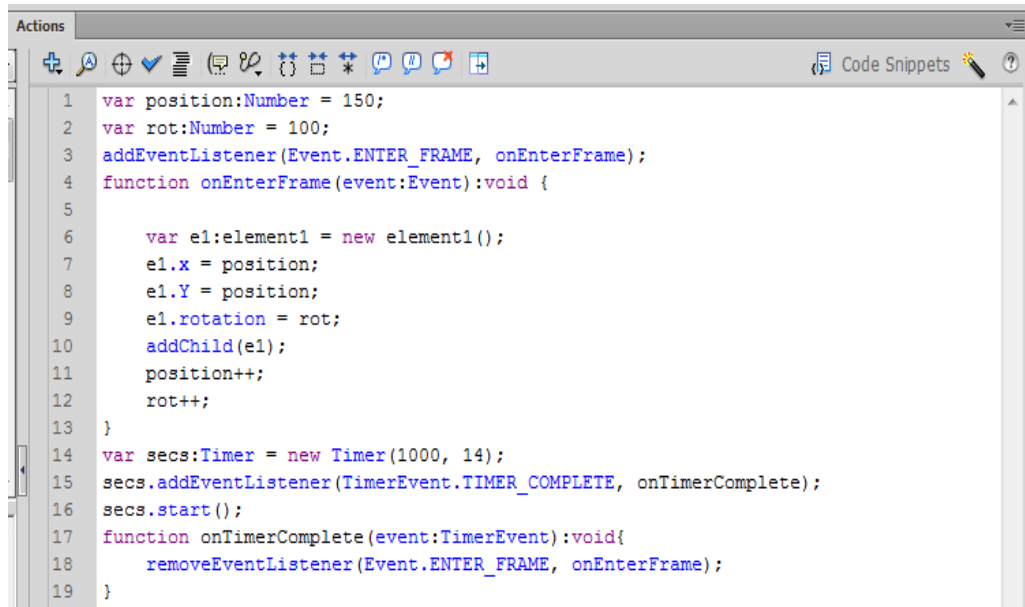
Actionscript for Hydrogen Bonding

The code for scratching the card is



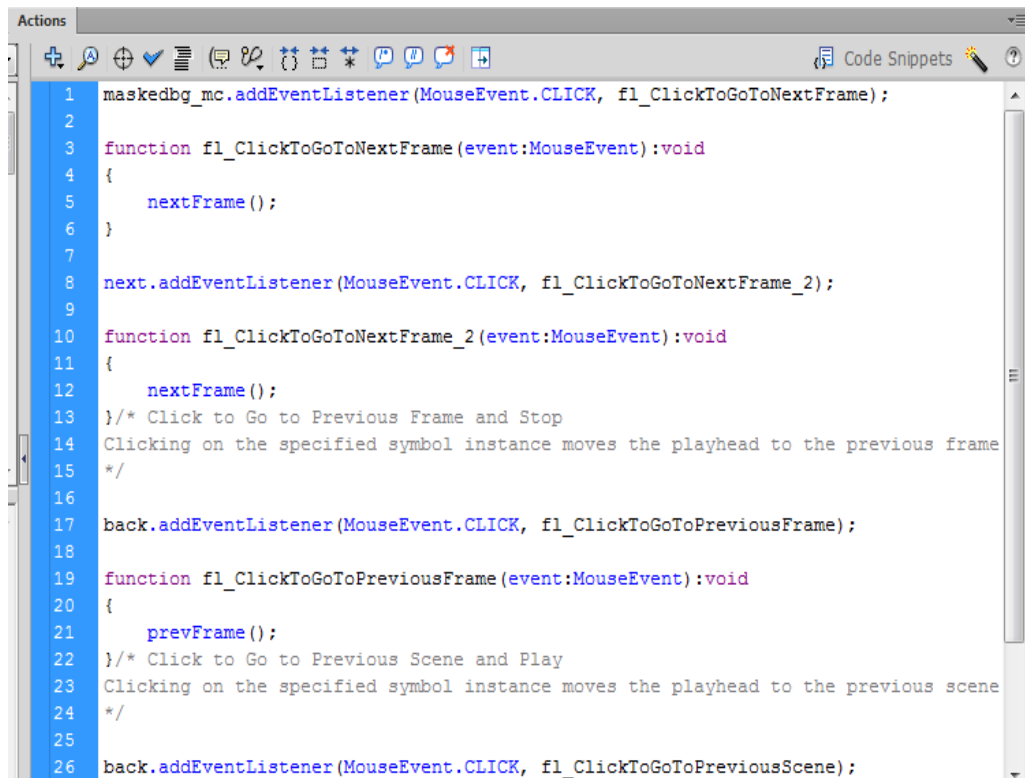
```
1  stop();
2  var mouseclick:Number=0;
3
4  //2.
5  var mask_mc:Sprite = new Sprite();
6  maskedbg_mc.mask = mask_mc;
7  addChild(mask_mc);
8
9  //3.
10 stage.addEventListener(MouseEvent.CLICK, mouseD);
11 stage.addEventListener(MouseEvent.CLICK, mouseM);
12 stage.addEventListener(MouseEvent.CLICK, mouseU);
13
14 //4.
15 function mouseD(event:MouseEvent):void {
16     mouseclick = 1;
17 }
18
19 //5.
20 function mouseM(event:MouseEvent):void {
21     if (mouseclick == 1) {
22         mask_mc.graphics.beginFill(0x000000);
23         mask_mc.graphics.drawEllipse(mouseX, mouseY, 70, 60);
24         mask_mc.graphics.endFill();
25     }
26 }
27
28 //6.
29 function mouseU(event:MouseEvent):void {
30     mouseclick = 0;
31 }
```

Code for DNA rotation:



```
1 var position:Number = 150;
2 var rot:Number = 100;
3 addEventListener(Event.ENTER_FRAME, onEnterFrame);
4 function onEnterFrame(event:Event):void {
5
6     var e1:element1 = new element1();
7     e1.x = position;
8     e1.y = position;
9     e1.rotation = rot;
10    addChild(e1);
11    position++;
12    rot++;
13 }
14 var secs:Timer = new Timer(1000, 14);
15 secs.addEventListener(TimerEvent.TIMER_COMPLETE, onTimerComplete);
16 secs.start();
17 function onTimerComplete(event:TimerEvent):void{
18     removeEventListener(Event.ENTER_FRAME, onEnterFrame);
19 }
```

The control buttons code:



```
1 maskedbg_mc.addEventListener(MouseEvent.CLICK, fl_ClickToGoToNextFrame);
2
3 function fl_ClickToGoToNextFrame(event:MouseEvent):void
4 {
5     nextFrame();
6 }
7
8 next.addEventListener(MouseEvent.CLICK, fl_ClickToGoToNextFrame_2);
9
10 function fl_ClickToGoToNextFrame_2(event:MouseEvent):void
11 {
12     nextFrame();
13 }
14 /* Click to Go to Previous Frame and Stop
15 Clicking on the specified symbol instance moves the playhead to the previous frame
16 */
17 back.addEventListener(MouseEvent.CLICK, fl_ClickToGoToPreviousFrame);
18
19 function fl_ClickToGoToPreviousFrame(event:MouseEvent):void
20 {
21     prevFrame();
22 }
23 /* Click to Go to Previous Scene and Play
24 Clicking on the specified symbol instance moves the playhead to the previous scene
25 */
26 back.addEventListener(MouseEvent.CLICK, fl_ClickToGoToPreviousScene);
```



```

27
28 function fl_ClickToGoToPreviousScene(event:MouseEvent):void
29 {
30     MovieClip(this.root).prevScene();
31 }

```

The stop action and playing frame 1 in the scene:

```

6 stop();/* Click to Go to Frame and Stop
7 Clicking on the specified symbol instance moves the playhead to the specified frame
8 Can be used on the main timeline or on movie clip timelines.
9
10 Instructions:
11 1. Replace the number 5 in the code below with the frame number you would like the
12 */
13
14 b1.addEventListener(MouseEvent.CLICK, fl_ClickToGoToAndStopAtFrame_4);
15
16 function fl_ClickToGoToAndStopAtFrame_4(event:MouseEvent):void
17 {
18     gotoAndStop(1);
19 }

```

Appendix 12

What do you need to know about this animation?

