Investigating the Effectiveness of the Gesture-Based Learning System (GBLS) Mode

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This thesis is produced for the degree of Doctor of Information Technology at Murdoch University 2017.
Declaration

I declare that this submission is my own work and it contains no materials previously published, written or submitted for a degree at any tertiary education institution by another person.

Signed: [Signature]

Name: Moamer Ali Ahmed Shakroum
Abstract

Several studies have been conducted in recent years to examine the values and advantages of using the Gesture-Based Learning System (GBLS). However, a proper investigation into the influence of the GBLS mode on learning outcomes is still scarce. Most previous studies failed to simultaneously address more than one category of learning outcomes (such as cognitive, affective and psychomotor outcomes), when trying to understand the impact of the GBLS mode. Moreover, none of these studies considered the differences in students’ characteristics such as learning styles and spatial abilities. In addition, none of the past research has explained how the application of the GBLS mode improves learning. Therefore, a comprehensive empirical research study into the effectiveness of the GBLS mode is needed.

The purpose of this research is to fill the gap and to investigate the effectiveness of the GBLS mode. The main purpose of the research has been broken down into three sub-goals. First, this study investigates the influence of the GBLS mode on learning by comparing the learning outcomes of the GBLS mode with two other learning modes, which are classified as the Computer Simulation Learning (CSL) mode and conventional learning mode. Second, this research investigates into whether the GBLS mode is able to serve all students with different learning styles and spatial abilities. Third, this study also investigates how the GBLS mode influences the learning outcomes, by using research models from the Technology Mediated Learning (TML) field. 151 first-year undergraduate students from 9 different learning areas participated in this study. Most of the participants are from the 18 - 22 age group.

The research revealed that the GBLS mode had a positive impact on students’ learning outcomes (cognitive and affective outcomes) when compared with the CSL and conventional learning modes. In addition, this study also found that the GBLS mode is capable of serving all students with different learning styles and spatial abilities. The results of this study revealed
that the GBLS mode outperformed the existing learning methods, by providing a unique learning experience that considers the differences between the students. The results have also shown that the natural user interface that was facilitated by the Kinect can create an interactive and enjoyable learning experience. On the other hand, this study developed a conceptual research model that explains how the GBLS mode improves learning. The research model revealed that the GBLS features positively affect students’ intrinsic motivation. Consequently, the increase in intrinsic motivation leads to improving the learning outcomes; this study also showed that the GBLS features indirectly influence the learning outcomes via intrinsic motivation. In other words, this study found that the GBLS features (interactivity and multimodality) create an instructional learning environment that positively influences students’ intrinsic motivation. As such, an increase in students’ positive intrinsic motivation led to an enhancement of the learning achievements of students.
Acknowledgment

First, I would like to thank the Almighty Allah for giving me the strength and abilities to carry out and complete this research. Second, I would like to express grateful thanks to my supervisors, Associate Professor Kevin Wong and Emeritus Professor Lance Fung from Murdoch University, Western Australia. Without their support, patience, and encouragement, I would never have completed this work.

Special thanks to my principal supervisor, Associate Professor Kevin Wong, for his insightful and constructive comments that helped me to overcome many difficulties throughout my research. I learned a lot from Associate Professor Kevin; he helped me a lot with my English and with every stage of my research. I am very lucky to have a supervisor like him. Thank you very much Dr. Kevin.

I would like to thank my parents for their support and prayers, that has kept me working hard abroad. Special thanks to my wife (Safa) who has left her job back home to join me here in Australia. Her love, understanding and hard work has made my educational journey easier. Also, I would like to thank my baby boy (Zaid), who was born in the middle of my studies; his smiles and companionship have changed my life and made me more committed to keep going forward. I would like to thank my siblings and everyone who has made my journey successful.

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I want to express my sincere thanks to the staff, lecturers and students at the Almergib University, Mesllatah branch, for their interest and participation in my research experiment; without their contribution, this research would not have been possible.
Publications

**Journal Paper 1:**


**Journal Paper 2:**


**Conference paper**

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### Definition of Key terms

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<th>Definition</th>
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<tr>
<td>Academic performance</td>
<td>The learner’s final grade that results from his/her interacting with a specific learning environment. The academic performance can be measured using the pre and post-test.</td>
</tr>
<tr>
<td>Accommodators</td>
<td>Learners who prefer learning by feeling and doing (Kolb, 1984).</td>
</tr>
<tr>
<td>Assimilators</td>
<td>Learners who prefer learning by thinking and watching (Kolb, 1984).</td>
</tr>
<tr>
<td>Conventional Learning Mode</td>
<td>The learning mode that uses PowerPoint slides in a lecture form.</td>
</tr>
<tr>
<td>Convergers</td>
<td>Learners who prefer learning by thinking and doing (Kolb, 1984).</td>
</tr>
<tr>
<td>CSL Mode</td>
<td>The learning mode that utilises simulation learning application that creates a realistic learning model in 3-D on a computer.</td>
</tr>
<tr>
<td>Divergers</td>
<td>Learners who prefer learning by feeling and watching (Kolb, 1984).</td>
</tr>
<tr>
<td>Embodied Cognition Theory</td>
<td>It is a cognitive science theory that believes that connecting cognitive tasks with the physical environment supports concept understanding and learning processes for students (Chao, Huang, Fang, &amp; Chen, 2013).</td>
</tr>
<tr>
<td>GBLS Features</td>
<td>Refers to the main traits of the GBLS mode; those that make it an effective learning mode.</td>
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<tr>
<td>GBLS Mode</td>
<td>A general term used in this research to represent the use of the Kinect or any full-body gesture-based user interface, as a teaching and learning tool.</td>
</tr>
<tr>
<td>Gesture</td>
<td>The body’s motions that are used with the intention to communicate with other people (Kaushik &amp; Jain, 2014).</td>
</tr>
<tr>
<td>Indicators</td>
<td>Observed values that are used to measure a construct (Bollen, 2002).</td>
</tr>
<tr>
<td>Interactivity</td>
<td>An interactive learning environment can be described as the learning method that ensures a prompt and continuous response to the student’s actions and feedback (Beauchamp &amp; Kennewell, 2010).</td>
</tr>
<tr>
<td>Intrinsic Motivation</td>
<td>What people are willing to do without any external stimulator (Malone &amp; Lepper, 1987).</td>
</tr>
<tr>
<td>Kinect Sensor</td>
<td>A full body motion sensing device that was developed by Microsoft (Lang, Block-Berlitz, &amp; Rojas, 2011).</td>
</tr>
<tr>
<td>Latent Variables</td>
<td>“Latent variables are hypothetical constructs that cannot be directly measured” (Bollen, 2002; MacCallum &amp; Austin, 2000).</td>
</tr>
<tr>
<td>Learning Outcomes</td>
<td>The consequences of a specific learning environment that can be computed by academic performance, perceived learning effectiveness and satisfaction.</td>
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<tr>
<td>Learning Style</td>
<td>It is the individual preferred method to understand and process information (Kolb, 1984).</td>
</tr>
<tr>
<td>Measurement Model</td>
<td>The model that represents the relationships between the constructs and their corresponding indicators.</td>
</tr>
<tr>
<td>Multimodality</td>
<td>Multimodality refers to the mode of interaction and knowledge representation that supports learners’ full sensory capabilities which include visual, audio, kinaesthetic and haptic (Birchfield et al., 2008).</td>
</tr>
<tr>
<td>Perceived Learning Effectiveness</td>
<td>The learner’s perception of the effectiveness of a specific learning experience.</td>
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<tr>
<td>PLP</td>
<td>It can be defined as the learner’s states that are involved in learning (Alavi &amp; Leidner, 2001).</td>
</tr>
<tr>
<td>PLS-SEM</td>
<td>It is an ordinary least square regression-based approach. The PLS-SEM uses the data to derive the path relationships in the model, with the aim of minimising the error terms of the endogenous constructs (Hair Jr, Hult, Ringle, &amp; Sarstedt, 2013).</td>
</tr>
<tr>
<td>Satisfaction</td>
<td>It is the learner’s attitude towards a specific learning experience.</td>
</tr>
<tr>
<td><strong>Smart-PLS</strong></td>
<td>The Smart-PLS is a tool for Partial Least Square – Structural Equation Modelling (PLS-SEM) (Hair Jr et al., 2013).</td>
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<tr>
<td><strong>Spatial Ability</strong></td>
<td>One’s ability to manipulate and transform an image of spatial patterns into another arrangement (Rafi, Anuar, Samad, Hayati, &amp; Mahadzir, 2005).</td>
</tr>
<tr>
<td><strong>Structural Model</strong></td>
<td>The model that describes the relationships between the constructs in PLS-SEM (Hair Jr et al., 2013).</td>
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## List of Abbreviations

<table>
<thead>
<tr>
<th>Full name</th>
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<tbody>
<tr>
<td>Abstract Conceptualization</td>
<td>AC</td>
</tr>
<tr>
<td>Active Experimentation</td>
<td>AE</td>
</tr>
<tr>
<td>Analysis of Covariance</td>
<td>ANCOVA</td>
</tr>
<tr>
<td>Analysis of Variance</td>
<td>ANOVA</td>
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<tr>
<td>Aptitude by Treatment Interaction</td>
<td>ATI</td>
</tr>
<tr>
<td>Average Variance Extracted</td>
<td>AVE</td>
</tr>
<tr>
<td>Computer Simulation Learning</td>
<td>CSL</td>
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<tr>
<td>Concrete experience</td>
<td>CE</td>
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<tr>
<td>Digital Learning Playground</td>
<td>DLP</td>
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<tr>
<td>Gesture-Based Learning System</td>
<td>GBLS</td>
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<tr>
<td>Hierarchical Component Model</td>
<td>HCM</td>
</tr>
<tr>
<td>Higher-Order Component</td>
<td>HOC</td>
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<tr>
<td>Human-Computer Interaction</td>
<td>HCI</td>
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<tr>
<td>Information Communications Technology</td>
<td>ICT</td>
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<tr>
<td>Intrinsic Motivation Inventory</td>
<td>IMI</td>
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<tr>
<td>Learning Style Inventory</td>
<td>LSI</td>
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<tr>
<td>Term</td>
<td>Abbreviation</td>
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<td>-------------------------------------------</td>
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<tr>
<td>Lower-Order Component</td>
<td>LOC</td>
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<tr>
<td>Mixed-Reality Integrated Learning Environment</td>
<td>MILE</td>
</tr>
<tr>
<td>Partial Least Square – Structural Equation Modelling</td>
<td>PLS-SEM</td>
</tr>
<tr>
<td>Personal Computer</td>
<td>PC</td>
</tr>
<tr>
<td>Psychological Learning Processes</td>
<td>PLP</td>
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<tr>
<td>Reflective Observation</td>
<td>RO</td>
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<tr>
<td>Sign Language</td>
<td>SL</td>
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<tr>
<td>Software Developing Kit</td>
<td>SDK</td>
</tr>
<tr>
<td>Statistical Package for the Social Sciences</td>
<td>SPSS</td>
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<tr>
<td>Technology Mediated Learning</td>
<td>TML</td>
</tr>
<tr>
<td>Three-Dimensional</td>
<td>3-D</td>
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<tr>
<td>Variance Inflation Factor</td>
<td>VIF</td>
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Chapter 1. Introduction

1.1 Research Background

Enhancing the learning outcomes and producing high-quality outputs are the main missions of all education systems worldwide. The methodology of learning has evolved over time from traditional learning, where the teacher is in charge of the entire learning process to e-learning, where the learning becomes more student-centred, with the assistance of advanced technologies (Säljö, 2010). Technology has been used in the education sector since the late 1970s, mainly for administrative purposes and evolved after that to be used as a support tool in the classroom. In fact, some educational systems, involving computers and projectors, have completely replaced traditional blackboards (Beatty & Ulasewicz, 2006; Säljö, 2010). Educational technologies have been used by more and more education systems around the world. Several studies claimed that technologies could help to foster an effective learning environment, while others believe that technologies only have a small impact on learning (Buckingham, 2013; Hooper & Rieber, 1995; Owston, 1997; Roschelle, Pea, Hoadley, Gordin, & Means, 2000). However, the best way to determine the educational potential of a particular technology is by evaluating that technology meticulously, and following that by an investigation into how the technology impacts the learning experience (Alavi & Leidner, 2001; Persico, Manca, & Pozzi, 2014).

The educational technology focus in this research is gesture-based technology. Horizon’s reports in 2011 and 2012 listed gesture-based technologies as one of the emerging technologies, with a great potential to be adopted in the education field within 4 to 5 years (Johnson et al., 2011, 2012). Gesture-based technologies have also achieved novel success in gaming and entertainment sectors, which subsequently drew the attention of researchers in the educational fields (Sheu & Chen, 2014). In recent years, a number of empirical studies have been conducted to develop and test gesture-based technologies in different educational disciplines including
physics, mathematics, music and arts, science, social development and physical therapy (Sheu & Chen, 2014). There are many types of technology that recognise gesturing, but this research focuses mainly on full body gesture-based technologies. Examples of full body gesture-based technologies include Nintendo Wii and Microsoft Xbox Kinect. However, Microsoft Kinect has been chosen among other full body gesture-based systems because of the following reasons:

1) Kinect is multimodal controller-free full-body gesture-based technology (Zhang, 2012);
2) The cost of the Kinect can be considered as low when compared with other learning technologies (Hsu, 2011b);
3) Most of the Kinect-based learning applications are open sourced and available for free (Kandroudi & Bratitsis, 2012).

Using the Kinect as a tool for learning has been introduced in previous studies under different terms such as Kinect in education, natural user interface, gestural interfaces in learning and Kinect-facilitated learning (Chao et al., 2013; Evans, 2012; Hsu, 2011a). However, in this thesis, a more generic term, the Gesture-Based Learning System (GBLS) mode, has been chosen to represent the use of the Kinect or any full-body gesture-based user interface, as a teaching and learning tool. The GBLS mode employs natural user interfaces of the Kinect to create an enjoyable and interactive learning environment in formal classrooms (Hsu, 2011a, 2011b; Johnson et al., 2012).

1.2 Research Problem Statement

Although the value and benefits of the GBLS mode have been proposed by several studies, a proper investigation of the influence of the GBLS mode on the learning outcomes is needed. Previous research lacks the study into the impact of the GBLS mode on more than one category of learning outcomes (cognitive, affective and psychomotor outcomes)
simultaneously. Moreover, none of these studies considered the differences in students’ characteristics such as learning styles and spatial abilities. In addition, none of the previous research have explained how the application of the GBLS mode improves learning (C.-Y. Chang, Y.-T. Chien, C.-Y. Chiang, M.-C. Lin, & H.-C. Lai, 2013; Chao et al., 2013; Hsiao & Chen, 2016; Ke, Lee, & Xu, 2016; Meng et al., 2013). According to Sheu, Fang and Chen (2013), the GBLS research field is still at its infancy stage; more studies are needed in order to determine the potential of the GBLS mode. However, a comprehensive empirical research that investigates the effectiveness of the GBLS mode can provide scientific results that can be used to judge the potential of the GBLS mode in the education sector. Moreover, an understanding on how the GBLS mode works will help support the legitimacy of the GBLS mode as an adequate learning technology.

1.3 Research Aim and Questions

Several studies have claimed that the GBLS mode has a positive effect on students’ performance and can create an enjoyable and interactive learning environment (Di Tore, 2012; Sheu & Chen, 2014). However, there is always a fear of overestimating the outcomes of emerging technologies (Abrahamson, Gutiérrez, Charoenying, Negrete, & Bumbacher, 2012; Cuban, 1986; Watson, 2001). According to John and Sutherland (2005), Information Communication Technology (ICT) should be evaluated carefully before making a decision to adopt it in the education field. Therefore, the aim of this study is to investigate the impact of the GBLS mode on the learning outcomes, as well as to investigate whether the GBLS mode is able to accommodate all learners with different learning styles and spatial abilities. Finally, this study also aims to investigate how the GBLS mode positively influences the learning experience. This research addresses the following high-level research questions:

- Does the GBLS mode positively influence students’ learning outcomes?
• Will the GBLS mode be able to accommodate all students with different learning styles and spatial abilities?

• How does the GBLS mode positively influence learning outcomes?