Chemistry guessing game

Introduction


This animation consist of a short video which have been created in Flash CS6, and will give a basic outline of using animation production as a guiding tool to help students understand what they have learned from the previous two animated samples in more effectively, interactively and enjoyable way of learning.

The concept of this video is to try and fill the dotted line underneath the hanging post. The selected words are related to what you have learned in previous lessons, videos and the hints on the top of the screen.

Why using animation?

- Visually appealing and easy to recall what you have seen.
- It will maintain your attention.
- Effective and easy to follow, therefore, it help to learn the topic quicker than normal text format, also it will guide for your exams preparation.

How to use this video

- This video is straight forward to use start by clicking the enter sign 
- Second page will appear to start your game.
- Fill in the dotted line in your on time, any correct letter will be display on the dotted line, and any incorrect letter will be shown as a part of the teddy's body been hanged on the post.
- If you guessed all the letters correctly a well done message will be displayed and if you like to have another go?
- If your guess was unsuccessful then a sorry you are hanged will be displayed, and please have another go.
- By choosing have another go button will take you to start of the game.



Chemistry Guessing Game Evaluation Form

Enter button

Please complete the Evaluation form, and score the video from 1 to 5 (1 being poor, 5 being Excellent). Total score out of 30 points

Gender M/F	Material	Poor	Fair	Average	Good	Excellent
	Did the animation give Knowledge to the topic?					
	Organization of the video was it easy to use?					
	Quality of animation					
	Did the animation achieve the objectives					

Evaluation Form

Male total score out of 30 points: 16

Female Total score out of 30 points: 14

Media Project Check List Form

Please give you feedback for the three animated samples (Na +Cl reaction, Hydrogen bonding and Day in chemistry) you have has performed.
Please fill in the following questions by clicking the box to the right in the check list below.

Item	Yes	No	Not sure	Don't Know
1. Was the storyboard complete?	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The role of the character presented in this animation was clear and suitable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. The animation was clear and not complicated to follow.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Animation video is useful to expand my knowledge and education				
4. Make study more interesting and fun to do.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. This animation process can be used to visualize a dynamic phenomenon which cannot be readily seen by the eye or science setting (e.g. molecules).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The animations meet your interception.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. The speed of animation video let you use it at your own pace and not have to keep up with everyone else.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. It's a form of group work, debatable session, and allows you bounce of ideas and knowledge off each other.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. Animation gives you familiarity with a variety of different subject and software.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. The animation final product reflected the content.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
11. The animation gave you the ability to work collaboratively in group-based activities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
12. Animation gives you opportunity to acquire skills in using ICT/multimedia in a pedagogical learning.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
13. Animation gives awareness to danger of any chemical experiment before, applying the real practice.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
14. Animation expanded your creative vision	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
15. Animation improves student's engagement and the quality of the work.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
16. This animation was capable of presenting true-to-life situations that you face every day.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
17. Animation it is not easy for every subject	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
18. More motivation to learn	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
19. Flexibility and safety	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
20. Animation gives you the ability to practice new concepts in a risk-free environment and improves your skills and abilities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Appendix 12

The ActionScript code for the Chemistry Guessing Game

Appendix 12

The ActionScript code for the Chemistry Guessing Game

The required code for all answers necessary for this game are:

```

stop();//Array containing all of the answers

gameanswers = ['Methane', 'Giant Lattice', 'Carbon Dioxide', 'Ammonia',
'Chlorine', 'Oxygen', 'Fluoride', 'Sodium chloride', 'Ionic Bonding', 'Magnesium
Chloride'];

//Attach the missgraphic

this.attachMovie('missgraphic','missgraphic',this.getNextHighestDepth(),
{_x:175,_y:10});

//Function that begins a new game

function newGame() {

    //select a random answer from the array

    answer = gameanswers[Math.floor(Math.random()*gameanswers.length)];

    //Add all 26 letter buttons to the stage

    for (curindex=0; curindex<26; curindex++) {

        //Use the character code for each letter to attach the letter

        attachMovie('guessletter',

'guess'+String.fromCharCode(curindex+65), this.getNextHighestDepth());

        //set the x position according to its position in the alphabet

        eval('guess'+String.fromCharCode(curindex+65))._x          =

(curindex%13-

6.5)*(eval('guess'+String.fromCharCode(curindex+65))._width+3)+Stage.width/2

;

        //set the y position according to its position in the alphabet

        eval('guess'+String.fromCharCode(curindex+65))._y          =

Stage.height-(2-

```

```

Math.floor(curindex/13))*(eval('guess'+String.fromCharCode(curindex+65))._height+3);

        //set the character display to the current letter in the loop
        eval('guess'+String.fromCharCode(curindex+65)).displayletter=
String.fromCharCode(curindex+65);

        //When the player clicks the button, call the pressLetter function
with the letter set
        eval('guess'+String.fromCharCode(curindex+65)).onPress =
function() {

            //process the letter
            pressLetter(this.displayletter);

            //remove the button from the stage
            removeMovieClip(this);

        };
    }

    //Determine how many characters are going to be printed on each line.

    //Keep the letters of words from being split onto different lines

    //start the row count at 0

    curline = 0;

    //the start position in the answer is 0

    linestart = 0;

    //store the length of each line into an array

    var linelengths:Array = new Array();

    //traverse all of the characters in the answer

```



```

for (linepos=0; linepos<length(answer); linepos++) {

    //Maximum length of each formatted line

    blanklinelength = 25;

    //check if the linelength is smaller than the max line length or the
first word on the line is longer than the max

    if ((linepos-linestart)<blanklinelength || linelengths[curline] ==
undefined) {

        //if the current character is a space, set a marker so we
know how long the line should be

        //it may be updated if another word fits within the current
line

        if (answer.charAt(linepos) == ' ') {

            //update the length of the current line

            linelengths[curline] = linepos-linestart+1;

        }

        //else the line has reached its limit, so move to the next line
and start at the end of the last word

    } else {

        //store where to start the next line

        linestart = linestart+linelengths[curline];

        //move to that position

        linepos = linestart;

        //move to the next line

        curline++;
    }
}

```

```

    }

}

//set the length of the last line

linelengths[curline] = length(answer)-linestart;

//Now we are going to add the blank holders to the stage

//start at the first row

currow = 0;

//set the position to 0

curpos = 0;

//Loop through the answer and add the blank holders to the stage

for (curindex=0; curindex<length(answer); curindex++) {

    //If the current position is a space, do not create a blank holder

    if (answer.charAt(curindex) != ' ') {

        //add the letter holder

        attachMovie('letterholder','holder'+curindex,

this.getNextHighestDepth());

        //set the x position relative to its position on the line and the

number of characters on the line

        eval('holder'+curindex)._x    =    Stage.width/2+((curpos-

(linelengths[currow]/2))*20);

        //set the y position according to the currow

        eval('holder'+curindex)._y    =    280+(currow-

(linelengths.length/2))*20;

        //if the current character is not A-Z, display it

```

```

        if (!hiddenCharacter(answer.charAt(curindex))) {

            //display the character, since it is a special character

            eval('holder'+curindex).displayletter=
answer.charAt(curindex);

        }

    }

    //If we are at the end of a row, go to the next row
    if (++curpos>=linelengths[currow]) {

        //move to the next row

        currow++;

        //reset the position to the left

        curpos = 0;

    }

}
}

```

//This function checks if the input character is an A-Z character

```

function hiddenCharacter(curchar) {

    //Set of characters that aren't revealed

    hiddenchars = 'abcdefghijklmnopqrstuvwxyz';

    //Loop through the character set

    for (charindex=0; charindex<length(hiddenchars); charindex++) {

        //If the input character is in the list, hide it

        if (curchar.toLowerCase() == hiddenchars.charAt(charindex)) {

```

```

        return true;
    }
}

//character is not A-Z, so display it
return false;
}

//function called each time a letter button is pressed
function pressLetter(pressedletter) {
    //check if the pressed letter is in the answer
    if (!inAnswer(pressedletter)) {
        //update the graphic to the next image
        missgraphic.gotoAndStop(missgraphic._currentframe+1);
        //check if the last frame has been reached
        if (missgraphic._currentframe == missgraphic._totalframes) {
            //game lost. remove all of the remaining buttons
            for (curindex=0; curindex<26; curindex++) {
                //if the letter button exists, remove it
                if
(eval('guess'+String.fromCharCode(curindex+65))) {
                    //delete the button. 65 is the ascii character
                    A

removeMovieClip('guess'+String.fromCharCode(curindex+65));
                }
            }
        }
    }
}

```

```

    }

    //the game has been lost, so fill in all of the blank spaces with the answers
in red

    for (curindex=0; curindex<length(answer); curindex++) {

        //if there is a space or the letter has been guessed
already do nothing

        if (answer.charAt(curindex) != ' ' &&
eval('holder'+curindex).displayletter == undefined) {

            //the letter has not been guessed, so reveal it
and make it red

            eval('holder'+curindex).displayletter=
answer.charAt(curindex);

            eval('holder'+curindex).letter.textColor =
'0xFF0000';

        }

    }

    //Display the button to start a new game
showPlayAgainButton();

}

}

}

```

```

//This function checks to see if a guessed letter is in the answer
function inAnswer(pressedletter) {

```

```

//initialize goodletter to false.

//we are going to loop through the answer to see if the guessed letter is in
the answer

goodletter = false;

//check if there are any letters in the answer that haven't been guessed yet
blankspace = 0;

//loop through the answer
for (curindex=0; curindex<length(answer); curindex++) {

    //check if the guessed letter is the character in the current position
of the answer

    if      (answer.charAt(curindex).toLowerCase()      ==
pressedletter.toLowerCase()) {

        //display the character

        eval('holder'+curindex).displayletter      =
answer.charAt(curindex);

        //setting goodletter to true prevents the image from going to
the next frame

        goodletter = true;

        //if the character at the current position hasn't been guessed,
reveal it

    } else if (answer.charAt(curindex) != ' ' '&&
eval('holder'+curindex).displayletter == undefined) {

        //there is at least one letter that hasn't been guessed

        blankspace = 1;

```

```

    }

}

//if every letter has been guessed, the player wins

if (!blankspace) {

    //remove all of the guess buttons

    for (curindex=0; curindex<26; curindex++) {

        //if the button at the current position exists, remove it

        if (eval('guess'+String.fromCharCode(curindex+65))) {

removeMovieClip('guess'+String.fromCharCode(curindex+65));

        }

    }

    //loop through all of the characters and set their color to green

    for (curindex=0; curindex<length(answer); curindex++) {

        //if the current character isn't a space, set its color to green

        if (answer.charAt(curindex) != ' ') {

            eval('holder'+curindex).letter.textColor =

'0x00FF00';

        }

    }

    //show the play again button

    showPlayAgainButton();

}

//return whether or not the guessed letter exists in the answer

```

```

        return (goodletter);
    }

    //Show the button to play again

    function showPlayAgainButton() {

        //attach the button

        attachMovie('playagain', 'playagain', this.getNextHighestDepth());

        //move it to the middle of the screen

        playagain._x = Stage.width/2;

        //move it towards the bottom

        playagain._y = 370;

        //Add a listener for when the button is pressed. When pressed, start a new
game

        playagain.onPress = function() {

            //Reset the hangman graphic to the first frame

            missgraphic.gotoAndStop(1);

            //loop through all of the letter holders of the answer on the screen
and delete them

            for (curindex=0; curindex<length(answer); curindex++) {

                //if the current position in the answer isn't a blank, remove
it

                if (answer.charAt(curindex) != ' ') {

                    removeMovieClip('holder'+curindex);

                }

            }

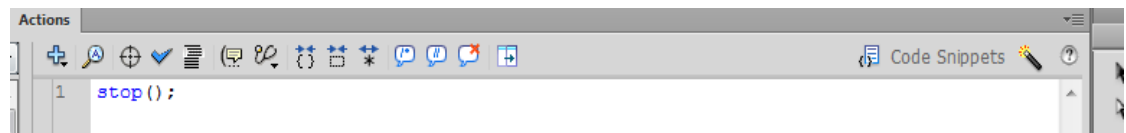
        }
    }

```



```
        //start a new game  
        newGame();  
  
        //delete this button  
        removeMovieClip('playagain');  
    };  
}  
  
//Start a new game when the applet loads  
newGame();
```

Finally is the stop action:

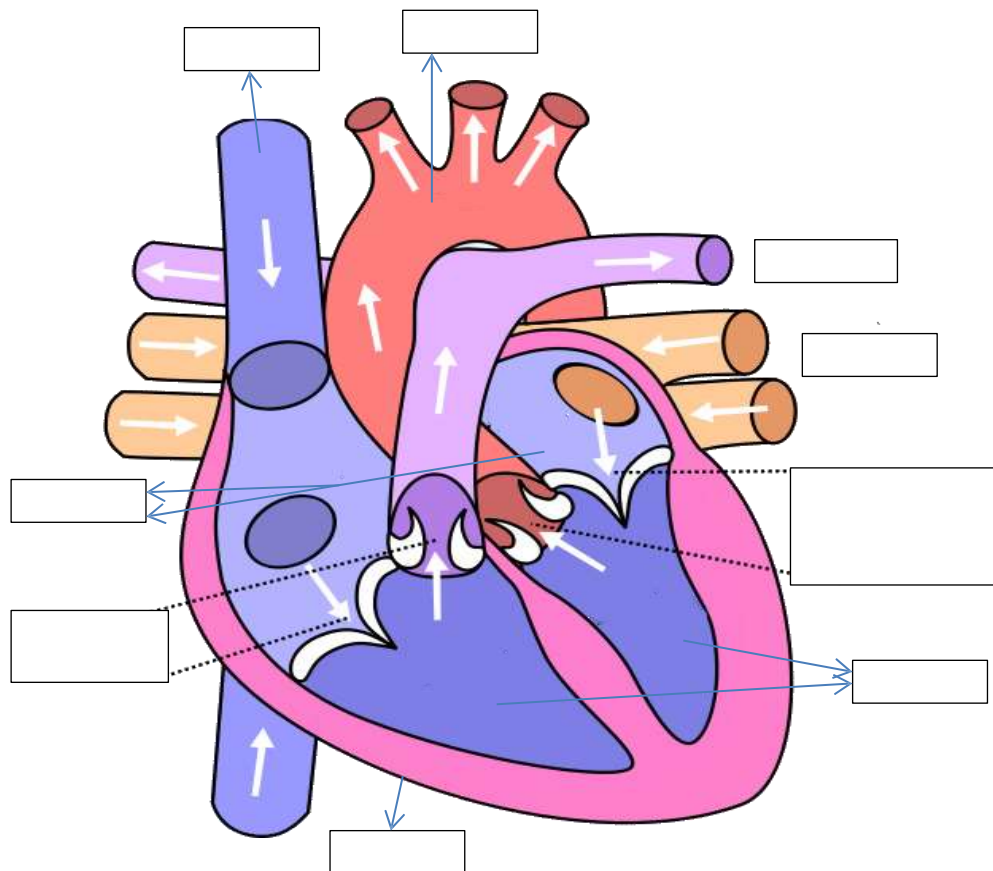


Appendix 13

Quiz animation samples and Chi-Square Distribution

Label your heart exercise

Please label the following diagram using the names provided below.