1.4 Research Objectives

The main objective of this study is to investigate and understand the effectiveness of the GBLS mode. The primary objective of the research can be subdivided into more detailed objectives, in order to answer the research questions as follows:

1. Comparing the learning outcomes of the GBLS mode, desktop learning mode and conventional learning mode.

2. Comparing the learning outcomes of students with different learning styles in the GBLS mode.

3. Comparing learning outcomes of students with different spatial abilities in the GBLS mode.

4. Defining the main features of the GBLS mode.

5. Investigating the relationships between the features of the GBLS mode, Psychological Learning Processes (PLP) and the learning outcomes, so as to understand how the GBLS mode influences learning outcomes.

1.5 Research Approaches

A research framework (Figure 1.1) was proposed and tested to answer the research questions. The research framework was built based on two models from the Technology-Mediated Learning (TML) field (Alavi & Leidner, 2001; Piccoli, Ahmad, & Ives, 2001). A quasi-experimental research design was employed in this study. Quantitative data was collected using pre-testing, post-testing and questionnaires. Most of the instruments that were used to measure the constructs were adopted from previous research, with a minor modification to fit the
purpose of this research. The data was collected in Libya and particularly at the Almergib University (Msellatah branch). Only first-year undergraduate students were invited to participate to ensure consistency.

Two statistical analysis tools are used to analyse the data of this research. The first tool is the Statistical Package for the Social Sciences (SPSS) V21, which is used to analyse descriptive statistics, one-way ANOVA and one-way ANCOVA. The second statistical tool is the Smart-PLS V2 and V3 that is used to test and analyse the research model.
Figure 1.1: The Research Framework
1.6 Research Significance and Contribution

In recent years, the potential and impact of the GBLS mode have been investigated in different educational disciplines such as schools, special education, therapy and job training (Di Tore, 2012; Sheu & Chen, 2014). Most past studies have shown a positive effect of the GBLS mode on the learning and training outcomes (C. Y. Chang, Y. T. Chien, C. Y. Chiang, M. C. Lin, & H. C. Lai, 2013; Chao et al., 2013; Sommool, Battulga, Shih, & Hwang, 2013). Despite the value of previous studies in the GBLS mode field, the GBLS research field is still in its early stage and more in-depth studies are required to determine the effectiveness of the GBLS mode. Therefore, this research will be conducted to investigate and thoroughly understand the effectiveness of the GBLS mode.

Furthermore, the results of this research will contribute to the scholarly literature and knowledge about the effectiveness of the GBLS mode in the following ways:

➢ The GBLS mode positively influences both cognitive and affective learning outcomes. Most previous studies focused only on the cognitive learning outcomes and neglected the affective learning outcomes; the current study will address this lack.

➢ The GBLS mode is able to accommodate all learners with different learning styles and with different levels of spatial abilities. None of the past studies have considered the individual differences of students when investigating the GBLS mode. However, this study will cover this gap, and will prove that the GBLS mode can serve all students regardless their learning styles or spatial abilities levels.

➢ The results of this study will provide a conceptual model that explains how the GBLS mode influences learning. Previous literature lacked clear explanation as to how the GBLS mode positively impacts the learning attainments of students. This study will cover this
knowledge gap by providing a scientific explanation of how the GBLS mode positively influences the learning outcomes.

1.7 The Thesis Outline

This thesis is organised into six chapters as follows.

**Chapter 1. Introduction**

Chapter 1 provides the background of the research topic. It also introduces the purpose, questions and objectives of the research, followed by a brief description of the research approach. This chapter also outlines the significance and contribution of this research. The thesis’s structure and definitions of the key terms are also covered in this chapter.

**Chapter 2. Literature Review**

Chapter 2 presents a review of the related literature to the research topic. This chapter is subdivided into four sections as follows. The first section discusses the importance of learning technologies and highlights the role of ICT in promoting interactivity and multimodality within the classroom. The second section introduces the main topic of this research that is the GBLS mode, by explaining the GBLS mode technically and from educational theories. The third section highlights the benefits and challenges of the GBLS mode. The last section explains the theoretical development of the research framework.

**Chapter 3. Research Framework**

Chapter 3 describes the research framework and its constructs and presents the research hypotheses that were developed to address the research questions.

**Chapter 4. Research Methodology**

Chapter 4 explains the research design, research instruments, data collection procedures and data analysis methods and tools.
Chapter 5. Research Results

Chapter 5 presents the results of the data analysis. This chapter has three main parts; the first part exhibits the descriptive statistics of the data. The second part presents the results that answer the first research question. The third part shows the results that answer the second research question. The last part displays the results of the third research question.

Chapter 6. Research Discussion and Conclusions

Chapter 6 explains the meaning of the research results, compares the results with previous studies, as well as highlights the limitation of this research. It also points out the avenues for future research. This chapter concludes the research by summarising the main points and outcomes of the research.
Chapter 2 . Literature Review

2.0 Overview

This chapter highlights relevant literature to the research topic that investigates the effectiveness of the GBLS mode. This chapter is divided into four sections as follows. The first section discusses the potential of technology in the learning field and highlights the role of multimedia technology in promoting interactivity and multimodality within the classroom. The second section introduces the main topic of this research, the GBLS mode, by explaining the GBLS mode technically and via the educational theories. The third section highlights the benefits and challenges of the GBLS mode. The last section explains the theoretical development of the research framework.

2.1 Technology and Learning

Several TML studies have shown the positive impact of the use of technology in the classroom on learners’ performance. Other studies showed that using technology in learning can facilitate the interaction among students and their teachers, and consequently boost learners’ motivations and engage them deeply in the learning activities (Saadé, Buyukkurt, & Alkhori, 2011; Shieh, Chang, & Liu, 2011; Webster & Hackley, 1997). However, using technologies in the classroom does not necessary enhance learning. In fact, the instructional environment supported by technology could lead to an improvement in the learning outcomes instead. For example, using technology as an assistive instructional tool in the classroom enables the learning environment to accommodate learners with different learning styles (Higgins, 2003; Sankey, Birch, & Gardiner, 2010). However, this section highlights two effective learning environments and explain how technologies can promote these learning environments.
2.1.1 Interactive Learning Environment

Interactivity and the effectiveness of learning methods are always linked to each other, as discovered by several educational research (Beauchamp & Kennewell, 2010; Roussou, 2004). Interactivity can be defined as the contingent responses to students' actions during lessons in the classroom (Beauchamp & Kennewell, 2010). Interactivity in the classrooms can be measured by the level of control that teachers have over the classroom interaction. In other words, interactivity in the classrooms depends on the pedagogy of learning, whether it is teacher-centred or student-centred (Burns & Myhill, 2004; Hsu, 2011b). Teacher-centred pedagogy represents the conventional learning method where teachers talk for a long time with a little or no students’ participation or feedback. In contrast, student-centred learning gives students more chances to participate, analyse and organise the knowledge content (Kain, 2003). According to Hsu (2011a), promoting interactivity in the classroom requires giving students ample opportunities to participate in the classroom activities.

Burns and Myhill (2004) have identified characteristics of the interactive learning environment as follows:

1) students get a chance to talk and participate;
2) it provides a proper participation environment;
3) it leverages on the level of student-centred learning.

It has been proven that student-centred learning improves students’ skills such as problem-solving and critical thinking (Saye & Brush, 2001). According to Saye and Brus (2001), in student-centred learning, the establishment of the roles with regards to the organisation of knowledge content and objectives are shifted from the instructor to the students. However, interactive multimedia technologies can be used in classrooms to promote interactivity, as these technologies encourage self-information seeking and individual decision making (Hannafin &
According to Beauchamp and Kennewell (2010), technology itself cannot achieve the desired interactivity in the classroom, but it can be used by teachers and learners to orchestrate the learning resources and facilitate an interactive environment to achieve the desired learning goals.

2.1.2 Multimodal Learning Environment

Multimodality refers to the mode of interaction and knowledge representation that supports learners’ full sensory capabilities which include visual, audio, kinaesthetic and haptic (Birchfield et al., 2008). According to Megowan (2007), the conventional learning system supports only the conceptual structure which represents knowledge as symbols, words and equations. Megowan (2007) states that many students with different learning styles struggle with learning via the conventional learning mode, as some of them prefer learning using images, while others prefer learning by doing. The multimodal learning environment is the idea of representing knowledge in various methods to serve all students in the classroom who have different learning styles (Birchfield et al., 2008). Nowadays, low-cost advanced technologies can help promote the multimodal learning environment. However, it is important to highlight the differences between the technologies that support multimodality and the others that do not. Therefore, below is a comparison between the unimodal and multimodal technologies.

2.1.2.1 Unimodal Systems

With unimodal systems, the user can only communicate with the computer through one channel. An example of the communication channel can be a gesture, speech or touch. Each communication channel is called a modality; therefore, any technology that is based only on one modality is categorised under unimodal technology. Based on the communication channel (modality), the unimodal technologies can be categorised into three sub-categories: Visual-based systems, Audio-based systems and Sensor-based systems.
• **Visual-based systems**: The user communicates with the computer through visual interaction, where the technology can detect and recognise the user’s actions, be it facial expressions, hand gestures, eyeball or body movements (Jose, Miglani, & Yadav, 2014; Karray, Alemzadeh, Saleh, & Arab, 2008).

• **Audio-based systems**: The user communicates with the system via audio or speech as an input method. An audio-based system can recognise the user’s voice and interpret it to perform a particular command. Examples of audio-based systems include speech recognition systems, speaker recognition systems and musical interaction systems (Jose et al., 2014; Karray et al., 2008).

• **Sensor-based systems**: There is at least one sensor between the user and machine to provide the interaction. The sensor can be very simple such as a mouse, keyboard and joysticks or advanced input devices such as motion tracking, haptic, pressure and taste/smell sensors (Karray et al., 2008).

### 2.1.2.2 Multimodal Systems

Multimodal systems refer to those systems that can handle multi-input modes at the same time. In these systems, the user can communicate with the system via more than one communication channel. The multimodal interface can handle two or more communication channels simultaneously and coordinate between them effectively. The most common multimodal systems are the ones that can take a combination-input of gestures and speech (Jose et al., 2014; Karray et al., 2008). For example, Microsoft Kinect is a full-body multimodal gesture-based system and can recognise human’s gestures and voices simultaneously.

### 2.2 Gesture-Based Learning System (GBLS) Mode

As mentioned in Chapter 1, the GBLS mode will be used in this thesis to represent the use of the Kinect sensor or any full-body gesture-based user interface, as a teaching and learning tool.
The GBLS mode has been tested in different educational disciplines including physics, mathematics, special education, music and arts, science, social development and physical therapy (Sheu & Chen, 2014). In addition, some research activities studied the effect of the GBLS on specific learning aspects such as memory and physical rehabilitation (Chao et al., 2013; Shih-Ching et al., 2012). According to Hsu (2011b), the GBLS mode has great potential to be the focal learning technology in the classrooms in a few years. However, the next section will provide a detailed description of the GBLS mode technically, and via the educational theories.

2.2.1 Technical Description of the GBLS Mode

This section provides a technical description of the GBLS mode. Technically, the GBLS mode is made up of a Kinect sensor attached to a computer using middleware and the Kinect-based learning application.

2.2.1.1 Kinect Sensor

The Kinect sensor was released in November 2010 by Microsoft as part of the Xbox 360 game console that exemplifies the first controller-free video game console; it was advertised with the slogan, “You are the controller” (Lang et al., 2011). Microsoft Xbox 360 became popular in a short period of time; for example, in the first ten days after its release, more than 1 million units were sold. Another study reported that, just after 60 days of its release, more than 8 million units of Microsoft Xbox 360 were sold (O’Donovan et al., 2012). The Kinect sensor can be described as an Red, Green and Blue (RGB) camera, along with a microphone array and depth sensor using an infrared projector (see Figure 2.1). The Kinect is able to recognise a player’s body movements and voice.

Shortly after the Kinect’s release, Adafruit Industries offered USD1000 to anyone who could release a complete open-source driver for the Kinect sensor (Villaroman, Rowe, & Swan,
2011). Not long after that, a hacker successfully developed the first open-source Kinect driver called ‘Libfreenect’ that enabled the Kinect to run on Linux. Microsoft responded to this hacking by announcing that the hacker will not be sued for that. In December 2010, PrimeSense released another open-source driver for the Kinect called OpenNI (Hsu, 2011b). In June 2011, Microsoft launched an official non-commercial driver for the Kinect for Windows OS. In particular, Microsoft released two versions of the Software Developing Kit (SDK) - one for personal use and the other for developers. All the above Kinect drivers used a skeletal tracking model. These drivers enable the Kinect sensor to be attached to any personal computer/Laptop.

![Kinect design](Zhang, 2012, p. 5)

### 2.2.1.2 Kinect-Based Learning Applications

Most of the Kinect-based learning applications are open-sourced and available for free, which gives more research freedom without the concern of breaching copyright conditions. On the software development side, some projects have been launched to develop the GBLS mode applications such as KinectEDucation (http://www.kinecteducation.com). KinectEDucation is a non-commercial platform for all GBLS stakeholders including teachers, students, enthusiasts and software developers (Kandroudi & Bratitsis, 2012). Moreover, Microsoft has established a website to support learning using Kinect - [http://www.microsoft.com/kinecteducation](http://www.microsoft.com/kinecteducation).
Having described the GBLS mode’s technical characteristics, the following section is devoted to describe the GBLS mode’s educational features and potential.

2.2.2 GBLS Mode Description from Educational Theories

The purpose of this section is to link the main features of the GBLS mode to related educational theories. This section will highlight the following topics: first, the relationship between gestures and learning; second, embodied cognition theory and third, previous related research.

2.2.2.1 Gestures and Learning

The use of gestures is an old communication method between human beings. Gestures are the main constructs of Sign Language (SL), which is used by people who are hearing or speech impaired; these people use sets of gestures to communicate with their environments. As explained by Lang et al. (2011), SL has been used for centuries to communicate between dumb and deaf people, but it was not considered as a real language till the late 1960s; when it was introduced by William C. Stokoe, a Professor and English lecturer at Gallaudet University in the USA, who focused his research on analysing the American Sign Language (ASL). Professor Stokoe is one of the first scientists who explored the communication language of deaf people and linked sign language gestures to the spoken language. Besides, normal people also use gestures in their daily conversations to convey some messages without using words. For example, people nod their heads during a conversation to indicate an affirmation with the speaker.

According to Kaushik and Jain (2014), gestures can be defined as the body’s motions that are used with the intention to communicate with other people. A gesture can only be effective if both sender and receiver have the same set of information for it. To put it another way, gestures are the body’s motions that people use to express meanings that are understandable by both parties of communication. Gestures can be dynamic, static or a combination of both. A dynamic
gesture, such as waving of hands, changes over a period of time, whereas a static gesture, such as a stop sign, is observed at a particular moment in time. Moreover, a gesture can consist of both static and dynamic elements such as in the case of sign language gestures (Kaushik & Jain, 2014; Pavlovic, 1997). Specifically, human gestures can be divided into three main categories as follows:

a. **Hand and arm gestures:**

Hand and arm gestures are the most commonly used gestures by humans. Hand and arm gestures involve posture and gesture. Posture is static finger configuration without a hand movement, and gesture involves dynamic hand movements may or may not be combined with finger motion. Hand and arm gestures can be categorised into five categories that are: Gesticulation, Language-like gestures, Pantomimes gestures, Emblems gestures and Sign language gestures (Kaushik & Jain, 2014; Mitra & Acharya, 2007).

b. **Head and face gestures:**

This gesture type involves the use of head and facial features of a human to convey a meaningful message to other people. There are many examples of head and facial gestures and here is a list of the most common ones: 1) nodding or shaking the head to say Yes or No; 2) winking and 3) making an expression by looking surprised, fearful, disgusted, angry, sad or happy. People can easily recognise head and facial gestures. Facial expression changes continually and can convey various messages. To make computers understand facial and head gestures, all the possible changes that may happen to the user's face need to be modelled (Kaushik & Jain, 2014; Mitra & Acharya, 2007).

c. **Full-body gestures:**

This gesture type includes full-body movement. Full-body gestures recognition has many applications. For example, it is used intensively in monitoring patients’ body movements in medical rehabilitation and in monitoring dance movements during dance classes (Mitra &
Moreover, full-body gestures have been used in the educational field as well. The current research is only interested in full-body gesturing and its impact on learning. There are many technologies that can recognise full-body movements. Among the technologies that can track and recognise full-body gestures, Microsoft Xbox Kinect has been chosen for this study.

The positive role of gesturing in improving learning has been scientifically demonstrated. For example, a study by Autumn B Hostetter, Bieda, Alibali, Nathan and Knuth (2006) found that teachers can use gestures to strengthen their instructional tasks, help their students to link ideas and to simplify complicated concepts. Other studies indicate that gestures are powerful tools and can be used by instructors to communicate effectively with their students (Alibali et al., 2014; Autumn B Hostetter, 2011; Nathan, 2008). Furthermore, several studies have proved that using gestures during learning help students learn better, in terms of understanding the ideas and problems-solving (Autumn B. Hostetter & Alibali, 2008; Keene, Rasmussen, & Stephan, 2012). The following section explains how gesturing is linked with better learning performance via the educational theories.

2.2.2.2 Embodied Cognition Theory

Several studies have emphasised the positive impact of the combination of physical gestures with cognitive tasks on learning (Ratner, Foley, & McCaskill, 2001; Stevanoni & Salmon, 2005). Embodied Cognition Theory is a cognitive science theory that believes connecting cognitive tasks with the physical environment can support concept understanding and learning processes for students (Chao et al., 2013). According to Montessori (2004), performing physical movement and touching relevant things during learning provides a meaningful learning experience. Chang et al. (2013) have found that using gesture-based multimedia has a
satisfactory effect on concept understanding and memory retention. Kirsh (2013) also supports the Embodied Cognition Theory as he highlights the following points:

1) manipulating tools physically changes the way people think;
2) people think with their bodies not just with their brains;
3) people learn more by doing than watching.

Kirsh (2013) also proves the Embodied Cognition Theory by demonstrating that people learn more by performing simple marking (imperfect gesturing) than via simulating in the head or standard practising. He ran an experiment for practising dance phrases using three practising models: the first model is standard practising, the second model is marking practising (gesturing), while the third model is practising via simulation in the head. The results of the above experiment show that the marking model (gesturing) is the most effective learning model among the three, followed by standard practising and then simulation in the head (Kirsh, 2013).

2.2.2.3 Related Work

Since the GBLS was listed as potential educational technology by Horizon’s reports in 2011 and 2012 (Johnson et al., 2011, 2012), researchers and education specialists have been encouraged to take a closer step towards the GBLS mode and investigate its educational value. In recent years, a number of empirical studies have been conducted to develop and test the GBLS mode. Chang et al. (2013) ran an experiment using the Kinect as gestural-based multimedia to test the effect of body movements and gestures on learning. The results showed better concept understanding and knowledge retention using Kinect-based learning; the results were measured by pre-test and post-test. Moreover, Chao et al. (2013) examined the effect of using gestures during learning on students’ memory performance by comparing the desktop learning system with the Kinect-enhanced learning method. The results showed that the students who used the Kinect recalled more information than the other students who used desktop systems.
In addition, Meng et al. (2013) used a Kinect-based learning system to teach anatomy. The results of this research showed that using the Kinect-based learning method outperformed the existing learning system, which was Augmented Reality (AR) magic mirror. AR magic mirror is a medical education technology that creates an illusion, which augments virtual anatomy information to the user who is standing in front of a mirror. Another study (W.-J. Lee, Huang, Wu, Huang, & Chen, 2012) compared the Digital Learning Playground (DLP) with the Kinect-enhanced DLP to test the effect of embodied interaction on learning performance. The results of this comparison showed that the Kinect-enhanced DLP kept the participants’ attention on learning and gave them a more enjoyable learning experience than the convention DLP. Ayala, Mendívil, Salinas and Rios (2013) also developed kinaesthetic learning applications using the Kinect sensor to help teach Math; they found that there is a relationship between body movements and learning processes.

Sommool, Battulga, Shih and Hwang (2013) tested the usability satisfaction of Kinect-enhanced “Ho-lodeck” classroom; the results showed that the participants were satisfied with the use of the system. More recently, Hsiao & Chen (2016) used ASUS Xtion PRO, which is the Kinect-like device to test the effect of Gesture Interactive Game-based Learning (GIGL) on the learning performance and motor skills of pre-schoolers. The results of this study showed that the GIGL system improved kids’ learning performance and their motor skills when compared to traditional activity game-based learning. Ke, Lee and Xu (2016) also developed and examined the impact of Mixed-reality Integrated Learning Environment (MILE) on teaching performance; the Kinect-enabled sensorimotor interface was used to create a virtual reality learning method. MILE was used by 23 university teaching staff and they found that the MILE did reinforce the teaching tasks.
2.2.3 The Benefits and Challenges of the GBLS Mode

The GBLS mode has started to gain much attention as one of the promising learning technologies (Johnson et al., 2011, 2012). The GBLS mode can bring several advantages to the classroom as it provides a unique natural interaction method with the teaching material (Evans, 2012). The GBLS mode has several features that make it a potential learning technology (Hsu, 2011a, 2011b). However, this section will highlight the GBLS mode’s traits and link them to educational literature. First, the GBLS mode can operate as a stimulating tool for learners. Moreover, this could help to boost their motivation as the GBLS utilises a unique and natural interaction method.

Second, the GBLS is a multimodal system and is able to facilitate kinaesthetic interactions and coordinate them with auditory and visual information. The coordination of these three different inputs-modalities makes the GBLS mode an excellent learning mode that supports students with various learning styles, especially kinaesthetic learners (Hsu, 2011a, 2011b). To illustrate this, learning style theorists argue that students learn through different learning modalities. “Learning modalities are the sensory channels or pathways through which individuals give, receive and store information. Perception, memory and sensation comprise the concept of modality” (Gage, 1995, p. 52). There are mainly three learning modalities that are auditory, visual and kinaesthetic. Kinaesthetic learners represent 15% of the total population of students (Gage, 1995; Hsu, 2011b). Kinaesthetic students learn better when they are physically involved with the learning material. According to Gage (1995), kinaesthetic learners have been ignored by most learning methods. However, the GBLS mode can cater to the needs of kinaesthetic learners in order to achieve a better learning performance and at the same time, support other learning styles (Hsu, 2011a).
Third, the GBLS mode supports the Embodied Cognition Theory, which argues that students learn better when they combine cognitive tasks with physical movements (C. Y. Chang et al., 2013). The Embodied Cognition Theory suggests that manipulating and interacting with tools change the way we think and comprehend, and this change affects the way we perceive our environment. In other words, the Embodied Cognition Theory states that people learn with their bodies to complement their brains (Kirsh, 2013). Several studies have emphasised the positive impact of the combination of physical gestures with cognitive tasks on learning (Ratner et al., 2001; Stevanoni & Salmon, 2005). According to Chao et al. (2013), performing physical movements and touching relevant things during learning tasks provide a meaningful learning experience. Fourth, the Kinect is relatively cheap as compared to other learning technologies and can be attached to the classroom computer without the need for installing any other infrastructures (Hsu, 2011b). Fifth is relating to fitness and physical development. Besides its value in learning, a study by O’Hanlon (2007) showed that the GBLS mode could help overweight students by engaging them in physical activities during and after class time.

2.3 Theoretical Development of the Research Framework

The GBLS research field is still at its infancy stage (Sheu et al., 2013) and up to the time of writing this thesis, there is no research model that is specially built to guide GBLS research. Thus, TML models were used as a guide to achieve the objectives of this study. Moreover, Aptitude by Treatment Interaction (ATI) was also used to guide this research. The following section describes the TML models and ATI research used.

2.3.1 TML Models

Two research models (Alavi & Leidner, 2001; Piccoli et al., 2001) were used to build the research framework. Below is a brief description of these two models. Firstly, Alavi and Leidner’s framework (Alavi & Leidner, 2001) (Figure 2.2) provides a summary of the TML
The framework outlines the potential research avenues in the TML field. Alavi and Leidner have called for a broader and deeper research approach in investigating the effectiveness of learning-mediated technologies. They claimed that the research questions should be more detailed; so instead of only asking whether technology improves learning, the research should also ask how technology improves learning (Alavi & Leidner, 2001). The framework also identified and explained the missing dimensions of previous TML research.

Alavi and Leidner’s framework was built based on the input-process-output model and consists of four dimensions namely Instructional Strategy, Information Technology, Psychological Learning Processes (PLP) and Learning Outcomes. This framework mainly focuses on the relationship between technology and the instructional strategy, and their effect on PLP, which consequently influences the learning outcomes. Alavi and Leidner’s framework has been criticised as it ignored an important dimension, which is learners’ characteristics (Alavi & Leidner, 2001; Wan & Fang, 2006). According to Benbunan-Fich and Hiltz (2003), as well as Piccoli et al. (2001), learners’ characteristics play an important role in the success of technology use in the learning field.

![Figure 2.2: A Framework for TML Research (Alavi & Leidner, 2001, p. 5)](image)

Secondly, Piccoli et al.’s framework (Piccoli et al., 2001) was developed primarily for web-based learning (see Figure 2.3). This framework adds the human dimension which is missing
in Alavi and Leidner’s model (Alavi & Leidner, 2001). Piccoli’s framework consists of only three dimensions which are Human dimension, Design dimension and Effectiveness dimension. Piccoli et al.’s framework has also been criticised as it ignored the dimension of PLP. In addition, the framework also minimises the importance of the information technology dimension by including it just as a variable under the design dimension (Piccoli et al., 2001; Wan & Fang, 2006).

Figure 2.3: Dimensions and antecedents of VLE Effectiveness. (Piccoli et al., 2001, p. 406)
2.3.2 Aptitude by Treatment Interaction (ATI)

ATI research has been used in this study to discover further whether the GBLS mode is able to accommodate all students with different personality traits such as learning styles and spatial abilities. ATI was first introduced by Cronbach (1957), who believes that there is no single instructional method that fits all students. ATI focuses on the interaction between the treatment and the individual’s characteristics (Cronbach & Snow, 1977; Yeh, 2012). ATI research is usually conducted in the education field to discover which treatment (e.g. learning method) is effective for all students, with the consideration of their personal differences (Bracht, 1970; Hermann & Maria, 2006). According to Caspi and Bell (2004), the design of the ATI research considers the aptitude differences in the treatment evaluation. Therefore, ATI does not only focus on which treatment is better, but it also considers whether the treatment will be effective for all students who have different aptitudes. ATI research emphasise that some instructional methods have more or less impact on specific individuals, based on their personal characteristics or abilities (Hwu & Sun, 2012).

1. **Aptitude:** It refers to a set of personal characteristics that are identified before or during the treatment as an influence of the treatment outcomes (Caspi & Bell, 2004). According to Snow et al. (1980), aptitude refers to personal differences that can be physiological, cultural or biological. These personal differences can affect an individual’s performance in a specific situation. In this study, the students’ aptitudes that will be explored are learning styles and spatial abilities.

2. **Treatment:** It refers to the instructional method or learning mode (Grabowski & Jonassen, 1993). In this study, there are three treatments namely the GBLS mode, CSL Mode and conventional learning mode.
3. **Interaction**: It occurs when the aptitude variables and treatment variables interact with one another. Two types of interaction, ordinal and disordinal, may result from the ATI research framework (Caspi & Bell, 2004; Grabowski & Jonassen, 1993).

- **Ordinal interaction**: individuals with a high level of aptitude do well with treatments A and B, while individuals who attain low scores in the aptitude measurement will perform poorly in either treatment (see Figure 2.4).

  ![Figure 2.4: Ordinal ATI (Grabowski & Jonassen, 1993, p. 8)](image)

- **Disordinal interaction**: individuals with low aptitude scores attain better outcome scores with treatment A, while individuals with the same low level of aptitude scores perform poorly with treatment B. On the other hand, individuals who measure highly in aptitude score perform poorly with treatment A, while individuals with the same high level of aptitude scores attain good outcome scores with treatment B.

  ![Figure 2.5: Disordinal ATI (Grabowski & Jonassen, 1993, p. 9)](image)
Several educational studies have used ATI to determine whether a specific learning mode is able to accommodate all students with different characteristics. For example, McLachlan & Hunt (1973) used ATI research to match students’ learning styles with appropriate teaching methods. Another recent example is Lee (2011), who used ATI research to determine whether the non-immersive Virtual Learning mode can accommodate all students with different learning styles and spatial abilities.

2.4 Summary

This chapter outlined the related literature to the research topic and justified the significance of this research. First, the chapter provided a general overview of the potential of technologies in the classroom and how technologies can promote interactive and multimodal learning environments. Second, this chapter described the GBLS mode technically and via educational theories, where the relationship between the GBLS mode and the Embodied Cognition Theory was highlighted. Third, the theoretical foundation of the research framework was underlined and the models that were used to guide this study were described. In particular, two models from the TML field were explained in detail (Alavi & Leidner, 2001; Piccoli et al., 2001). This chapter also gave an explanation of ATI research and the reasons behind employing it in this study.
Chapter 3. Research Framework

3.0 Overview

Chapter 3 introduces the research framework and describes its constructs. This chapter is divided into four sections: the first section explains the latent variables that are of interest in this research, the second section describes the research framework, the third section presents the developed hypotheses and the last section summarises the contribution of this chapter.

3.1 Variables of Interest

This section will provide an explanation of the constructs that are used in this research framework.

3.1.1 Learning Modes

Three learning modes were used in this research: the GBLS mode, CLS mode and conventional learning mode. The GBLS mode is the main focus of the research, while the other two learning modes are included for comparison purposes. The CLS mode represents an example of the current educational technology used, whereas the conventional learning mode represents traditional teacher-centred learning that is still prevalent in some education institutions, table (3.1) summarises the three learning mode. Below is a brief description of each learning mode.

Table 3.1: Comparision between the three learning modes

<table>
<thead>
<tr>
<th>GBLS Mode</th>
<th>CSL Mode</th>
<th>Conventional Learning Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supports embodied cognition theory</td>
<td>Supports constructivist learning theory</td>
<td>Supports objectivist learning theory</td>
</tr>
<tr>
<td>Natural interactive learning method.</td>
<td>Interactive computer based learning method</td>
<td>Teacher centred learning method</td>
</tr>
<tr>
<td>Student get chance to freely move and use their body motions to control the learning system.</td>
<td>Students remain seated all time but they have chance to interact and control the learning material.</td>
<td>Teacher controls all the activities in the classroom with little or none participation from students.</td>
</tr>
</tbody>
</table>
3.1.1.1 Gesture-Based Learning System (GBLS) Mode

As described in Chapters 1 and 2, the GBLS mode is a general term used in current research to describe the use of full-body gesture-based technology in the education field. The GBLS mode supports the interactive and multimodal learning environments. The GBLS mode also supports the Embodied Cognition Theory that states that people learn better when they interact physically with their surroundings. A description of the components of the GBLS mode are available in Chapter 4: Research Methodology.

3.1.1.2 Computer Simulation Learning (CSL) Mode

The CSL mode is included in this research for comparison purposes only, as it represents one of the current learning technologies that are used by several educational organisations. The related literature (Buckingham, 2013; Persico et al., 2014) indicates that the CSL mode could be categorised as a constructivist learning approach. The Constructivist Learning Theory argues that students learn from the interaction between their experience and new ideas (Kain, 2003). The CSL mode’s technical description is also available in Chapter 4.

3.1.1.3 Conventional Learning Mode

The conventional learning mode is also included in the research for comparison purposes only. The conventional learning mode represents a teacher-centred method, where teachers dominate all the activities in the classroom with little or no student participation or feedback. Conventional learning is classified in most educational literature as an objectivist learning method (Homer et al., 2014). The objectivism learning theory believes that the teacher is the main source of knowledge in the classroom and that the students are empty brains; hence, learning happens through the process of communication between the learners and instructors (Jonassen, Davidson, Collins, Campbell, & Haag, 1995; Vrasidas, 2000).
3.1.2 Learning Outcomes

Learning outcomes cannot be measured directly, only the action and performance that results from learning can be measured (Alavi & Leidner, 2001). Sharda et al. (2004) have categorised learning outcomes into three components: Cognitive Outcomes, Affective Outcomes and Psychomotor Outcomes. Cognitive Outcomes include knowledge, comprehension, analysis and application. Affective outcomes include learners’ perception of satisfaction, attitude and appreciation for the learning experience using a new learning method. Psychomotor Outcomes includes response magnitude, accuracy and efficacy. Only the cognitive and affective learning outcomes are of interest in this study. However, this research will measure the cognitive outcomes using pre-test and post-test grades, as well as the affective outcomes through perceived learning effectiveness and satisfaction.