Key Words

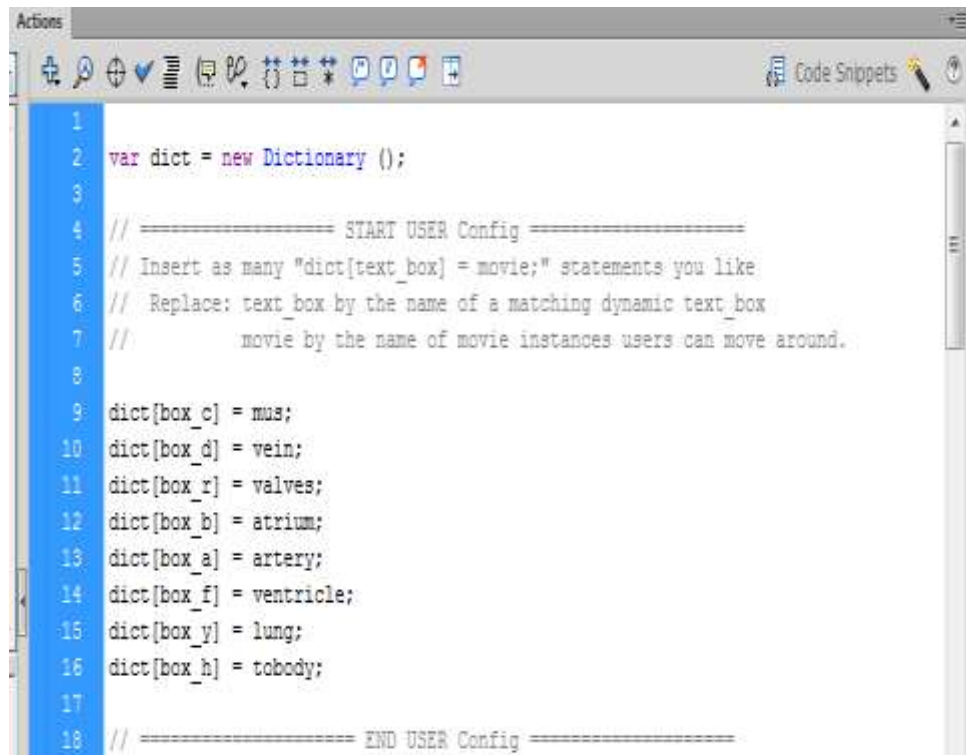
Artery, Atrium, Muscle, Vein, Valves, Aorta, Vena Cava.

Chi-square Distribution Table

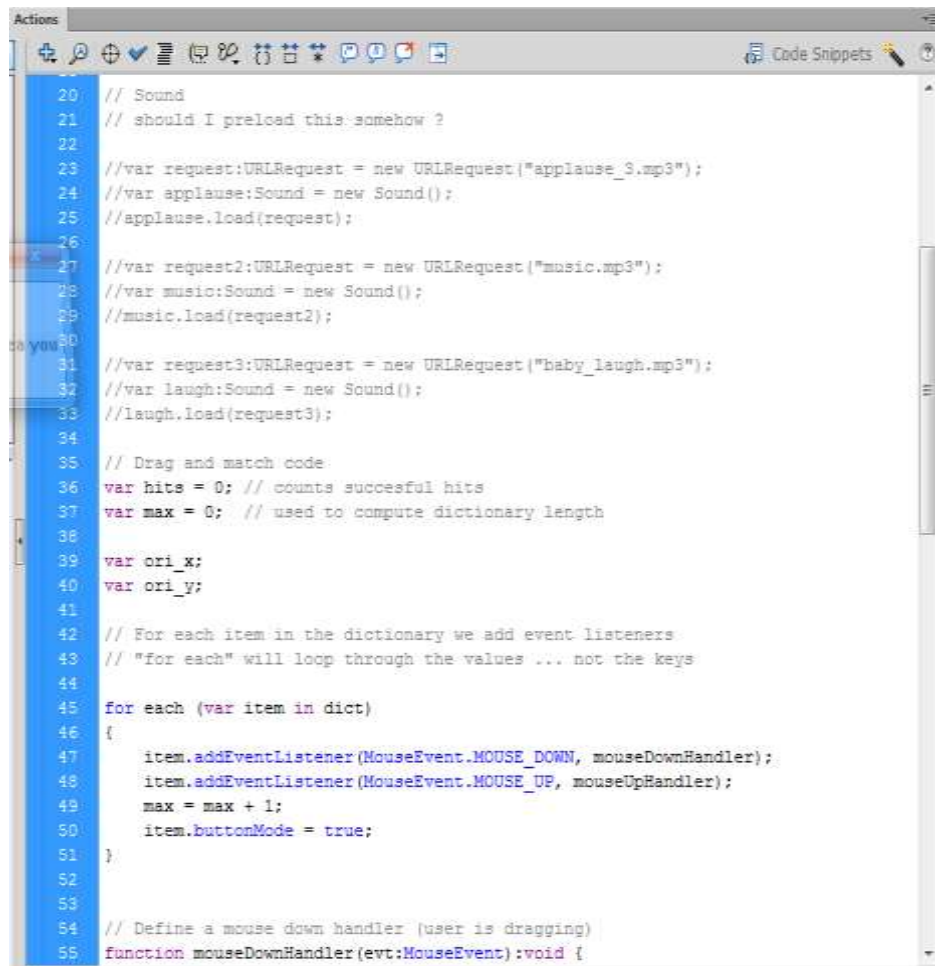
d.f.	.995	.99	.975	.95	.9	.1	.05	.025	.01
1	0.00	0.00	0.00	0.00	0.02	2.71	3.84	5.02	6.63
2	0.01	0.02	0.05	0.10	0.21	1.61	2.78	3.84	5.99
3	0.07	0.16	0.22	0.35	0.58	0.47	1.21	2.37	3.84
4	0.21	0.30	0.48	0.71	1.06	0.71	0.98	1.75	3.36
5	0.41	0.55	0.83	1.15	1.61	0.92	1.14	1.94	3.00
6	0.68	0.87	1.24	1.64	2.20	1.06	1.35	2.20	2.71
7	0.99	1.24	1.69	2.17	2.89	1.24	1.59	2.47	2.59
8	1.34	1.65	2.18	2.73	3.49	1.36	1.75	2.73	2.40
9	1.73	2.09	2.70	3.33	4.17	1.48	1.90	2.90	2.35
10	2.16	2.50	3.25	3.94	4.87	1.59	2.03	3.09	2.22
11	2.60	2.90	3.82	4.57	5.58	1.70	2.18	3.21	2.10
12	3.07	3.57	4.40	5.23	6.30	1.80	2.33	3.40	2.00
13	3.57	4.11	5.01	5.89	7.04	1.90	2.47	3.57	1.90
14	4.07	4.66	5.63	6.57	7.79	2.00	2.62	3.73	1.80
15	4.60	5.23	6.26	7.26	8.54	2.10	2.77	3.90	1.70
16	5.11	5.81	6.91	7.96	9.31	2.20	2.92	4.07	1.60
17	5.70	6.41	7.56	8.67	10.09	2.30	3.07	4.25	1.50
18	6.26	7.01	8.23	9.39	10.86	2.40	3.22	4.43	1.40
19	6.81	7.63	8.91	10.12	11.65	2.50	3.38	4.61	1.30
20	7.33	8.26	9.59	10.85	12.44	2.60	3.54	4.78	1.20
22	8.61	9.54	10.98	12.34	14.04	2.80	3.89	5.19	1.05
24	10.89	10.86	12.40	13.85	15.66	3.00	4.28	5.62	0.90