3.1.3 Learners’ Characteristics

Students are the most important component in the education processes, and they represent the raw subjects for any educational system. Indeed, students are the key members of the stakeholders involved in the education cycle (Lengnick-Hall, 1996; Sirvanci, 1996). As such, understanding students’ characteristics is a crucial factor to ensuring the success of an educational system or method. Individual differences include learning styles, diversity in motivations, spatial abilities and demographic differences (Alavi & Leidner, 2001). According to Lengnick-Hall and Sanders (1997), the variation of students’ characteristics has become a challenge for all educational institutions around the world, as those differences may affect the learning outcomes of the students when they are taught by the same learning method. Alavi (2001) argues that studying the impact of any instructional based technology method on learning outcomes should consider learners’ characteristics. This research focuses on investigating the influence of the GBLS mode on learning outcomes. Therefore, two individual
characteristics (learning styles and spatial abilities) will be included in this study, to find out if the GBLS mode is able to serve all students with different individual characteristics.

3.1.3.1 Learning Style

The term, ‘Learning style’ was first introduced to the literature in the mid-1950s by Thelen (1954). Kolb (1984) defines learning styles as the individual preferred method to understand and process information. Kolb also introduced an Experiential Learning Model to explain four different learning styles models (see Figure 3.1). To illustrate this, Kolb explained the learning process in four stages which are:

1) Concrete Experience (CE);
2) Reflective Observation (RO);
3) Abstract Conceptualization (AC); and
4) Active Experimentation (AE) (Hawk & Shah, 2007; Kolb, 1984).

Kolb built his model based on the above four stages. Thus, each learning style is a product of two pairs of preferences. Kolb presented the four stages as line axes, each with contradictory modes in either end, CE (Feeling) versus AC (Thinking), and AE (Doing) versus RO (Watching). Each learning style is a combination of how students respond to new information and how they process this information. In responding to the new information, learners choose between CE (Feeling) and AC (Thinking). On the other hand, in processing information, learners choose between AE (Doing) and RO (Watching). The combination of these preferences result in the four learning styles as follows:

1. **Divergers** are a combination of CE and RO; these learners prefer learning by feeling and watching.
2. **Assimilators** are a combination of AC and RO; these learners prefer learning by thinking and watching.
3. **Convergers** are a combination of AC and AE; these learners prefer learning by thinking and doing.

4. **Accommodators** are a combination of CE and AE; these learners prefer learning by feeling and doing.

---

Figure 3.1: Kolb experiential learning model and learning Models. (Hawk & Shah, 2007, p.4)

### 3.1.3.2 Spatial Abilities

Spatial abilities refer to one’s ability to manipulate and transform an image of spatial patterns into another arrangement (Rafi et al., 2005). Spatial abilities are considered as one of the seven main components of human intelligence (Tzuriel & Egozi, 2010). Despite the fact that the vast majority of researchers have an agreement on the importance of spatial abilities as an intellectual component, there is still no agreement on the nature of spatial abilities (Yilmaz, 2009). Besides, the components of spatial abilities have been defined in different ways by different scholars, and this has created some confusion. McGee (1979) conducted a review of the spatial abilities literature to clear that confusion. Thus, McGee (1979) categorised the spatial ability components into two main components namely, spatial visualisation and spatial orientation.
Spatial visualisation can be defined as “the ability to imagine manipulating, rotating, twisting, or inverting objects without reference to one’s self” (Yilmaz, 2009, p. 84). Visualisation abilities are usually measured using sophisticated methods such as folding and unfolding a piece of paper or mentally rotating a 3-D figure (Hegarty & Kriz, 2008; Yilmaz, 2009). On the other hand, spatial orientation is the ability to not be confused by changing the orientation of the visual stimuli (Rafi et al., 2005; Sorby, 2009; Yilmaz, 2009). In other words, spatial orientation is the individual’s ability to imagine the shape of a particular object from different viewpoints (Yilmaz, 2009).

However, several educational studies have emphasised the relationship between the level of spatial abilities and individuals’ academic performance, especially in the fields of Engineering, Science and Architecture (Lajoie, 2003; Tzuriel & Egozi, 2010). For example, Smith (1964) found that spatial visualisation plays a significant role in people’s success in more than 84 different professions. Moreover, Sorby (2009) asserts that possessing visualisation and mental rotation abilities is key for success in technical careers. Norman (1994) adds that spatial abilities are a very important factor to a person’s success when interacting with computer graphical interfaces. Pleck et al. (1990) emphasise that the importance of spatial visualisation has increased rapidly as a result of the advancement of computer technologies. According to Hegarty and Kriz (2008), individuals with a high level of spatial abilities are better in understanding mechanical processes. Mayer and Sims (1994) conducted a study to test the effect of visual-spatial abilities on the learning from animation. The results showed that people with high visual abilities learn more from well-designed animations than people with low levels of visual-spatial abilities.

Moreover, several studies were conducted to find the methods of developing individuals’ spatial abilities. For example, Gagnon (1985) found that there is a strong relationship between playing video games and high scores in the spatial abilities test. Moreover, Wexler et al. (1998)
found that a combination of motor processes and mental rotation resulted in faster time and fewer errors in the spatial visualisation test. In other words, using body movement during mental rotation tasks helps in performing spatial tasks. Furthermore, Chu and Kita (2011) conducted three experiments to investigate whether gestures enhance spatial visualisation tasks. The results of these three experiments show that individuals who used gestures solved more problems correctly than individuals who did not use gestures. Also, the results showed that people used more gestures when they encounter harder mental orientation problems.

Based on the above literature, it can be concluded that spatial abilities can affect learners’ performance, especially when they deal with computer animation or 3-D objects. Therefore, in this study, it is important to consider students’ spatial abilities as it can help to explain the research finding.

3.1.4 GBLS Features

Technology has been used in the classroom for many years as an assistive tool to support the instructional strategy. Technology can benefit classroom instructions in several ways, for example, presenting the learning content in different ways and promoting interaction between the students and instructors in the classroom. However, Alavi and Leidner (2001) believe that technology features influence learning outcomes through impacting the psychological learning processes. Therefore, in order to assist in understanding how technology influences the learning outcomes, it requires defining the technology features that may influence PLP. As this study is aimed at investigating how the GBLS mode influences the learning outcomes, it is crucial to define the main features of the GBLS mode. Two features of the GBLS mode were identified and tested in this research, namely interactivity and multimodality.
3.1.4.1 Interactivity

Interactivity was explained in detail in Chapter 2. The interactive learning environment can be described as the learning method that ensures a prompt and continuous respond to students’ actions and feedback (Beauchamp & Kennewell, 2010). Promoting interactivity in the classroom also requires giving students a chance to participate in the design and organisation of the learning activities, so that they get the opportunity to express their interest and creativity (Hsu, 2011a; Kain, 2003). It has continually been argued that employing interactive multimedia can create an effective learning method that promotes deep learning and actively engages students (Cairncross & Mannion, 2001; Schwan & Riempp, 2004). The GBLS mode can promote interactivity in the classroom in several ways. For example, the GBLS mode can accommodate more than one user, which enables instructors to share the interaction with their students, meaning that a teacher can work with students one-to-one. Hence, the interaction will encourage group work and cooperation within the classroom (Hsu, 2011a, 2011b).

3.1.4.2 Multimodality

The multimodal learning environment was also explained in Chapter 2. Multimodal learning refers to the learning environment that presents the learning materials in various ways to match the interest of most students with different learning styles (Pashler, McDaniel, Rohrer, & Bjork, 2008). However, many educational organisations have adopted a mix of multimodal and hypermedia technologies, to create a multimodal learning environment that serves all learners with different learning styles (Sankey et al., 2010). The primary benefit of the multimodal learning environment is that it allows students to experience learning in the way that suits them (Picciano, 2009). The GBLS mode provides the multimodal learning environment that facilitates almost all learning styles. Unlike other learning technologies that ignore the kinaesthetic learning style, the GBLS enables users to interact with the learning materials using their body movements (Hsu, 2011b).
3.1.5 Psychological Learning Processes (PLP)

Alavi and Leidner (2001, p. 4) defined PLP as “states within the learner that are involved in learning”. The states include motivation, information processing activities, memory and interest. Alavi and Leidner (2001) affirmed that learning occurs through psychological learning processes. Therefore, understanding how a particular technology affects learning outcomes requires investigating the impact of that technology on the psychological learning processes. Current research is aimed at understanding how the GBLS mode influences learning outcomes. Thus, the impact of the GBLS features on one example of PLP, specifically intrinsic motivation, will be studied. In the following section, motivation will be highlighted in general, and then intrinsic motivation will be explained.

3.1.5.1 Motivation

In general, motivation can be defined as the factor or cause that stimulates a person to act or behave in a particular way (Packer, 2004). Motivational theories (Locke & Latham, 1994; Pintrich, Marx, & Boyle, 1993) have defined motivation more specifically as the factor that impacts the person’s behaviour in three ways:

1) the direction of behaviour that explains why a person chooses a behaviour over another;

2) the energisation of behaviour that explains the amount of effort that a person devotes to a specific behaviour and

3) the regulation of behaviour that explains the reason that leads a person to change his behaviour or maintain it.

However, Ford (1992, p. 20) summarised several motivational theories in one clear definition, “motivation is defined as the organised patterning of three psychological functions that serve to direct, energise, and regulate goal-directed activity: personal goal, emotional arousal processes, and personal agency beliefs.”
There is no doubt that motivation is very important in all stages of the learning process. Educational researchers have clearly confirmed the link between learning outcomes and motivation (Packer, 2004; Pintrich et al., 1993). According to Schiefele (1991), individuals who are motivated to learn are readier to engage deeply in cognitive processes that require sustainable effort and persistence. Thus, motivation supplies the mental energy that is required for learning (Csikszentmihalyi & Hermason, 1995; Koran, Koran, & Foster, 1988).

Motivation can be categorised into two types: intrinsic motivation and extrinsic motivation. Intrinsic motivation is the kind of motivation that is associated with internal factors such as interest, curiosity, spontaneity and exploration. On the other hand, extrinsic motivation is based on external factors such as reward, grade, promotion and pressure from authority figures (Holton & Swanson, 2005; Müller & Louw, 2004). In learning, both intrinsic and extrinsic motivations have a positive impact on learning performance. However, many studies have shown that intrinsic motivation is always associated with higher learning quality, better learning approaches and more enjoyment of the learning experience (Czubaj, 2004; Deci & Ryan, 1985; Holton & Swanson, 2005). Extrinsic motivation usually produces a short-range of learning activity and interest of the learning topic. Therefore, Lepper and Hodell (1989) suggests that extrinsic motivation alone is not reliable for supporting long-term learning experiences, and thus, extrinsic motivation should be backed up by intrinsic motivation. However, this study is only interested in intrinsic motivation. Therefore, intrinsic motivation is explained in the following section.

3.1.5.1.1 Intrinsic Motivation

Intrinsic motivation can be defined as what people are willing to do without any external stimulator. In other words, an intrinsically motivated person engages in an activity for no reward but the enjoyment and interest that accompanies it (Malone & Lepper, 1987). The value of intrinsic motivation has been studied and proven in the field of education (Shia, 2000).
Students who are intrinsically motivated will be able to maintain interest in the learning subject, acquire knowledge and have more chances to apply and retain that knowledge, show better academic achievement and have self-competency (Pintrich, Meece, & Pintrich, 2008; Ryan & Deci, 2000). However, the classroom environment also plays an important role in facilitating and promoting motivation (Stefanou & Salisbury-Glennon, 2002). According to Deci & Ryan (1985), the classroom environment can stimulate learners’ motivation when the educational program is able to serve students with different needs. Alfassi (2004) proved that a student-centred learning environment improves learners’ intrinsic motivation. In the current research, students’ intrinsic motivation will be measured using the Intrinsic Motivation Inventory (IMI). Four subclasses have been chosen from the IMI to evaluate students’ intrinsic motivation in this study. These subclasses are: 1) Interest and Enjoyment; 2) Perceived Competence; 3) Value/ Usefulness and 4) Tension and Pressure.

3.2 Research Framework

Figure 3.2 shows the research framework. The research framework was developed to guide the research to answer the three main research questions. The research framework consists of two main parts: Parts 1 and 2. Below is a description of each part.

3.2.1 Part 1 of the Framework

Part 1 of the framework (see Figure 3.2) was developed to guide the research to answer the research question of whether the GBLS mode positively influences students’ learning outcomes. Part 1 consists of two dimensions: the independent variables (the three learning modes) and the dependent variables (the learning outcomes). This part of the framework compares the learning outcomes of the GBLS mode with the learning outcomes of the other two learning modes, that are the CSL mode and traditional learning mode.
Dependent Variables:
Learning Outcomes
Cognitive outcomes
- Academic performance
Effective outcomes
- Perceived learning effectiveness
- Satisfaction

Independent Variables:
(Learning Modes)
- Gesture-Based Learning System (GBLS) Mode
- Computer Simulation Learning (CSL) Mode
- Conventional Learning Mode

Learning Style
- Accommodating
- Assimilating
- Converging
- Diverging

Spatial Ability
- High
- Medium
- Low

Independent Variables:
Learners’ Characteristics

Independent Variables:
GBLS Features
- Interactivity
- Multimodality

Mediator variables:
Psychological Learning Processes
- Intrinsic Motivation

Dependent Variables:
Learning Outcomes
Cognitive outcomes
- Academic performance
Effective outcomes
- Perceived learning effectiveness
- Satisfaction

Figure 3.2: The Research Framework
3.2.2 Part 2 of The Framework

Part 2 (see Figure 3.2) was developed to help answer the two research questions: whether the GBLS mode will be able to accommodate all students with different learning styles and spatial abilities, as well as how the GBLS mode positively influences the learning outcomes. Also, Part 2 is made up of four dimensions: learners’ characteristics, GBLS features, intrinsic motivation and learning outcomes. Part 2 of the research framework compares the learning outcomes for people with different learning styles and spatial abilities in the GBLS mode. It is also used to generate the conceptual research model that explains how the GBLS mode positively impacts the learning outcomes.

3.3 Developing Research Hypotheses

Null hypotheses were generated from the related literature and from the research framework to answer the research questions as follows:

**Q1: Does the GBLS mode influence students’ learning outcomes?**

H1.1: There is no significant difference in students’ academic performance between the GBLS mode, CSL mode and conventional learning mode.

H1.2: There is no significant difference in students’ perceived learning effectiveness between the GBLS mode, CSL mode and conventional learning mode.

H1.3: There is no significant difference in students’ satisfaction between the GBLS mode, CSL mode and conventional learning mode.

H1.4: There is no significant difference in the students’ overall learning outcomes between the GBLS mode, CSL mode and conventional learning mode.
Q2: Will the GBLS mode be able to accommodate all students with different learning styles and spatial abilities?

H2.1: There is a significant difference in the academic performance between students with different learning styles in the GBLS mode.

H2.2: There is a significant difference in the perceived learning effectiveness between students with different learning styles in the GBLS mode.

H2.3: There is a significant difference in the satisfaction between students with different learning styles in the GBLS mode.

H2.4: There is a significant difference in the academic performance between students with different spatial abilities in the GBLS.

H2.5: There is a significant difference in the perceived learning effectiveness between students with different spatial abilities in the GBLS.

H2.6: There is a significant difference in the satisfaction between students with different spatial abilities in the GBLS.

Q3: How does the GBLS influence the learning outcomes?

H3.1: GBLS features have a direct positive effect on intrinsic motivation.

H3.2: Intrinsic motivation has a direct positive effect on the learning outcomes.

H3.3: Intrinsic motivation mediates the influence of the GBLS features on the learning outcomes.

H3.4: Interactivity is a first-order factor of GBLS features.