26	11.16	12.20	13.84	15.38	17.29	35.56	a8.8D	41.!)2	4fi.64
28	12.46	13.56	15.31	16.93	18.94	a1.D2	41.3l	lll.'16	l8.28
30	13.79	14.95	16.79	18.49	20.60	40.26	-1.77	l16.98	50.89
32	15.13	16.36	18.29	20.07	22.27	12.58	16.1!)	19.18	53.19
31	16.50	17.79	19. 1	21.66	23.95	44.90	I '.60	51.!)7	56.()6
38	1!).2!)	20.69	22.88	24.	27.34	49.51	53.3.	56.!)()	61.16
12	22.1 I	2:3.65	26.00	28.14	30.77	5-1.09	58.12	61.78	66.21
16	25.0 I	26.66	29.16	;HA.!	34.22	5 .64	62.8:..!	66.62	71.20
.5()	27.!)!)	2!).71	:32:..!6	34.76	a7.69	63.17	67.50	71. 12	76.15
.55	:n.n	: u 1	:H...t0	38.96	42.06	68.80	n: 1	77.: :	82.2!)
(i()	:35.5:!	:!7.48	:!0.48	43.19	46.46	74.40	7!).08	8:3.:10	88.: 8
(i5	:!9.:!8	-11.44	44.(i0	47.45	50.88	79.97	8! .82	8D.18	D4.42
70	4:1.28	45.44	48.76	51.74	55.aa	85.53	!)0.fi:l	!)1).02	100.43
7ii	47.21	40.48	!12.94	56.05	59.79	91.06	!)(i.22	100.84	10G.3D
80	ii1.17	ii3.ii4	57.15	60.39	64.28	96.58	101.88	l0G.G:l	112.33
85	5ii.17	57.G3	()1.39	64.75	68.78	102.08	107.52	11 2.3!)	118.24
!)0	50.20	G1. 7ii	65.65	69.13	73.29	107.57	ll U5	11 8.14	124.12
!)5	() !25	65.!)0	()9.92	73.52	77.82	113.04	118.75	t23.8G	12!).!)7
100	67.33	70.0G	74.22	77.93	82.36	118.50	12! l. 4	l20.5G	135.81

Actionscript behind the Label your heart Quiz



```
1
2 var dict = new Dictionary ();
3
4 // ===== START USER Config =====
5 // Insert as many "dict[text_box] = movie;" statements you like
6 // Replace: text_box by the name of a matching dynamic text_box
7 //         movie by the name of movie instances users can move around.
8
9 dict[box_c] = mus;
10 dict[box_d] = vein;
11 dict[box_r] = valves;
12 dict[box_b] = atrium;
13 dict[box_a] = artery;
14 dict[box_f] = ventricle;
15 dict[box_y] = lung;
16 dict[box_h] = tobody;
17
18 // ===== END USER Config =====
```

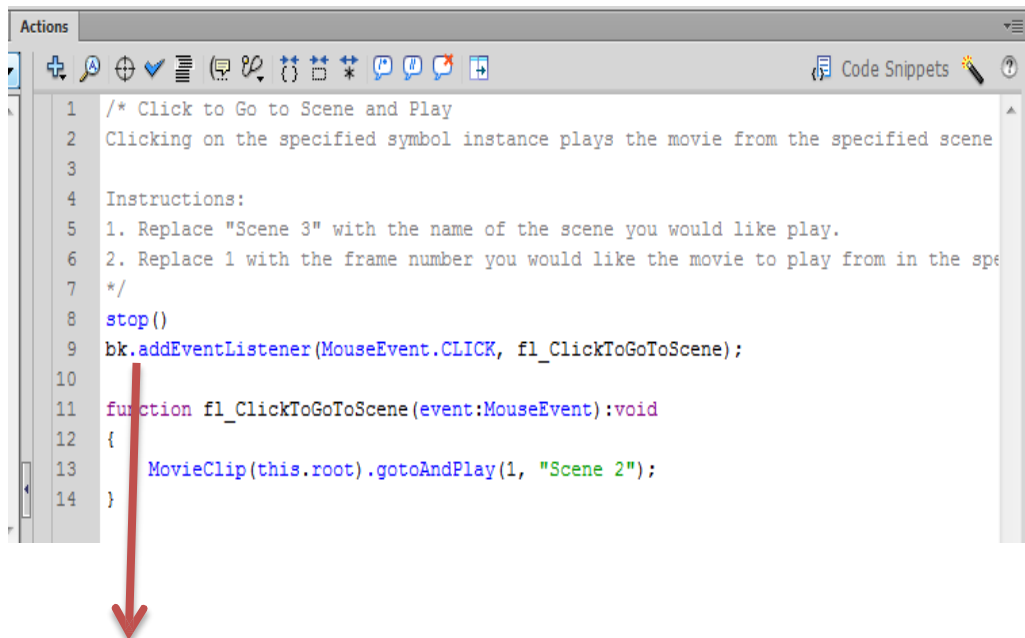
A screenshot of a code editor window. The title bar says "Actions". The code is in JavaScript and includes comments and function definitions. The code is as follows:

```
20 // Sound
21 // should I preload this somehow ?
22
23 //var request:URLRequest = new URLRequest("applause_3.mp3");
24 //var applause:Sound = new Sound();
25 //applause.load(request);
26
27 //var request2:URLRequest = new URLRequest("music.mp3");
28 //var music:Sound = new Sound();
29 //music.load(request2);
30
31 //var request3:URLRequest = new URLRequest("baby_laugh.mp3");
32 //var laugh:Sound = new Sound();
33 //laugh.load(request3);
34
35 // Drag and match code
36 var hits = 0; // counts succesful hits
37 var max = 0; // used to compute dictionary length
38
39 var ori_x;
40 var ori_y;
41
42 // For each item in the dictionary we add event listeners
43 // "for each" will loop through the values ... not the keys
44
45 for each (var item in dict)
46 {
47     item.addEventListener(MouseEvent.CLICK, mouseDownHandler);
48     item.addEventListener(MouseEvent.CLICK, mouseUpHandler);
49     max = max + 1;
50     item.buttonMode = true;
51 }
52
53
54 // Define a mouse down handler (user is dragging)
55 function mouseDownHandler(evt:MouseEvent):void {
```

The Sound included in this code has been terminated upon teacher request.

```
Actions
56     var objecc = evc.cargec;
57     ori_x = objecc.x ori_y =
58     objecc.y
59     objecc.useHandCursor true;
60     objecc.scarcDrag();
61
62
63     funcction mouseUpHandler(evc:HouseEvenc):void
64         llscop all sounds
65         IIIISoundHixer.scopAll();
66         var obj = evc.cargec;
67         II obj.dropTargec wlll glve us che reference co che shape of
68         II che ob)ecc over which we dropped che circle.
69         var cargec = obj.dropTargec;
70         II If che cargec objecc exiscs che we ask che cesc macch funcction
71         II co compare moved obj and cargec where ic was dropped.
72         if (cargec != null)
73
74             cesc_macch(cargec, obj);
75
76         obj.scopDrag();
77
78
79
80     funcction cesc_macch(cargec,obj)
81         II cesc if che pairs rnacch
82         if (dicc[cargec] • •obj)
83
84             II we goc a hn hies =
85             hics+1; cexcField.cexc =
86             "correct";
87             llapplaue.play();
88             II make che objecc cransparenc
89             obj.alpha = 0.5;
90             II klll lCs evenc llsceners- objecc can'c be moved anYFore
91             obj.rernoveEvencLiscener(llouseEvenc.HOUSE_DOWN, mouseDownHandler);
```

The code for playing the first scene, and the reset button which has been given (bk) as an instance name.



Instance name for the reset button

Appendix 14

Benchmark Sample Questionnaires

This animation samples been created in Adobe Flash CS6 to represent variety of different animation methods.

Please read the questions below and allows us to have your valuable feedback from Fully Agree to Fully Disagree.