H3.5: Multimodality is a first-order factor of GBLS features.

H3.6: Interest/ Enjoyment is a first-order factor of intrinsic motivation.

H3.7: Perceived competence is a first-order factor of intrinsic motivation.
H3.8: Pressure/Tension is first-order factor of intrinsic motivation.

H3.9: Value/Usefulness is a first-order factor of intrinsic motivation.

H3.10: Academic performance is a first-order factor of learning outcomes.

H3.11: Perceived learning effectiveness is a first-order factor of learning outcomes.

H3.12: Satisfaction is a first-order factor of learning outcomes.

3.4 Summary

This chapter has explained the research framework. First, this chapter explained the main constructs that are of interest, which include learning modes, learning outcomes, learners’ characteristics, GBLS features and PLP. Second, this chapter introduced the research framework that is divided into two parts. The first part was developed to address the research question whether the GBLS mode influences the learning outcomes. The second part of the research framework was built to answer the research question whether the GBLS mode is able to accommodate all students with different learning styles and spatial abilities, as well as how the GBLS influences the learning outcomes. Finally, this chapter introduced the research hypotheses that were developed to answer the research questions.
Chapter 4 . Research Methodology

4.1 Overview

This chapter presents the research methodology used in the study. This chapter is divided into five sections. The first section explains the research design, which includes descriptions of the research experiment and its tools. The second section outlines the population and sample size for the research experiment. The third section highlights the research instruments that were employed to collect the data for this research. The fourth section explains the procedures for the data collection. The fifth section describes the statistical methods and techniques that were used to analyse the data.

4.2 Research Design

This research is a quantitative research; three groups of quasi-experimental research design have been used in this study to establish a causality relationship between the learning modes and learning outcomes (Campbell & Stanley, 2015). This study was designed and conducted as follows.

4.2.1 The Experiment Design

The experiment consists of three groups; each experimental group represents a specific learning mode (see Table 4.1).

Table 4.1: The experimental groups

<table>
<thead>
<tr>
<th>Experimental group</th>
<th>Learning mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Gesture-Based Learning system (GBLS) mode</td>
</tr>
<tr>
<td>Group B</td>
<td>Computer Simulation Learning (CSL) mode</td>
</tr>
<tr>
<td>Group C</td>
<td>Conventional learning mode</td>
</tr>
</tbody>
</table>
• **Group A:** The GBLS mode

This learning mode was set up by applying some modifications to a formal classroom; these modifications include the use of the Microsoft Kinect sensor that was connected to the classroom computer. The OpenNI driver was installed onto the classroom’s personal computer (PC) to enable the Kinect sensor to work on the PC (Villaroman et al., 2011). The K-Solar System application was also installed on the classroom PC. The K-Solar system is described in detail later in this chapter.

• **Group B:** The CSL mode

This group was set up by making the necessary arrangements for the computer lab prior to the experiment day. The Solar System 3D Simulator application was installed on the computers in the lab. The Solar System 3D Simulation is explained later in this chapter.

• **Group C:** The Conventional Learning Mode

The conventional classroom with a computer and projector was used. A PowerPoint presentation was prepared by the researcher to explain the topic.

4.2.2 Software

4.2.2.1 K- Solar System

The K-Solar System is a Kinect-based application. The application was developed by Juan de Lanuza School and BIFI- Biocomputation and Physics of Complex Systems Institute of the University of Zaragoza, Spain ("K-Solar System," 2012). The K-Solar System’s developers have granted a license to the researcher to use it in this experiment. The K-Solar System can be described as an interactive 3-D software for learning the solar system: planetary and satellite movements, and the phenomena they create (such as eclipses, the seasons and lunar phases). The interaction is carried out through the Kinect device, which recognises the students’ body movements and reproduces them in the 3-D virtual models that are visualised on the classroom
board. This way of interaction offers the students a new and motivating experience (see Figure 4.1).

Figure 4.1: K- Solar System (2012, Photos are reproduced from the website "K-Solar System")
4.2.2.2 The Solar System 3D

The Solar System 3D was developed by Softonic International S.A Company, and it is freely available to download from the company website ("Solar System 3D Simulator," 2006). However, the application runs only on Windows operating systems. The Solar System 3D Simulator is a learning software that creates a realistic solar system model in 3-D on a computer. The application can simulate the nine planets and their orbits, the Sun and the Moon. The application can also display Planet Earth and its detailed physical and chemical information and pictures including solar power, solar energy and solar eclipse details. The graphical output is in high-resolution 3-D full-colour format. The application enables users to adjust, tilt and rotate the view of the orbits. The speed of the movement of the solar system can also be modified by users. The solar system model that is simulated by this learning application is useful for interactive learning about the solar system, astronomy, physics of the universe and science experiments for both adults and children (see Figure 4.2).

![Figure 4.2: The Solar System 3D ("Solar System 3D Simulator," 2006)](image)
4.3 Population and Sample

The population of this research is the first-year undergraduate students at Almergib University, Msellatah branch, Libya. The number of first-year students at the Msellatah branch at the time of the experiment was about 500 students, according to the University’s registration office. Almergib University was chosen using the convenience sampling method, as the researcher had access to the university, which helped him to recruit the students. The sample size for this study is determined by the researcher as 198 participants. The sample size is calculated based on the table introduced by Barlett, Kotrlik and Higgins (2001). The table recommended that with an alpha of 0.01 and 3% margin of error, the proper sample size for the population of 500 students is 147 participants. Israel (1992) recommends recruiting extra participants to compensate for possible dropout and non-response. Not only that, the sample size calculation also considered recent recommendations from the Human-Computer Interaction (HCI) field. Hornbæk (2011) recommends that in the case of comparing experimental groups, the minimum number of participants per group should be 30, and the ideal number is 64 participants per group.

198 first-year undergraduate students from different learning areas voluntarily participated in this research. Only first-year students were invited to participate to ensure the consistency of participants’ knowledge and experience. All participants are Libyans. Out of 198 participants, only 151 participants completed all stages of the experiment with a response rate of 76.2%.

4.4 Instruments to Measure Variables

Most of the research instruments were adopted from previous studies and a few were built for this study. Table 4.2 lists all the instruments used in this study.
### Table 4.2: Research Instrument

<table>
<thead>
<tr>
<th>No.</th>
<th>Variable</th>
<th>Type of variable</th>
<th>Instrument</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Learning style</td>
<td>Independent</td>
<td>Kolb Learning Style Inventory (LSI)</td>
<td>Kolb Learning Style Inventory (LSI) was used. LSI is commercially available on: <a href="http://www.learningfromexperience.com">www.learningfromexperience.com</a>.</td>
</tr>
<tr>
<td>2</td>
<td>Spatial ability</td>
<td>Independent</td>
<td>Spatial Ability Test</td>
<td>The Spatial Ability Test from Barrett and Williams (2003) was used.</td>
</tr>
<tr>
<td>3</td>
<td>Academic Performance</td>
<td>Dependent</td>
<td>Pre-test and post-test</td>
<td>Twenty-seven multiple-choice and true/false questions were quoted from the test-bank (Pearson Education, 2014), as well as and reviewed and edited by a professional lecturer in the subject area.</td>
</tr>
<tr>
<td>4</td>
<td>Perceived Learning Effectiveness</td>
<td>Dependent</td>
<td>Questionnaire</td>
<td>Eleven items were adapted from previous studies (Benbunan-Fich &amp; Hiltz, 2003; Lee, 2011; Marks, Sibley, &amp; Arbaugh, 2005).</td>
</tr>
<tr>
<td>5</td>
<td>Satisfaction</td>
<td>Dependent</td>
<td>Questionnaire</td>
<td>Seven items were adopted from previous studies (Chou &amp; Liu, 2005; Lee, 2011).</td>
</tr>
<tr>
<td>6</td>
<td>Interactivity</td>
<td>Dependent</td>
<td>Questionnaire</td>
<td>Three items were adopted from Pituch and Lee (2006).</td>
</tr>
<tr>
<td>7</td>
<td>Multimodality</td>
<td>Dependent</td>
<td>Questionnaire</td>
<td>Three items were devolved from the theory of multimodality (Birchfield et al., 2008; Picciano, 2009; Sankey et al., 2010).</td>
</tr>
<tr>
<td>8</td>
<td>Intrinsic Motivation</td>
<td>Mediator</td>
<td>Questionnaire</td>
<td>The Intrinsic Motivation Inventory (IMI) was used in this study to measure participants’ intrinsic motivation (Deci, Eghrari, Patrick, &amp; Leone, 1994; Ryan, Koestner, &amp; Deci, 1991).</td>
</tr>
</tbody>
</table>

#### 4.4.1 Learning Styles

The Kolb LSI was used in this study to determine the learning styles of the participants. According to Hawk and Shah (2007) who reviewed the six different learning styles model, the Kolb learning style model is one of the most reliable learning style instruments; indeed, many researchers have supported the Kolb’s model validity and reliability (Hickcox, 1990; Kayes,
The Kolb LSI consists of one example and 12 sentences for the actual test. It gives the participants a sentence with four different endings, and asks the participants to rank the endings of each sentence according to how well they think each ending best describes the way they learn. After which, the participants were asked to write 4 to the ending that describes how they learn best and so on, down to 1 for the ending that seems least like the way they learn. Using a special marking sheet provided with the instrument, the participants were classified based on their answers into 4 learning styles:

1) Diverging learners;
2) Accommodating learners;
3) Assimilating learners; and
4) Converging learners.

Kolb LSI’s reliability and validity have been indicated by several previous studies with Internal consistency alphas ranges between 0.67 to 0.84 (Kayes, 2005; Ruble & Stout, 1991; Wierstra & De Jong, 2002)

### 4.4.2 Spatial Abilities

The spatial abilities of the participants were tested using a spatial abilities instrument that was developed by Barrett and Williams (2003). The instrument explores how easily the participants can manipulate shapes and figures in space. The participants were asked to move the shapes and figures through three dimensions as fast as they could. The test consists of two types of questions. The first type involves giving a plan of a three-dimensional shape, as if it is made from a sheet of cardboard. Following the plan, the participants were given three or four shapes, and they were asked to state whether or not the shape could be made from the plan.

The second type involves giving the participants two shapes, where the second shape is to be taken off the first. Following these two shapes, the participants were given three or four shapes,
and they were asked to state whether or not this shape will be left. The test consists of 16 sample questions for practice and 75 questions for the actual test. The participants were given 10 minutes to answer as much as they could. The test is marked by the researcher, who allocates a mark for each correct answer, according to the answer key that is included with the instrument. The final special ability score for each participant will be out of 75. Based on the final score, the participants’ spatial abilities levels were classified accordingly to three categories: low, medium or high. The test’s reliability and validity have been proved by Lee (2011).

4.4.3 Academic Performance

A pre-test and post-test were used to measure the participants’ academic performance. The pre-test and post-test questions were quoted from the test-bank (Pearson Education, 2014), as well as reviewed and edited by a lecturer from the subject’s area to ensure the reliability and the validity of the tests. The pre-test consists of twenty-seven multiple-choice and true/ false questions. Likewise, the post-test consists of the same questions, but the order of the questions is changed to reduce the risk of the set response effect (see Appendixes C - F). The scoring was done by the researcher, where 1 mark was given to each correct answer. The total score for each participant taking the test is out of a possible 27. The higher the score for the post-test, the higher the student’s academic performance. The reliability and validity of this instrument were conducted on the actual data that were collected for research.

4.4.4 Perceived Learning Effectiveness

The level of the participants’ perceived learning effectiveness was measured by an eleven-item scale (see Appendixes G - L). The items were adapted from previous studies (Benbunan-Fich & Hiltz, 2003; Lee, 2011; Marks et al., 2005). For all items, students were asked to rate themselves on a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree.
The total score for each participant was calculated by summing the scores of the 11 items. A high total score in the scale indicates that the participant thought that he/she learned effectively using the specific learning mode. The reliability and validity of this instrument were conducted on the actual data that were collected for research.

4.4.5 Satisfaction

The level of the participants’ satisfaction was measured using the seven-item scale that was adopted from previous studies (Chou & Liu, 2005; Lee, 2011) (see Appendixes G - L). For all items, the students were asked to rate themselves on a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. The total score for each student was calculated by summing the scores of the 7 items. A high total score represents that the participant was satisfied with the learning experience. The reliability and validity of this instrument were conducted on the actual data that were collected for research.

4.4.6 Intrinsic Motivation

The participants’ intrinsic motivation was measured using the IMI; The IMI has been used in several studies to measure participant’s intrinsic motivation (Deci et al., 1994; Ryan et al., 1991). The IMI measures intrinsic motivation using seven subclasses. However, only four subclasses are related to this study. These subclasses are:

1) Interest and Enjoyment;
2) Perceived Competence;
3) Value/Usefulness; and
4) Tension and Pressure.

However, based on the above four subclasses, a 21 item-scale was developed to measure the intrinsic motivation of the participants (see Appendixes G & J). The division of the items over...
the subclasses is shown in Table 4.3. For all items, the students were asked to rate themselves on a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. The score for each subclass is the sum of the scores of its items. A high score indicates that the student’s intrinsic motivation was boosted as a result of using the GBLS mode. The reliability and validity of this instrument were conducted on actual data that were collected for research.

**Table 4.3: Intrinsic Motivation Subclasses**

<table>
<thead>
<tr>
<th>Subclasses</th>
<th>Number of items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest/ Enjoyment</td>
<td>6 items</td>
</tr>
<tr>
<td>Perceived Competence</td>
<td>5 items</td>
</tr>
<tr>
<td>Value/ Usefulness</td>
<td>6 items</td>
</tr>
<tr>
<td>Tension/ Pressure</td>
<td>4 items</td>
</tr>
</tbody>
</table>

**4.4.7 Interactivity**

The GBLS’s interactivity was measured using a three-item scale that was borrowed from Pituch and Lee (2006); the items were modified to suit the purpose of this study (see Appendixes G & J). For all items, the students were asked to rate themselves on a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. The score for each participant was calculated by summing the score of the 3 items. A high total score means that the participant thought that the GBLS mode promotes interactivity within the classroom. The reliability and validity of this instrument were conducted on actual data that were collected for research.

**4.4.8 Multimodality**

A three-item scale was built based on the literature to measure the GBLS’s multimodality (Birchfield et al., 2008; Picciano, 2009; Sankey et al., 2010) (see Appendixes G & J). For all items, the students were asked to rate themselves on a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. The total score for each student is the sum of the 3
items’ scores. A high total score represents that the student believed that the GBLS mode provides a multimodal learning environment. The reliability and validity of this instrument were conducted on the actual data that were collected for research.

4.5 Data Collection Procedures

1. 198 participants were randomly divided into three equal groups, which resulted in 66 participants per group. Each group was randomly assigned to one of the three learning groups (see Table 4.4).

2. For the first session of the experiment, all participants in the three groups were asked to sit for the pre-test and to complete the initial questionnaire. The initial questionnaire consists of three parts that are, background information, Kolb LSI and the spatial abilities test (see Figure 4.3 & Appendixes A - F).

3. For the second session of the experiment:
   a. The participants in groups A and B received 10 minutes of introduction to the learning mode before the lecture, to ensure that all participants in these two groups are familiar with the use of the technologies.
   b. The participants in group A received a lecture using the GBLS mode, whereas the participants in group B received a lecture using the CSL mode. In addition, the participants in group C received a lecture using the PowerPoint presentation (see Table 4.4). The learning topic title was “Introduction to the solar system and time measurement”. The lectures were delivered in the Arabic language, which is the native language of the participants.

<table>
<thead>
<tr>
<th>Table 4.4: Assigning participants to the experimental groups</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Experimental group</strong></td>
</tr>
<tr>
<td>------------------------</td>
</tr>
<tr>
<td>Group A</td>
</tr>
<tr>
<td>Group B</td>
</tr>
<tr>
<td>Group C</td>
</tr>
</tbody>
</table>
4. After having received the treatment, all students in the three groups were asked to sit the post-test and to complete the final questionnaire (see Figure 4.3). The final questionnaire consists of two parts, namely Perceived learning effectiveness and Satisfaction (see Appendixes H - L). The final questionnaire for group A consists of extra parts that include Intrinsic motivation and the GBLS features (see Appendixes G & J).