	Fully Agree	Somewhat Disagree	Unsure	Somewhat Agree	Fully Disagree
1. Using comic animation is quite an effectively tools for learning.	1	2	3	4	5
2. Text format animation very useful to use as it can be used to visualize a dynamic phenomenon or process which cannot be readily seen by the eye or science setting.	1	2	3	4	5
3. Quiz method is fun to do, further students' knowledge and adds benefits to student knowledge when compared to static/textbook graphics or diagrams.	1	2	3	4	5
4. Animated Games are exciting enjoyable and useful to learn from. And it acts as methods for soaking up information. Also students can increase their collaboration, creativity and communication.	1	2	3	4	5

5. Multiple choice questions method is very interesting and useful to store information especially for exams.	1 2 3 4 5
6. Please chose the animation methods that is useful to use as a tool for your learning.	Comic Text Format Quiz Games

Actionscript for animation samples:

Comic

Text Format

Drag and Drop Quiz

Game

Multiple Choices

ActionScript for Comic animation

```
home.addEventListener(MouseEvent.CLICK, clickhome);

function clickhome(event:Event):void {

    //trace("lizhouse");

        gotoAndStop("home");

}

movie1.addEventListener(MouseEvent.CLICK, clickmovie1);

function clickmovie1(event:Event):void {

    //trace("movie1");

        gotoAndStop("movie1");

}

movie2.addEventListener(MouseEvent.CLICK, clickmovie2);

function clickmovie2(event:Event):void {

    //trace("movie2");

        gotoAndStop("movie2");

}
```

```

}

movie3.addEventListener(MouseEvent.CLICK, clickmovie3);

function clickmovie3(event:Event):void {

    //trace("movie3");

        gotoAndStop("movie3");

}

movie4.addEventListener(MouseEvent.CLICK, clickmovie4);

function clickmovie4(event:Event):void {

    //trace("movie4");

        gotoAndStop("movie4");}

```

With a stop() action for the next layer

Actionscript for Text Format

Timer Code:

```

var position:Number = 150; var rot:Number = 100;

addEventListener(Event.ENTER_FRAME, onEnterFrame);

function onEnterFrame(event:Event):void {

    var e1:element1 = new element1();

    e1.x = position;

        e1.Y = position;

    e1.rotation = rot;

        addChild(e1);

    position++;

```

```

        rot++;
    }

    var secs:Timer = new Timer(1000, 14);

    secs.addEventListener(TimerEvent.TIMER_COMPLETE, onTimerComplete);

    secs.start();

    function onTimerComplete(event:TimerEvent):void{

        removeEventListener(Event.ENTER_FRAME, onEnterFrame);

    }

```

Mask code:

```

stop();

var mouseclick:Number=0;

//2.

var mask_mc:Sprite = new Sprite();

maskedbg_mc.mask = mask_mc;

addChild(mask_mc);

//3.

stage.addEventListener(MouseEvent.CLICK, mouseD);

stage.addEventListener(MouseEvent.CLICK, mouseM);

stage.addEventListener(MouseEvent.CLICK, mouseU);

//4.

function mouseD(event:MouseEvent):void {

    mouseclick = 1;

}

//5.

```

```

function mouseM(event:MouseEvent):void { if
(mouseclick == 1) {
mask_mc.graphics.beginFill(0x000000);
mask_mc.graphics.drawEllipse(mouseX, mouseY, 70, 60);
mask_mc.graphics.endFill();
}}

```

//6.

```

function mouseU(event:MouseEvent):void {
mouseclick = 0;
}

```

Mask movie clip:

```

maskedbg_mc.addEventListener(MouseEvent.CLICK,
fl_ClickToGoToNextFrame);
function fl_ClickToGoToNextFrame(event:MouseEvent):void
{
nextFrame();
}
next.addEventListener(MouseEvent.CLICK, fl_ClickToGoToNextFrame_2);
function fl_ClickToGoToNextFrame_2(event:MouseEvent):void
{
nextFrame();
}/* Click to Go to Previous Frame and Stop

```

Clicking on the specified symbol instance moves the playhead to the previous frame and stops the movie.

```
*/  
  
back.addEventListener(MouseEvent.CLICK, fl_ClickToGoToPreviousFrame);  
  
function fl_ClickToGoToPreviousFrame(event:MouseEvent):void  
{  
  
    prevFrame();  
  
}/* Click to Go to Previous Scene and Play
```

Clicking on the specified symbol instance moves the playhead to the previous scene in the timeline and continues playback in that scene.

```
*/  
  
back.addEventListener(MouseEvent.CLICK, fl_ClickToGoToPreviousScene);  
  
function fl_ClickToGoToPreviousScene(event:MouseEvent):void  
{  
  
    MovieClip(this.root).prevScene();  
  
}
```

The stop code:

```
/* Stop at This Frame
```

The Flash timeline will stop/pause at the frame where you insert this code.

Can also be used to stop/pause the timeline of movieclips.

```
*/  
  
stop();  
  
/* Click to Go to Frame and Stop
```

Clicking on the specified symbol instance moves the playhead to the specified frame in the timeline and stops the movie.

Can be used on the main timeline or on movie clip timelines.

Playing the first frame to demonstrate the start page:

```
b1.addEventListener(MouseEvent.CLICK, fl_ClickToGoToAndStopAtFrame_4);
```

```
function fl_ClickToGoToAndStopAtFrame_4(event:MouseEvent):void
{
    gotoAndStop(1);
}
```

Actionscript for Drag and Drop Quiz

```
var dict = new Dictionary ();
// ===== START USER Config =====
// Insert as many "dict[text_box] = movie;" statements you like
// Replace: text_box by the name of a matching dynamic text_box
//      movie by the name of movie instances users can move around.
dict[box_c] = mus;
dict[box_d] = vein;
dict[box_r] = valves;
dict[box_b] = atrium;
dict[box_a] = artery;
dict[box_f] = ventricle;
dict[box_y] = lung;
dict[box_h] = tobody;
// make sure to respect add ";" at the end of each line.
// ===== END USER Config =====
// Sound
//var request:URLRequest = new URLRequest("applause_3.mp3");
//var applause:Sound = new Sound();
//applause.load(request);
//var request2:URLRequest = new URLRequest("music.mp3");
//var music:Sound = new Sound();
```



```

//music.load(request2);
//var request3:URLRequest = new URLRequest("baby_laugh.mp3");
//var laugh:Sound = new Sound();
//laugh.load(request3);
// Drag and match code
var hits = 0; // counts succesful hits
var max = 0; // used to compute dictionary length
var ori_x;
var ori_y;
// For each item in the dictionary we add event listeners
// "for each" will loop through the values ... not the keys
for each (var item in dict)
{
item.addEventListener(MouseEvent.CLICK, mouseDownHandler);
    item.addEventListener(MouseEvent.CLICK, mouseUpHandler);
    max = max + 1;
    item.buttonMode = true;
}
// Define a mouse down handler (user is dragging)
function mouseDownHandler(evt:MouseEvent):void {
    var object = evt.target;
    ori_x = object.x;
    ori_y = object.y;
    object.useHandCursor = true;
    object.startDrag();
}
function mouseUpHandler(evt:MouseEvent):void {
    //stop all sounds
    ///SoundMixer.stopAll();
    var obj = evt.target;
    // obj.dropTarget will give us the reference to the shape of
    // the object over which we dropped the circle.
    var target = obj.dropTarget;
    // If the target object exists the we ask the test_match function
    // to compare moved obj and target where it was dropped.
    if (target != null)
    {
        test_match(target, obj);
    }
    obj.stopDrag();
}
function test_match(target,obj) {
    // test if the pairs match
    if (dict[target] == obj)
    {
        // we got a hit hits =
        hits+1; textField.text =
        "correct";
        //applause.play();
        // make the object transparent
        obj.alpha = 0.5;
        // kill its event listeners - object can't be moved anymore
    }
}

```

```

        obj.removeEventListener(MouseEvent.CLICK, mouseDownHandler);
        obj.removeEventListener(MouseEvent.CLICK, mouseUpHandler);
        // Test if done
        if (hits == max)
        {
            textField.text = "correct";
            //music.play(0,5);
        }
    else{
        obj.x = ori_x; obj.y =
        ori_y; textField.text=
        "incorrect";
        //laugh.play();
    }
}