**Figure 4.3: The Experiment Procedures**

4.6 Data Analysis

The research data was analysed using different statistical tools. Thus, this section will describe the statistical tools that are used to analyse the data, as well as the requirements and assumptions of each statistical tool.

4.6.1 Statistical Package for the Social Sciences (SPSS)

The SPSS was used to run three statistical tests that are descriptive statistics, One-way Analysis of Covariance (ANCOVA) and One-way Analysis of Variance (ANOVA).
4.6.1.1 One-way Analysis of Covariance (ANCOVA)

One-way ANCOVA was conducted to determine the differences between the three learning groups, in term of the academic performance with the pre-test as a covariate. One-way ANCOVA has 5 assumptions that must be tested prior to conducting the test. Failure to meet those assumptions affects the validity of the One-way ANCOVA outcomes. Below is a brief description of the assumptions of this test (Cengage Learning, Allen, & Heritage, 2014).

4.6.1.1.1 Assumptions of One-way ANCOVA

Assumption 1: Independence

The observations should be independent. In other words, there should be no relationship between the observations in each group or between the groups themselves. This assumption was considered in the design of this research experiment. Firstly, different participants were used in each group and there was no participant allowed to take part in more than one group.

Assumption 2: Normality

Each group of scores should be normally distributed. The ANCOVA requires only approximate normality because it is quite robust to violations of normality, meaning that the assumption can be moderately violated and still provide valid results. Normality can be tested using the Shapiro-Wilk test in SPSS.

Assumption 3: Homogeneity of Regression Slopes

Homogeneity of regression slopes means that there is no interaction between the covariate and independent variable. The violation of this assumption can result in a reduction of the power of the ANCOVA to detect differences among the groups.

Assumption 4: Linearity

The covariate should be linearly related to the dependent variable at each level of the independent variable. This assumption can be tested in the SPSS statistics by plotting a grouped scatterplot of the covariate, dependent and independent variables.
Assumption 5: Homogeneity of Variances
Homogeneity of variances means that there should be roughly an equal amount of variability in each score set. This assumption can be tested in SPSS using the Levene's test for homogeneity of variances.

4.6.1.2 One-way Analysis of Variance (ANOVA)
One-way ANOVA was carried out to determine whether there are any significant differences between the means of the three learning modes, with respect to perceived learning effectiveness and satisfaction. One-way ANOVA was also used to explore any significant differences between students with different learning styles and spatial abilities in the GBLS mode, with respect to the academic performance, perceived learning effectiveness and satisfaction. To ensure the validity of the results of One-way ANOVA, four assumptions must be checked prior to conducting the test. The following are the assumptions for One-way ANOVA (Cengage Learning et al., 2014).

4.6.1.2.1 Assumptions for One-way ANOVA:

Assumption 1: Scale of Measurement
The dependent variables should be measured on a continuous scale; this assumption was considered in the study design, as all dependent variables were measured on continuous scales.

Assumption 2: Independence
The observations should be independent. In other words, there should be no relationship between the observations in each group or between the groups themselves. This assumption was considered in the design of this research experiment. Firstly, different participants were used in each group and there was no participant allowed to take part in more than one group.
Assumption 3: Normality

The ANOVA test also requires approximate normality as the ANOVA is quite robust to moderate violation of the normality assumption.

Assumption 4: Homogeneity of Variances

Homogeneity of variances means that there should be roughly an equal amount of variability in each score set. This assumption can be tested in SPSS using the Levene's test for homogeneity of variances.

4.6.2 Smart-Partial Least Square (PLS)

The Smart-PLS V2 and V3 were employed to analyse the research model to determine how the GBLS mode positively influence the learning outcomes. The Smart-PLS is a tool for Partial Least Square – Structural Equation Modelling (PLS-SEM). PLS-SEM is an ordinary least square regression-based approach. PLS-SEM uses the data to derive the path relationships in the model with the aim of minimising the error terms of the endogenous constructs (Hair Jr et al., 2013).

PLS-SEM was chosen to analyse this research model among other SEM techniques for the following reasons. First, PLS-SEM has no issue with small sample sizes and achieves a high level of statistical power with small sample sizes. Second, PLS-SEM does not require distributional assumptions. Third, PLS-SEM is robust in the case of a few missing values. Fourth, PLS-SEM works with different scales of measurement including metric data, ordinal scaled data and binary coded data. Moreover, PLS-SEM can handle constructs measured with single or multi-item measures. PLS-SEM can incorporate reflective and formative constructs. Also, PLS-SEM can handle a complex model with a large number of indicators (Hair, Sarstedt, Ringle, & Mena, 2012; Hair Jr et al., 2013; Tenenhaus, Vinzi, Chatelin, & Lauro, 2005).

The data set size for the current research is relatively small as only the data that was collected from the GBLS mode group (N = 56) was used to run the model. Due to the restraint of the
small sample size, the SEM with Analysis Of a Moment Structures (AMOS) could not be used as the SEM requires larger samples, where $N > 200$ (Kline, 2005; Lei & Wu, 2007). Instead, the Smart-PLS was used to assess the model’s validity and to examine the relationships between the constructs of the proposed research model. As explained earlier, the Smart-PLS can detect the significance of small sample sizes. Therefore, this section is devoted to explain how the model analysis was conducted using the Smart-PLS.

According to Hair Jr et al., (2013), analysing the model in the Smart-PLS can be performed in two steps. In the first step, the validity of the measurement model is assessed. Then, the assessment of the structural model is done in the second step.

### 4.6.2.1 Assessing the Measurement Model

As shown in Figure 5.10, all the constructs of the research model are reflective. Therefore, only the methods of assessing the reflective measurement model are explained in this section. Assessing the reflective measurement model includes evaluating internal consistency, indicator reliability, convergent validity and discriminant validity. Below is a description of each criterion for the reflective measurement model (Hair Jr et al., 2013; Hair Jr, Hult, Ringle, & Sarstedt, 2016).

1. **Internal Consistency Reliability**

Internal consistency reliability can be evaluated using composite reliability values. According to Hair Jr et al. (2013), composite reliability values of 0.60 to 0.70 are acceptable in exploratory research, while values between 0.70 and 0.90 can be regarded as satisfactory. Also, values above 0.90 and definitely $> 0.95$ are not desirable, while values below 0.60 indicate a lack of internal consistency reliability.
2. Convergent Validity

Convergent validity can be evaluated using either of the following criteria: the outer loading of the indicators and the Average Variance Extracted (AVE).

a. The Indicator’s Outer Loading

It is also known as indicator reliability; the rule of thumb is that each indicator’s outer loading should be 0.70 or higher. However, indicators with outer loadings between 0.40 and 0.70 should be considered for removal only when the deletion of the indicator leads to an increase in the variable composite reliability. In addition, indicators with outer loading below 0.40 should be deleted.

b. Average Variance Extracted (AVE)

The AVE is the grand mean on the squared outer loading of the indicators associated with a specific construct. The threshold of AVE is 0.50 or higher for each reflective construct.

3. Discriminant Validity

Establishing discriminant validity means that a construct is truly distinguished from other constructs. In other words, a construct should capture a specific phenomenal that is not explained by any other construct in the model. There are two criteria that can be used to evaluate the discriminant validity, namely cross-loading of indicators and the Fornell-Larcker criterion.

a. Cross Loading of Indicators

The cross loading of an indicator implies that the outer loading of the indicator on its associated construct should be greater than all its loadings on any other constructs in the model.
b. The Fornell-Larcker Criterion

The Fornell-Larcker criterion compares the square root of the AVE value with the latent variable correlations. The square root of each construct’s AVE should be higher than its greatest correlation with any other construct.

4.6.2.2 Assessing the Structural Model

The assessment of the structural model can be done in six steps: assessing the structural model for collinearity issues; assessing path coefficients; assessing the level of $R^2$; assessing the effect sizes $f^2$, as well as assessing the predictive relevance $Q^2$ and $q^2$ effect sizes.

1. Assessing the structural model for collinearity issues

Prior to interpreting the results of the structural model, it is important to check for collinearity issues. The Smart-PLS V2 does not provide the tolerance value or Variance Inflation Factor (VIF) statistics. However, the Smart-PLS V3 and other statistical software such as the IBM SPSS package statistics do provide collinearity assessment statistics. The Smart-PLS V3 was used in this research to assess for collinearity issues.

2. Assessing path coefficients (T-value)

In the Smart-PLS software, the analysis of the structural model’s relations can be done through examining the path coefficient values as to whether they are positive or negative. The path coefficient values can be obtained from bootstrapping calculation results. According to Wong (2013), the bootstrapping procedure involves taking a large number of subsamples (for example 5000) from the original sample with replacement, to give bootstrap standard errors, which consequently provides estimated T-values for a significant examination of the structural model’s path coefficients. The rule of thumb of the path coefficient is to compare the T-value with the critical values. If the T-value is higher than the critical value, then the path coefficient is significant at a specific error probability.
3. **Assessing the level of R² (Coefficient of Determination)**

The R² value is a common way to evaluate the structural model. The R² value is a measure of the model’s predictive accuracy. R² is calculated as the squared correlation between a certain endogenous construct’s actual value and its predictive value; R² value ranges between 0 to 1. The closer the R² value is to 1, the higher the level of predictive accuracy. According to Hair Jr et al. (2013), the acceptable R² value depends on the research area and the model’s complexity. However, the R² value of 0.75 is considered as substantially high. 0.50 is moderate, while 0.25 is weak.

4. **Assessing the effect sizes f²**

The effect size f² is the change in the value of R² when a certain exogenous construct is excluded from the model. In other words, this assists in checking whether the excluded construct has a substantive effect on the endogenous constructs. f² can be calculated using the following formula: \( f^2 = \frac{R^2_{\text{included}} - R^2_{\text{excluded}}}{1 - R^2_{\text{included}}} \). The rule of thumb for the value of f² is that the value of 0.02 represents a small effect, 0.15 represents a medium effect and 0.35 represents a large effect.

5. **Assessing the blindfolding and predictive relevance of Q²**

Q² is an indicator of the model’s predictive relevance. The Q² measure only applies to reflective constructs and single item constructs, and not to formative constructs. When PLS-SEM shows predictive relevance, it precisely predicts the data points of the indicators of reflective measurement models of endogenous and single item constructs. The rule of thumb for the value of Q² is that it should be larger than zero. For example, if the Q² value of a specific reflective endogenous construct is bigger than zero, it indicates the path model’s predictive relevance for a certain exogenous construct. In the Smart-PLS, the Q² value can be obtained using blindfolding calculation for a specific omission distance (D). D should be between 5 - 10. The
D should be chosen carefully, so that when the number of observations is divided by the D, it must not result in an integer. For example, if the sample size is 80, the D value must not be 8 or 10, so as to avoid getting an integer result.

6. Effect size $q^2$

The $q^2$ effect size cannot be obtained from the Smart-PLS, but it can be calculated manually from the following equation:

$$q^2 = \frac{Q^2_{\text{included}} - Q^2_{\text{excluded}}}{1 - Q^2_{\text{included}}}$$

The rule of thumb of the $q^2$ value is as follows: the values of 0.02, 0.15 and 0.35 represent that a certain exogenous variable has a small, medium or large predictive relevance respectively for a specific endogenous latent variable.

4.6.2.3 Analysing for Mediation

The research model proposes that the intrinsic motivation construct mediates the relationship between the GBLS features and learning outcomes. Therefore, this section will describe the method of testing mediation in the Smart-PLS. The mediator construct is the variable that captures a part of the relationship between an exogenous construct and endogenous construct in the PLS path model through the indirect effect. The indirect effect is the relationship between the exogenous construct and mediator, and between the mediator and endogenous construct. The mediator helps to explain the relationship between the independent and dependent constructs. A significant mediation effect can partially or fully capture the direct relationship between the exogenous and endogenous constructs, and in some cases, change the direction of the relationship; this is called the suppressor effect. Analysing the mediation in the Smart-PLS requires a series of steps as can be seen in Figure 4.4.

The first step is to check the significance of the indirect relationship between the independent variable and the dependent variable via the mediator. If the indirect effect is not significant,
then it can be concluded that there is no mediation. On the other hand, if the indirect effect is significant, then it can be concluded that there is mediation. To test the type of mediation, we need to check the direct relationship between the independent and dependent variables. If the direct effect is significant, the mediation is partial. If the direct effect is not significant, it can be considered as a full mediation. The direct and indirect effects can be obtained from the bootstrapping calculation (Hair Jr et al., 2016).

![Figure 4.4: Mediation analysis steps (Hair Jr et al., 2016, p. 228)](image)

**4.6.2.4 Dealing with Second-order Constructs**

This research model is the Hierarchical Component Model (HCM) as seen in Figure 5.9. Thus, this section will explain the meaning of the HCM and how the HCM can be analysed using the Smart-PLS. The HCM model consists of Higher-Order Components (HOCs) and Lower-order Components (LOCs). However, depending on the relationship between HOCs and LOCs, there are four types of HCM, namely Reflective-Reflective, Reflective-Formative, Formative-Reflective and Formative-Formative (Becker, Klein, & Wetzels, 2012) (see Figure 4.5).

According to Hair Jr et al. (2013), analysing the HCM is different from analysing ordinary models. Analysing the HCM can be done using one of the following approaches.
4.6.2.4.1 The Repeated Measurement Approach

In this approach, all indicators from the LOCs are assigned to the HOCs (see Figure 4.6) (Becker et al., 2012). Even though the repeated indicator approach is the most used approach and is easy to implement, it has some requirements that should be considered. First, the number of indicators across the LOCs should be similar. Second, all the model’s evaluation criteria that apply to the LOCs should be applied to the HOCs as well.

4.6.2.4.2 Two-stage Approach

In this approach, the latent variable scores are estimated without the present of the HOCs, but with only all the LOCs in the model; the measurement model is also evaluated at this stage. The saved latent variable scores are then used as indicators for the HOCs in a separate high order structural analysis (see Figure 4.7) (Becker et al., 2012).

![Diagram of the Four Types of the Hierarchical Component Model](image)

*Figure 4.5: The Four Types of the Hierarchical Component Model (Becker et al., 2012, p. 363)*
Figure 4.6: Repeated Measurement Approach (Becker et al., 2012, p. 380)

Figure 4.7: Two-stage approach (Becker et al., 2012, p. 382)
4.7 Summary

This chapter explained the research methods that were used to conduct this study. The quantitative research approach was used in the research, which was carried out through the quasi-experiment and questionnaires. This chapter also explained the experiment design and procedures, as well as highlighted the research population and sampling. The statistical tools that were used to analysis the data and the reason behind choosing these tools were further explained in this chapter. The following chapter will present the results of the data analysis that was undertaken to answer the research questions.
Chapter 5 . Research Results

5.0 Overview

This chapter presents the results of the data analysis of this study; this chapter is divided into four sections. The first section presents a brief description of the subjects. The second section shows the results for the first research question, which examines whether the GBLS mode influences students’ learning outcomes. The third section provides the results for the second research question, which examines whether the GBLS mode will be able to accommodate all students with different learning styles and spatial abilities. The fourth section shows the results for the third research question, which examines how the GBLS mode positively influences learning outcomes.

5.1 Descriptive Statistics of Participants

A total of 151 participants completed all stages of the experiment. This section provides the description of the demographics of the participants, which includes the distribution of the participants over the groups, their genders, age groups, study areas, computer experience and knowledge about the GBLS mode.

5.1.1 Distribution and Gender

Table 5.1 exhibits the distribution of participants over the groups. The participants were distributed as follows. Group A: 56 participants; 47 females and 9 males. Group B: 40 participants; 11 females and 29 males. Group C: 55 participants; 28 females and 27 males.

<table>
<thead>
<tr>
<th>Group</th>
<th>Gender</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Group A</td>
<td>9</td>
<td>47</td>
</tr>
<tr>
<td>Group B</td>
<td>29</td>
<td>11</td>
</tr>
<tr>
<td>Group C</td>
<td>27</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>65</td>
<td>86</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode
5.1.2 Age Groups

Only first-year students were invited to participate, and therefore, most of the participants are from the same age group. For example, 128 participants are from the age group of 18-22 (see Table 5.2).