```

The stop code and going back to the main scene

/* Click to Go to Scene and Play

Clicking on the specified symbol instance plays the movie from the specified scene and frame.

```
stop()
```

```
bk.addEventListener(MouseEvent.CLICK, fl_ClickToGoToScene);
```

```
function fl_ClickToGoToScene(event:MouseEvent):void
```

```

{
    MovieClip(this.root).gotoAndPlay(1, "Scene 2");
}

```

Actionscript for Game method

Preparation for answers procedure:

```
stop();//Array containing all of the answers
```

```

gameanswers = ['Methane', 'Giant Lattice', 'Carbon Dioxide', 'Ammonia',
'Chlorine', 'Oxygen', 'Fluoride', 'Sodium chloride', 'Ionic Bonding', 'Magnesium
Chloride'];

```

```

//Attach the missgraphic
this.attachMovie('missgraphic','missgraphic',this.getNextHighestDepth(),
{_x:175,_y:10});

//Function that begins a new game
function newGame() {

    //select a random answer from the array

    answer =
gameanswers[Math.floor(Math.random()*gameanswers.length)];

    //Add all 26 letter buttons to the stage
    for (curindex=0; curindex<26; curindex++) {

        //Use the character code for each letter to attach the letter
        attachMovie('guessletter',
'guess'+String.fromCharCode(curindex+65), this.getNextHighestDepth());

        //set the x position according to its position in the alphabet
        eval('guess'+String.fromCharCode(curindex+65))._x =
(curindex%13-
6.5)*(eval('guess'+String.fromCharCode(curindex+65))._width+3)+Stage.width/;

        //set the y position according to its position in the alphabet
        eval('guess'+String.fromCharCode(curindex+65))._y =
Stage.height-(2-
Math.floor(curindex/13))*(eval('guess'+String.fromCharCode(curindex+65))._hei
ght+3);

        //set the character display to the current letter in the loop

```

```

        eval('guess'+String.fromCharCode(curindex+65)).displaylette
r = String.fromCharCode(curindex+65);

        //When the player clicks the button, call the pressLetter
function with the letter set

        eval('guess'+String.fromCharCode(curindex+65)).onPress
= function() {

                //process the letter

                pressLetter(this.displayletter);

                //remove the button from the stage

                removeMovieClip(this);

        };
}

//Determine how many characters are going to be printed on
each line.

//Keep the letters of words from being split onto different
lines

//start the row count at 0

curline = 0;

//the start position in the answer is 0

linestart = 0;

//store the length of each line into an array

var linelengths:Array = new Array();

//traverse all of the characters in the answer

for (linepos=0; linepos<length(answer); linepos++) {

```

```

//Maximum length of each formatted line

blanklinelength = 25;

//check if the linelength is smaller than the max line length
or the first word on the line is longer than the max

if ((linepos-linestart)<blanklinelength || linelengths[curline]
== undefined) {

    //if the current character is a space, set a marker so
we know how long the line should be

    //it may be updated if another word fits within the
current line

    if (answer.charAt(linepos) == ' ') {

        //update the length of the current line

        linelengths[curline] = linepos-linestart+1;

    }

    //else the line has reached its limit, so move to the
next line and start at the end of the last word

} else {

    //store where to start the next line

    linestart = linestart+linelengths[curline];

    //move to that position

    linepos = linestart;

    //move to the next line

    curline++;

}

```

```

    }

    //set the length of the last line

    linelengths[curline] = length(answer)-linestart;

    //Now we are going to add the blank holders to the stage

    //start at the first row

    currow = 0;

    //set the position to 0

    curpos = 0;

    //Loop through the answer and add the blank holders to the
stage

    for (curindex=0; curindex<length(answer); curindex++) {

        //If the current position is a space, do not create a blank
holder

        if (answer.charAt(curindex) != ' ') {

            //add the letter holder

            attachMovie('letterholder', 'holder'+curindex,
this.getNextHighestDepth());

            //set the x position relative to its position on the line
and the number of characters on the line

            eval('holder'+curindex)._x =
Stage.width/2+((curpos-(linelengths[currow]/2))*20);

            //set the y position according to the currow

            eval('holder'+curindex)._y = 280+(currow-
(linelengths.length/2))*20;

```

```

        //if the current character is not A-Z, display it
        if (!hiddenCharacter(answer.charAt(curindex))) {

            //display the character, since it is a special
character

            eval('holder'+curindex).displayletter      =
answer.charAt(curindex);

        }

    }

    //If we are at the end of a row, go to the next row
    if (++curpos>=linelengths[currow]) {

        //move to the next row

        currow++;

        //reset the position to the left

        curpos = 0;

    }

}

}

//This function checks if the input character is an A-Z character
function hiddenCharacter(curchar) {

    //Set of characters that aren't revealed

    hiddenchars = 'abcdefghijklmnopqrstuvwxyz';

    //Loop through the character set

    for (charindex=0; charindex<length(hiddenchars);

charindex++) {

```

```

        //If the input character is in the list, hide it
        if (curchar.toLowerCase() ==
hiddenchars.charAt(charindex)) {
            return true;
        }
    }

    //character is not A-Z, so display it
    return false;
}

//function called each time a letter button is pressed
function pressLetter(pressedletter) {
    //check if the pressed letter is in the answer
    if (!inAnswer(pressedletter)) {
        //update the graphic to the next image
        missgraphic.gotoAndStop(missgraphic._currentframe+1);
        //check if the last frame has been reached
        if (missgraphic._currentframe == missgraphic._totalframes)
        {
            //game lost. remove all of the remaining buttons
            for (curindex=0; curindex<26; curindex++) {
                //if the letter button exists, remove it
                if
(eval('guess'+String.fromCharCode(curindex+65))) {

```



```

//delete the button. 65 is the ascii
character A

removeMovieClip('guess'+String.fromCharCode(curindex+65
));

    }

}

//the game has been lost, so fill in all of the blank
spaces with the answers in red

    for    (curindex=0;    curindex<length(answer);
curindex++) {

        //if there is a space or the letter has been
guessed already do nothing

        if (answer.charAt(curindex) != ' ' &&
eval('holder'+curindex).displayletter == undefined) {

            //the letter has not been guesed, so
reveal it and make it red

            eval('holder'+curindex).displayletter
= answer.charAt(curindex);

            eval('holder'+curindex).letter.textColor = '0xFF0000';

        }

    }

//Display the button to start a new game

```

```

        showPlayAgainButton();
    }
}

}

//This function checks to see if a guessed letter is in the answer
function inAnswer(pressedletter) {
    //initialize goodletter to false.

    //we are going to loop through the answer to see if the guessed
letter is in the answer

    goodletter = false;

    //check if there are any letters in the answer that haven't been
guessed yet

    blankspace = 0;

    //loop through the answer
    for (curindex=0; curindex<length(answer); curindex++) {
        //check if the guessed letter is the character in the current
position of the answer

        if      (answer.charAt(curindex).toLowerCase()      ==
pressedletter.toLowerCase()) {

            //display the character

            eval('holder'+curindex).displayletter          =
answer.charAt(curindex);

```

```

        //setting goodletter to true prevents the image from
going to the next frame

        goodletter = true;

        //if the character at the current position hasn't been
guessed, reveal it

        } else if (answer.charAt(curindex) != ' ' &&
eval('holder'+curindex).displayletter == undefined) {

            //there is at least one letter that hasn't been guessed

            blankspace = 1;

        }

    }

    //if every letter has been guessed, the player wins
    if (!blankspace) {

        //remove all of the guess buttons

        for (curindex=0; curindex<26; curindex++) {

            //if the button at the current position exists, remove
it

            if

(eval('guess'+String.fromCharCode(curindex+65))) {

                removeMovieClip('guess'+String.fromCharCode(curindex+65

));

            }

        }