*Table 5.2: Age Cross-tabulation by Group*

<table>
<thead>
<tr>
<th>Age</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>(18-22)</td>
<td>(23-26)</td>
</tr>
<tr>
<td>Group A</td>
<td>42</td>
</tr>
<tr>
<td>Group B</td>
<td>38</td>
</tr>
<tr>
<td>Group C</td>
<td>48</td>
</tr>
<tr>
<td>Total</td>
<td>128</td>
</tr>
</tbody>
</table>

*Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode

5.1.3 Area of Study

As shown in Table 5.3, the participants are a mix from nine different learning areas.

*Table 5.3: Area of Study Cross-tabulation by Group*

<table>
<thead>
<tr>
<th>Area of study</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer</td>
<td></td>
</tr>
<tr>
<td>Pathology</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
</tr>
<tr>
<td>Civil</td>
<td></td>
</tr>
<tr>
<td>Economy</td>
<td></td>
</tr>
<tr>
<td>Management</td>
<td></td>
</tr>
<tr>
<td>Nursing</td>
<td></td>
</tr>
<tr>
<td>Medicine</td>
<td></td>
</tr>
<tr>
<td>Community</td>
<td></td>
</tr>
<tr>
<td>Accounting</td>
<td></td>
</tr>
<tr>
<td>Chemical</td>
<td></td>
</tr>
<tr>
<td>Engineering</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Group</th>
<th>Group A</th>
<th>23</th>
<th>15</th>
<th>8</th>
<th>0</th>
<th>6</th>
<th>3</th>
<th>1</th>
<th>0</th>
<th>0</th>
<th>56</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group B</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>33</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Group C</td>
<td>12</td>
<td>2</td>
<td>25</td>
<td>0</td>
<td>8</td>
<td>0</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>17</td>
<td>33</td>
<td>33</td>
<td>18</td>
<td>3</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>151</td>
<td></td>
</tr>
</tbody>
</table>

*Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode*
5.1.4 Computer Usage and Experience

From the statistics, most of the participants have computers at home. Specifically, 121 out of 151 said that they have computers at home (see Table 5.4). Also, almost all the participants use computers at home and/ or at school at different frequencies. Only 3 participants claimed that they have never used computers before (see Table 5.5). 103 out of 151 participants have intermediate computer experience, while there are also some advanced users, a few beginners and those with no experience at all (see Table 5.6). 96 of the participants said they use computers only to access the internet, 73 use computers for word processing purposes, 66 use computers to play games, 33 use computers to access their email, and only 24 said they use computers for drill and practice (see Table 5.7).

Table 5.4: Group * Do you have a computer at home? Cross-tabulation

<table>
<thead>
<tr>
<th>Group</th>
<th>Do you have a computer at home?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>yes</td>
<td>No</td>
</tr>
<tr>
<td>Group A</td>
<td>48</td>
<td>8</td>
</tr>
<tr>
<td>Group B</td>
<td>28</td>
<td>12</td>
</tr>
<tr>
<td>Group C</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>121</td>
<td>30</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode

Table 5.5: Group *How often do you use computers at home or at school? Cross-tabulation

<table>
<thead>
<tr>
<th>Group</th>
<th>How often do you use computers at home or at school?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Alway</td>
<td>Frequently</td>
</tr>
<tr>
<td>Group A</td>
<td>8</td>
<td>17</td>
</tr>
<tr>
<td>Group B</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Group C</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>17</td>
<td>33</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode
Table 5.6: Group A Which statement best describes your level of experience of using a computer? Cross-tabulation

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Beginner</th>
<th>Intermediate</th>
<th>Advanced</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>0</td>
<td>4</td>
<td>39</td>
<td>13</td>
<td>56</td>
</tr>
<tr>
<td>Group B</td>
<td>4</td>
<td>6</td>
<td>23</td>
<td>7</td>
<td>40</td>
</tr>
<tr>
<td>Group C</td>
<td>4</td>
<td>3</td>
<td>41</td>
<td>7</td>
<td>55</td>
</tr>
<tr>
<td>Total</td>
<td>8</td>
<td>13</td>
<td>103</td>
<td>27</td>
<td>151</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode

Table 5.7: Group A What Do you use computers at home or at the university for? Cross-tabulation

<table>
<thead>
<tr>
<th></th>
<th>Internet</th>
<th>Word processing</th>
<th>Games</th>
<th>Electronic mail</th>
<th>Drill and Practice</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>34</td>
<td>37</td>
<td>22</td>
<td>13</td>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>Group B</td>
<td>24</td>
<td>10</td>
<td>20</td>
<td>08</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Group C</td>
<td>38</td>
<td>26</td>
<td>24</td>
<td>12</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>96</td>
<td>73</td>
<td>66</td>
<td>33</td>
<td>24</td>
<td>33</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode

5.1.5 GBLS Mode Experience

Most of the participants in the GBLS mode said that they did not know anything about the GBLS mode prior to the experiment. A few declared that they had some knowledge about the GBLS mode, and only one person stated that she knew a lot about the GBLS mode (see Table 5.8). On the other hand, almost all the participants indicated their intention to use the GBLS mode in the future if they are offered the opportunity (see Table 5.9).
Table 5.8: Group * Did you know about Gesture-Based Learning before taking this lesson? Cross-tabulation

<table>
<thead>
<tr>
<th>Did you know about Gesture-Based Learning before taking this lesson?</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>I knew nothing about Gesture-based Learning</td>
<td></td>
</tr>
<tr>
<td>I had some knowledge about Gesture-based Learning</td>
<td></td>
</tr>
<tr>
<td>I had lots of knowledge about Gesture-based Learning</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode.

Table 5.9: Group * Would you like to use Gesture-Based Learning in the future? Cross-tabulation

<table>
<thead>
<tr>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Would you like to use Gesture-Based Learning in the future?</td>
</tr>
<tr>
<td>yes</td>
</tr>
<tr>
<td>Group</td>
</tr>
<tr>
<td>Group A</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

* Group A = GBLS mode.

5.2 Results for Question 1: Does the GBLS mode influence students’ learning outcomes?

Two statistical tests were used to test the hypotheses that answer the first research question; these tests are One-way ANCOVA and One-way ANOVA. As explained in Chapter 4, prior to conducting these statistical tests, there are some assumptions that need to be checked for each test. Below are the results of the assumptions of One-way ANCOVA and One-way ANOVA.
5.2.1 Assumptions of One-Way ANCOVA

An examination of the Shapiro-Wilk statistics for each group indicated that the ANCOVA assumption of normality was supported (see Table 5.10). Scatterplots (Figure 5.1) showed that the relationship between the covariate (Pre-test scores) and independent variable (Post-test scores) for each level of the three learning modes (Groups A, B and C) was linear. The assumption of homogeneity of the regression slopes was supported by the non-significant interaction between the groups by the pre-test, where F (2,145) = .000, p = 1.000. Finally, the assumption of homogeneity of variance was not violated by the non-significant Levene’s test, where F (2,148) = 2.637, p = 0.75.

Table 5.10: Tests of Normality

<table>
<thead>
<tr>
<th>Group</th>
<th>Kolmogorov-Smirnov*</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic df Sig.</td>
<td>Statistic df Sig.</td>
</tr>
<tr>
<td>Post-test</td>
<td>Group A .117 56 .053</td>
<td>.978 56 .409</td>
</tr>
<tr>
<td>score</td>
<td>Group B .118 40 .172</td>
<td>.976 40 .561</td>
</tr>
<tr>
<td></td>
<td>Group C .113 55 .080</td>
<td>.963 55 .093</td>
</tr>
</tbody>
</table>

* Group A = EBLS mode. Group B = CSL mode. Group C = Conventional learning mode
a. Lilliefors Significance Correction

Figure 5.1: Linearity plot
5.2.2 Assumptions for One-way ANOVA

According to the Shapiro-Wilk statistics (Table 5.11), the assumption of normality was supported by groups A and C and was slightly violated by group B. As discussed in the previous chapter, ANOVA is quite robust for the moderate violation of the normality assumption. Levene’s statistics was significant for perceived learning effectiveness and satisfaction, where $F(2, 148)$, $p = .002$, $F(2, 148)$, $p = .001$ respectively, and thus the assumption of homogeneity of variance was violated. Therefore, the results of ANOVA need to be confirmed with the Welch and Brown-Forsythe tests. On the other hand, the assumption of homogeneity of variance was not violated for overall learning outcomes with Levene's statistics of $F(2, 148) = 1.949$, $p = .146$.

Table 5.11: Tests of Normality

<table>
<thead>
<tr>
<th>Group</th>
<th>Kolmogorov-Smirnov(a)</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic   df  Sig.</td>
<td>Statistic   df  Sig.</td>
</tr>
<tr>
<td><strong>Perceived Learning Effectiveness</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>.102        56  .200(*)</td>
<td>.970        56  .173</td>
</tr>
<tr>
<td>Group B</td>
<td>.119        40  .158</td>
<td>.931        40  .017</td>
</tr>
<tr>
<td>Group C</td>
<td>.087        55  .200(*)</td>
<td>.963        55  .087</td>
</tr>
<tr>
<td><strong>Satisfaction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>.103        56  .200(*)</td>
<td>.953        56  .030</td>
</tr>
<tr>
<td>Group B</td>
<td>.202        40  .000</td>
<td>.873        40  .000</td>
</tr>
<tr>
<td>Group C</td>
<td>.071        55  .200(*)</td>
<td>.983        55  .637</td>
</tr>
<tr>
<td><strong>Overall Learning Outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group A</td>
<td>.084        56  .200(*)</td>
<td>.965        56  .104</td>
</tr>
<tr>
<td>Group B</td>
<td>.141        40  .043</td>
<td>.919        40  .007</td>
</tr>
<tr>
<td>Group C</td>
<td>.051        55  .200(*)</td>
<td>.994        55  .996</td>
</tr>
</tbody>
</table>

*    Group A = GBLS mode. Group B = CSL mode. Group C = Conventional learning mode

* This is a lower bound of the true significance.

a Lilliefors Significance Correction
5.2.3 Hypothesis Testing

To answer the first research question, four null hypotheses were developed. The significance level was set at 0.05. A significance level of 0.05 implies that there is a 5% risk of claiming false differences.

**H1.1: There is no significant difference in students’ academic performance between the GBLS mode, CSL mode and conventional learning mode.**

One-way ANCOVA was conducted to determine the statistical difference between the GBLS, CSL and conventional learning modes in the post-test scores, while controlling the pre-test scores. There is no statistically significant difference between the three learning modes in the post-test score after controlling for the pre-test score, where $F (2,147) = 2.198, p = .115$. Although there were no statistically significant differences in the academic performance between the three groups, the research found differences in the research sample. The students in the GBLS did better in the post-test than the students in the other learning modes (see Figure 5.2).

![Figure 5.2: Estimated Margin Means for Post Test Scores](image-url)
H1.2: There is no significant difference in students’ perceived learning effectiveness between the GBLS mode, CSL mode and conventional learning mode.

One-way ANOVA was conducted to determine the difference in the perceived learning effectiveness between students in the three learning modes. One-way ANOVA showed that the difference in perceived learning effectiveness between students in Group A (GBLS) (N = 56, M = 81.52, SD = 9.95), Group B (CSL mode) (N = 40, M = 70.36, SD = 16.60) and Group C (conventional learning mode) (N = 55, M = 74.67, SD = 12.10) were statistically significant, where $F(2,148) = 9.438, p < .001$. The Welch and Brown-Forsythe tests were conducted because the homogeneity of variance assumption was violated, $p = .002$. However, the Welch and Brown-Forsythe tests confirmed the one-way ANOVA results (see Table 5.12). As the one-way ANOVA results were statistically significant, post hoc analyses were conducted. Specifically, the Games and Howell post hoc tests were conducted on all possible pairwise contrasts. The Games and Howell tests found the following pairs to be significantly different ($p < .05$): Groups A and B: $p = .001$; Groups A and C: $p = .004$. The Games-Howell test also suggested that there is no significant difference between Groups B and C: $p = .349$. In other words, the students in the GBLS mode showed higher perceived learning effectiveness than the other two modes (see Figure 5.3).

### Table 5.12: Robust Tests of Perceived Learning Effectiveness

<table>
<thead>
<tr>
<th>Statistic</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welch</td>
<td>9.676</td>
<td>2</td>
<td>85.065</td>
</tr>
<tr>
<td>Brown-Forsythe</td>
<td>8.588</td>
<td>2</td>
<td>99.884</td>
</tr>
</tbody>
</table>
H1.3: There is no significant difference in students’ satisfaction between the GBLS mode, CSL mode and conventional learning mode.

One-way ANOVA was conducted to determine the difference in the satisfaction between the students in the three learning modes. One-way ANOVA showed that the difference in satisfaction between the students in Group A (N = 56, M = 87.1, SD = 8.73), Group B (N = 40, M = 71.3, SD = 15.1) and Group C (N = 55, M = 65.35, SD = 15.90) were statistically significant ($F(2,148) = 38.140, p < .001$). The Welch and Brown-Forsythe tests were conducted because the homogeneity of variance assumption was violated, $p = .001$. However, the Welch and Brown-Forsythe tests confirmed the one-way ANOVA results (see Table 5.13). As the one-way ANOVA results were statistically significant, post hoc analyses were conducted. Specifically, the Games and Howell post hoc test was conducted on all possible pairwise contrasts. The Games and Howell test found the following pairs to be significantly different: Groups A and B: $p < .001$, Groups A and C: $p < .001$. The Games and Howell test also suggested that there is no significant difference between Groups B and C: $p = .153$. In other words, the students in the GBLS mode showed higher satisfaction than students in the other two groups - B and C (see Figure 5.4).
Table 5.13: Robust Tests of Satisfaction

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Statistic(a)</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welch</td>
<td>47.612</td>
<td>2</td>
<td>81.955</td>
<td>.000</td>
</tr>
<tr>
<td>Brown-Forsythe</td>
<td>36.641</td>
<td>2</td>
<td>114.289</td>
<td>.000</td>
</tr>
</tbody>
</table>

Figure 5.4: Estimated Margin Means for Satisfaction

H1.4: There is no significant difference in students’ overall learning outcomes between the GBLS mode, CSL mode and conventional learning mode.

One-way ANOVA was conducted to determine the difference in the overall learning outcomes between the students in the three learning modes. The one-way ANOVA results showed that the differences in the overall learning outcomes between the students in Group A (N = 56, M = 203, SD = 20.9), Group B (N = 40, M = 173, SD = 28.8) and Group C (N = 55, M = 174, SD = 29.8) were statistically significant, where $F(2,148) = 21.509, p < .001$. As the one-way ANOVA results are statistically significant, post hoc analyses were conducted. Specifically, the Tukey HSD post hoc test was conducted on all possible pairwise contrasts. The Tukey HSD test found the following pairs to be significantly different: Groups A and B: $p < .001$, as well as Groups A and C: $p < .001$. The Games-Howell test also suggested that there is no significant difference statistically between Groups B and C, where $p = .996$. Thus, the students in the GBLS mode outperform the students in the other two groups in overall learning outcomes (see Figure 5.5).
5.3 Results for question 2: Will the GBLS mode be able to accommodate all students with different learning styles and spatial abilities?

One-way ANOVA was used to test the hypotheses to answer question 2. Below are the results of the ANOVA assumptions testing for the related variables.