```

```

        //loop through all of the characters and set their color to
green
        for (curindex=0; curindex<length(answer); curindex++) {
            //if the current character isn't a space, set its color to
green
            if (answer.charAt(curindex) != ' ') {
                eval('holder'+curindex).letter.textColor =
'0x00FF00';
            }
        }
        //show the play again button
        showPlayAgainButton();
    }
    //return whether or not the guessed letter exists in the answer
    return (goodletter);
}

```

```

//Show the button to play again
function showPlayAgainButton() {
    //attach the button
    attachMovie('playagain', 'playagain',
this.getNextHighestDepth());
    //move it to the middle of the screen
    playagain._x = Stage.width/2;
}

```

```

        //move it towards the bottom

        playagain._y = 370;

        //Add a listener for when the button is pressed. When pressed,
start a new game

        playagain.onPress = function() {

            //Reset the hangman graphic to the first frame

            missgraphic.gotoAndStop(1);

            //loop through all of the letter holders of the answer on the
screen and delete them

            for (curindex=0; curindex<length(answer); curindex++) {

                //if the current position in the answer isn't a blank,
remove it

                if (answer.charAt(curindex) != ' ') {

                    removeMovieClip('holder'+curindex)}

                }//start a new game

                newGame();

                //delete this button

                removeMovieClip('playagain');

            };

        }

        //Start a new game when the applet loads

        newGame();

```

The stop Code on the first scene:

```
Stop();
```

Actionscript for Multiple Choices

This code been add using Actionscript class

```
package {

    import flash.display.Sprite;

    import fl.controls.Button;

    import flash.events.MouseEvent;

    import flash.text.TextField;

    import flash.text.TextFieldAutoSize;

    public class QuizApp extends Sprite {

        //for managing questions:

        private var quizQuestions:Array;

        private var currentQuestion:QuizQuestion;

        private var currentIndex:int = 0;

        //the buttons:

        private var prevButton:Button;

        private var nextButton:Button;

        private var finishButton:Button;

        //scoring and messages:

        private var score:int = 0;

        private var status:TextField;

        public function QuizApp() {

            quizQuestions = new Array();

            createQuestions();
```

```

createButtons();

createStatusBox();

addAllQuestions();

hideAllQuestions();

firstQuestion();

}

private function createQuestions() {

    quizQuestions.push(new QuizQuestion("1) Which element is a very soft
silvery solid metal at room temperature?",

                                     1, "Sodium",

                                     "Aluminium",

                                     "Chlorine",

                                     "Bromine"));

    quizQuestions.push(new QuizQuestion("2) Which metal that cannot be
extracted by displacement with carbon?",

                                     3,

                                     "Copper",

                                     "Hydrogen",

                                     "Magnesium",

                                     "Iron"));

    quizQuestions.push(new QuizQuestion("3) Which element is a liquid
metal at room temperature and pressure?",

```

2,

"Mercury",

"Nickel",

"Phosphorus",

"none of the above"));

quizQuestions.push(new QuizQuestion("4) Which of the following is formed when a carbonate reacts with an acid? ",

2,

"Salt + Hydrogen",

"Salt + Water + Carbon Dioxide",

"Carbon Dioxide + Water",

"An Oxide "));

quizQuestions.push(new QuizQuestion("5) Which of these can make a solid substance dissolve faster in a liquid? ",

2,

"Use a little solid at a time to a large volume of liquid",

"Stir the mixture regularly",

"Cool the solid-liquid mixture",

"Use larger lumps of solid in a small volume of liquid"));


```
quizQuestions.push(new QuizQuestion("6) Which of the following  
statements is completely TRUE?",
```

```
4,
```

```
"Vinegar is alkaline  
and so preserves food",
```

```
"Cola fizzy drinks are weakly alkaline",
```

```
"Washing up liquid is strongly alkaline but  
not harmful",
```

```
"Vitamin C is a safe weak acid"));
```

```
quizQuestions.push(new QuizQuestion("7) Which  
of the following is a simple test to see if a rock contains bits of a metal?",
```

```
3,
```

```
" Mix with universal indicator  
solution and see if it turns green",
```

```
" Test the resulting solution with red litmus  
and see if it turns purple",
```

```
" Add a little acid, collect any gas  
formed and test it with a lit splint",
```

```
        " Add a little acid, collect any gas formed  
and test it with limewater"));
```

```
        quizQuestions.push(new QuizQuestion("8) If  
substance added to an acid, the solution turned green.The substance is likely to  
be?",
```

```
        2,
```

```
        "Metal carbonate",
```

```
        "Metal oxide",
```

```
        "Non-metal carbonate",
```

```
        "Metal"));
```

```
    }
```

```
    private function createButtons() {
```

```
        var yPos:Number = stage.stageHeight - 40;
```

```
        prevButton = new Button();
```

```
        prevButton.label = "Previous";
```

```
        prevButton.x = 30;
```

```
        prevButton.y = yPos;
```

```
        prevButton.addEventListener(MouseEvent.CLICK, prevHandler);
```

```
        addChild(prevButton);
```

```
        nextButton = new Button();
```

```

        nextButton.label = "Next";

        nextButton.x = prevButton.x + prevButton.width + 40;

        nextButton.y = yPos;

        nextButton.addEventListener(MouseEvent.CLICK, nextHandler);

        addChild(nextButton);

        finishButton = new Button();

        finishButton.label = "Finish";

        finishButton.x = nextButton.x + nextButton.width + 40;

        finishButton.y = yPos;

        finishButton.addEventListener(MouseEvent.CLICK, finishHandler);

        addChild(finishButton);

    }

    private function createStatusBox() {

        status = new TextField();

        status.autoSize = TextFieldAutoSize.LEFT;

        status.y = stage.stageHeight - 80;

        addChild(status);

    }

    private function showMessage(theMessage:String) {

        status.text = theMessage;

        status.x = (stage.stageWidth / 2) - (status.width / 2);

    }

    private function addAllQuestions() {

        for(var i:int = 0; i < quizQuestions.length; i++) {

```

```

        addChild(quizQuestions[i]);
    }
}

private function hideAllQuestions() {
    for(var i:int = 0; i < quizQuestions.length; i++) {
        quizQuestions[i].visible = false;
    }
}

private function firstQuestion() {
    currentQuestion = quizQuestions[0];
    currentQuestion.visible = true;
}

private function prevHandler(event:MouseEvent) {
    showMessage("");
    if(currentIndex > 0) {
        currentQuestion.visible = false;
        currentIndex--;
        currentQuestion = quizQuestions[currentIndex];
        currentQuestion.visible = true;
    } else {
        showMessage("This is the first question, there are no previous ones");
    }
}

private function nextHandler(event:MouseEvent) {

```

```

showMessage("");

if(currentQuestion.userAnswer == 0) {

    showMessage("Please answer the current question before continuing");

    return;

}

if(currentIndex < (quizQuestions.length - 1)) {

    currentQuestion.visible = false;

    currentIndex++;

    currentQuestion = quizQuestions[currentIndex];

    currentQuestion.visible = true;

} else {

    showMessage("That's all the questions! Click Finish to Score, or
Previous to go back");

}

}

private function finishHandler(event:MouseEvent) {

    showMessage("");

    var finished:Boolean = true;

    for(var i:int = 0; i < quizQuestions.length; i++) {

        if(quizQuestions[i].userAnswer == 0) {

            finished = false;

            break;

        }

    }

}

```

```

    if(finished) {

        prevButton.visible = false;

        nextButton.visible = false;

        finishButton.visible = false;

        hideAllQuestions();

        computeScore();

    } else {

        showMessage("You haven't answered all of the questions");

    }

}

private function computeScore() {

    for(var i:int = 0; i < quizQuestions.length; i++) {

        if(quizQuestions[i].userAnswer == quizQuestions[i].correctAnswer) {

            score++;

        }

    }

    showMessage("You answered " + score + " correct out of " +
quizQuestions.length + " questions Good Try !!");

}

}

}

```

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