5.3.1 Assumptions for One-way ANOVA

An inspection of the Shapiro-Wilk results indicated that the assumption of normality was supported for almost all categories of learning styles and spatial abilities (see Tables 5.14 & 5.15). As discussed in the previous chapter, ANOVA is quite robust for the moderate violation of the normality assumption. According to the Levene’s statistics (see Tables 5.16 & 5.17), the assumption of homogeneity of variance was not violated for all variables, except for satisfaction under spatial abilities.
<table>
<thead>
<tr>
<th>Table 5.14: Tests of Normality for learning styles</th>
<th>Learning Style</th>
<th>Kolmogorov-Smirnov(a)</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
<td>Sig.</td>
</tr>
<tr>
<td>Perceived Learning Effectiveness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diverging</td>
<td>.180</td>
<td>53</td>
<td>.000</td>
</tr>
<tr>
<td>Accommodating</td>
<td>.160</td>
<td>22</td>
<td>.146</td>
</tr>
<tr>
<td>Assimilating</td>
<td>.136</td>
<td>40</td>
<td>.060</td>
</tr>
<tr>
<td>Converging</td>
<td>.090</td>
<td>36</td>
<td>.200(*)</td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diverging</td>
<td>.108</td>
<td>53</td>
<td>.177</td>
</tr>
<tr>
<td>Accommodating</td>
<td>.207</td>
<td>22</td>
<td>.015</td>
</tr>
<tr>
<td>Assimilating</td>
<td>.124</td>
<td>40</td>
<td>.123</td>
</tr>
<tr>
<td>Converging</td>
<td>.145</td>
<td>36</td>
<td>.055</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance.

a Lilliefors Significance Correction

<table>
<thead>
<tr>
<th>Table 5.15: Tests of Normality for spatial abilities</th>
<th>Spatial Abilities</th>
<th>Kolmogorov-Smirnov(a)</th>
<th>Shapiro-Wilk</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Statistic</td>
<td>df</td>
<td>Sig.</td>
</tr>
<tr>
<td>Perceived Learning Effectiveness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high</td>
<td>.105</td>
<td>65</td>
<td>.073</td>
</tr>
<tr>
<td>medium</td>
<td>.108</td>
<td>58</td>
<td>.092</td>
</tr>
<tr>
<td>low</td>
<td>.194</td>
<td>28</td>
<td>.009</td>
</tr>
<tr>
<td>Satisfaction</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high</td>
<td>.081</td>
<td>65</td>
<td>.200(*)</td>
</tr>
<tr>
<td>medium</td>
<td>.178</td>
<td>58</td>
<td>.000</td>
</tr>
<tr>
<td>low</td>
<td>.213</td>
<td>28</td>
<td>.002</td>
</tr>
</tbody>
</table>

* This is a lower bound of the true significance.

a Lilliefors Significance Correction

<table>
<thead>
<tr>
<th>Table 5.16: Test of Homogeneity of Variances for learning style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene's Statistic</td>
</tr>
<tr>
<td>Academic Performance</td>
</tr>
<tr>
<td>Perceived Learning Effectiveness</td>
</tr>
<tr>
<td>Satisfaction</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 5.17: Test of Homogeneity of Variances for spatial ability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levene's Statistic</td>
</tr>
<tr>
<td>Academic Performance</td>
</tr>
<tr>
<td>Perceived Learning Effectiveness</td>
</tr>
<tr>
<td>Satisfaction</td>
</tr>
</tbody>
</table>
5.3.2 Hypotheses Testing

To answer research question 2, six null hypotheses were developed and tested.

**H2.1: There is a significant difference in the academic performance between students with different learning styles in the GBLS mode.**

One-way ANOVA was conducted to determine the difference in the academic performance between the students with different learning styles in the GBLS mode. The One-way ANOVA results showed that the difference in academic performance between the diverging (N = 16, M = 34.72, SD = 16.72), accommodating (N = 10, M = 33.7, SD = 11.6), assimilating (N = 16, M = 33.1, SD = 14.1) and converging (N = 14, M = 35.7, SD = 13.9) were not statistically significant ($F(3, 52) = .091, p = .965$). Therefore, the results rejected the null hypothesis and showed that there is no difference in the academic performance between the students with different learning styles in the GBLS mode.

**H2.2: There is a significant difference in the perceived learning effectiveness between students with different learning styles in the GBLS mode.**

One-way ANOVA was conducted to determine the difference in the perceived learning effectiveness between the students with different learning styles in the GBLS mode. The one-way ANOVA results showed that the difference in perceived learning effectiveness between the diverging (N = 16, M = 82.50, SD = 6.99), accommodating (N = 10, M = 83.63, SD = 6.96), assimilating (N = 16, M = 81.8, SD = 12.6) and converging (N = 14, M = 78.6, SD = 11.5) learning styles were not statistically significant ($F(3, 52) = .603, p = .616$). Therefore, the null hypothesis was rejected by the results that showed that there was no significant difference in the perceived learning effectiveness between the students with different learning styles in the GBLS mode.
H2.3: There is a significant difference in the satisfaction between students with different learning styles in the GBLS mode.

One-way ANOVA was conducted to determine the difference in satisfaction between the students with different learning styles in the GBLS mode. The one-way ANOVA results showed that the difference in satisfaction between the diverging (N = 16, M = 81.3, SD = 1.60), accommodating (N = 10, M = 80.85, SD = 6.64), assimilating (N = 16, M = 80.7, SD = 1.39) and converging (N = 14, M = 78.4, SD = 10.8) learning styles were not statistically significant (F (3, 52) = .423, p = .737). Therefore, the results rejected the null hypothesis and presented that there was no significant difference in satisfaction between the students with different learning styles in the GBLS mode.

H2.4: There is a significant difference in the academic performance between students with different spatial abilities in the GBLS mode.

One-way ANOVA was conducted to determine the difference in the academic performance between the students with different spatial abilities in the GBLS mode. The one-way ANOVA results showed that the difference in the academic performance between students in the high (N = 23, M = 36.1, SD = 13.3), medium (N = 21, M = 35.5, SD = 16.4) and low (N = 12, M = 29.01, SD = 10.5) levels of spatial abilities were not statistically significant (F (2, 52) = 1.096, p = .342). The results rejected the null hypothesis and indicated that there is no difference in academic performance between the students with different spatial abilities in the GBLS mode.

H2.5: There is a significant difference in the perceived learning effectiveness between students with different spatial abilities in the GBLS mode.

One-way ANOVA was conducted to determine the difference in the perceived learning effectiveness between the students with different spatial abilities in the GBLS mode. The one-
way ANOVA results showed that the difference in perceived learning effectiveness between the high (N = 23, M = 80.3, SD = 11.1), medium (N = 21, M = 81.6, SD = 7.58) and low (N = 12, M = 83.6, SD = 9.95) levels of spatial ability were not statistically significant ($F (2, 53) = .432, p = .652$). The results rejected the null hypothesis and showed that there is no difference in perceived learning effectiveness between the students with different spatial abilities in the GBLS mode.

**H2.6: There is a significant difference in the satisfaction between students with different spatial abilities in the GBLS mode.**

One-way ANOVA was conducted to determine the difference in the satisfaction between the students with different spatial ability levels in the GBLS mode. The one-way ANOVA results showed that the difference in the satisfaction between the high (N = 23, M = 85.59, SD = 9.86), medium (N = 21, M = 88.9, SD = 6.34) and low (N = 12, M = 87.1, SD = 1.16) levels of spatial ability were not statistically significant ($F (2, 53) = .860, p = .429$). The Welch and Brown-Forsythe tests were conducted because the homogeneity of variance assumption was violated, $p < .05$. However, the Welch and Brown-Forsythe tests confirmed the one-way ANOVA results (see Table 5.18). The results rejected the null hypothesis and indicated that there is no difference in satisfaction between the students with different spatial abilities in the GBLS mode.

<table>
<thead>
<tr>
<th>Statistic(a)</th>
<th>df1</th>
<th>df2</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Welch</td>
<td>1.036</td>
<td>2</td>
<td>26.332</td>
</tr>
<tr>
<td>Brown-Forsythe</td>
<td>.796</td>
<td>2</td>
<td>33.023</td>
</tr>
</tbody>
</table>

*Table 5.18: Robust Tests of Satisfaction*
5.4 Results for question 3: How does the GBL system influence learning outcomes?

5.4.1 Description of the Research Model

The research model is shown in Figure 5.6. The research model is the Hierarchical Component Model (HCM), which consists of 3 HOC reflective-reflective constructs, namely the GBLS features, intrinsic motivation and learning outcomes. The GBLS features construct composed of 2 reflective LOCs that are multimodality and interactivity. The intrinsic motivation composed of 4 reflective LOCs, namely perceived competence, pressure/tension, value/usefulness and interest/enjoyment. The learning outcome construct composed of 3 LOCs that are academic performance, perceived learning effectiveness and satisfaction. Intrinsic motivation is proposed to mediate the relationship between the GBLS features and learning outcomes.

As described in Chapter 4, the HCM should be analysed in a special way using either the repeated indicator approach or two-stage approach. The two-stage approach was found to be the most appropriate, among the two approaches, to analyse this research model, as the number of indicators across the LOCs are not similar (Becker et al., 2012) (see Figure 5.7).

5.4.2 Two-stage Approach

As explained in Chapter 4, the model analysis is done in two stages.

5.4.2.1 Stage One

This stage entails creating a model without the presence of the HOCs, but only with all LOCs in the model, as seen in Figure 5.7. Then, the measurement model is evaluated. Finally, the latent variables scores are saved to be used as indicators to the HOC, in order to evaluate the structural model.
5.4.2.1.1 Evaluating the Measurement Model

As seen in Figure 5.7, all constructs are reflective. Assessing the reflective measurement model includes evaluating the convergent validity, discriminant validity and internal consistency reliability. The assessment of each criterion has been explained in detail in Chapter 4. Below are the results of the assessment of each criterion for the reflective measurement model.

1. Convergent Validity

Convergent validity can be evaluated using one of the following criteria: the outer loading of the indicators or the Average Variance Extracted (AVE). Figure 5.8 indicates the results of the indicators’ outer loadings; any indicator that has not met the rule of thumb was dropped from the model. The remaining indicators are shown in Figure 5.9. All the remaining indicators in the nine reflective constructs are way higher than the minimum acceptable threshold. Convergent validity can also be established based on the AVE values for the nine reflective constructs (see Table 5.21). All the AVE values of the nine reflective constructs are above the threshold of AVE that is 0.50.

2. Discriminant Validity

There are two criteria that were used to evaluate discriminant validity: the cross-loading of indicators and Fornell-Larcker criterion. Table 5.19 shows the results of the cross-loading. The discriminant validity can be established for all nine reflective constructs as the outer loading of each indicator on its associated construct is greater than its loadings on the other constructs. Table 5.20 shows the results of the Fornell-Larcker criterion. Based on these results, the discriminant validity can be established for all nine reflective constructs.
Figure 5.6 Model Description
Figure 5.7: Stage One of the Two-stage Approach
Figure 5.8: Initial Measurement Model before dropping the Unsatisfactory Indicators
Figure 5.9: Initial Measurement Model after dropping the Unsatisfactory Indicators
Table 5.19: Table of cross-loadings

<table>
<thead>
<tr>
<th></th>
<th>Interest / Enjoyment</th>
<th>Interactivity</th>
<th>Multimodality</th>
<th>Competence</th>
<th>Perceived Learning</th>
<th>Perceived Tension</th>
<th>Pressure / Performance</th>
<th>Academic</th>
<th>Satisfaction</th>
<th>Value / Usefulness</th>
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<tbody>
<tr>
<td>IE 1</td>
<td>0.852</td>
<td>0.582</td>
<td>0.292</td>
<td>0.196</td>
<td>0.106</td>
<td>0.311</td>
<td>-0.087</td>
<td>0.590</td>
<td>0.468</td>
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<tr>
<td>IE 2</td>
<td>0.845</td>
<td>0.346</td>
<td>0.291</td>
<td>0.144</td>
<td>0.159</td>
<td>0.316</td>
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<tr>
<td>IE 6</td>
<td>0.617</td>
<td>0.330</td>
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<td>0.133</td>
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</tr>
<tr>
<td>Int 1</td>
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<td>Multimodality</td>
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<td>Perceived Competence</td>
<td>Performance</td>
<td>Pressure/Tension</td>
<td>Value/Usefulness</td>
<td>Satisfaction</td>
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<td>Sat 1</td>
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<td>0.387</td>
<td>0.351</td>
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<td>0.337</td>
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<td>0.119</td>
<td>0.499</td>
<td><strong>0.760</strong></td>
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<td>0.517</td>
<td>0.111</td>
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<td>-0.193</td>
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Table 5.20: Fornell-Larcker Results

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<tr>
<th></th>
<th>Interactivity</th>
<th>Interest/Enjoyment</th>
<th>Multimodality</th>
<th>Perceived Learning Effectiveness</th>
<th>Perceived Competence</th>
<th>Performance</th>
<th>Pressure/Tension</th>
<th>Value/Usefulness</th>
<th>Satisfaction</th>
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<tr>
<td>Multimodality</td>
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<td>0.428</td>
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<tr>
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<td>Performance</td>
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</table>
3. Internal Consistency Reliability

As shown in Table 5.21, the composite reliability values of all latent variables are in the satisfactory limit between 0.70 and 0.90. Therefore, all nine reflective constructs demonstrated a high level of internal consistency reliability.

Table 5.21: Results summary of the measurement model analysis

<table>
<thead>
<tr>
<th>Latent Variable</th>
<th>Indicators</th>
<th>Loading</th>
<th>Composite Reliability</th>
<th>AVE</th>
<th>Discriminant Validity</th>
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<tbody>
<tr>
<td>Interactivity</td>
<td>Int 1</td>
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<td>0.870</td>
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<td></td>
<td>Int 2</td>
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</tr>
<tr>
<td></td>
<td>Int 3</td>
<td>0.843</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multimodality</td>
<td>Mul 1</td>
<td>0.873</td>
<td></td>
<td>0.812</td>
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<td>Mul 2</td>
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<td>VU 4</td>
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<td></td>
<td>VU 5</td>
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<td></td>
<td>VU 6</td>
<td>0.682</td>
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<td>PC 4</td>
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<td>Single-item construct</td>
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<td>Single-item construct</td>
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<td></td>
<td>PLE 8</td>
<td>0.720</td>
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</table>
5.4.2.2 Stage Two

The saved latent variable scores are used as indicators for the HOCs in a separate high order structural analysis (see Figure 5.10).

5.4.2.2.1 Evaluating the Structural Model

The assessment of the structural model was performed in 6 steps: checking the model for collinearity issues, assessing path coefficients, assessing the level of $R^2$, assessing the effect sizes $f^2$ and assessing the predictive relevance $Q^2$ and $q^2$ effect sizes. Below are the results of the structural model analysis.

**Step 1: Assess structural model for collinearity issues**

The collinearity issue was assessed for the following sets of predictor contracts:

a. *interactivity* and *multimodality* as predictors of *interest/enjoyment, perceived competence, pressure/tension* and *value/usefulness*.

b. *interactivity, multimodality, interest/enjoyment, perceived competence, pressure/tension* and *value/usefulness* as predictors of *academic performance, perceived learning effectiveness* and *satisfaction*.

Table 5.22 shows the VIF values of the collinearity assessment; all the VIF values are below the threshold of 5.0. Accordingly, there is no collinearity issue among the predictor constructs in the research model.
Step 2: Path coefficients

Figure 5.11 shows the T-values for the structural model relationships resulting from the bootstrapping calculation with 5000 sub-samples. With a 5% significance level, all relationships in the model are significant, except for the relationship between the GBLS features and learning outcomes with a T-value of 0.396. More details are provided under the hypothesis testing section (5.4.3). Figure 5.11 shows the results of the construct indicators’ outer weight, which can help identify the specific elements of each construct. A summary of the results can be found in Table 5.25.

Step 3: Assess the level of $R^2$

$R^2$ has been used to test whether the model is able to explain the variance in the dependent variables. 44.4% of the variance in intrinsic motivation is explained by the GBLS features. The research model explained 56.8% of the variability in the learning outcomes.

<table>
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<th>Table 5.22: Collinearity issue assessment</th>
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<tr>
<td>Interest/ Enjoyment</td>
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<td>Perceived competence</td>
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<td>Pressure/ Tension</td>
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<tr>
<td>Value / Usefulness</td>
</tr>
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</table>
Figure 5.10: Stage Two of the Two-stage Approach
Figure 5.11: Bootstrapping results
Step 4: Assess the effect sizes $f^2$

Table 5.23 indicates the results of the $f^2$ value of the exogenous latent variables on endogenous latent variables. The GBLS features have a large effect size (0.799) on intrinsic motivation. Intrinsic motivation also has a large effect size of 0.816 on learning outcomes. On the other hand, the GBLS features have no direct effect (0.006) on learning outcomes.

*Table 5.23: $f^2$ Results*

<table>
<thead>
<tr>
<th>Constructs</th>
<th>$f^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>GBLS features on intrinsic motivation</td>
<td>0.799</td>
</tr>
<tr>
<td>GBLS features on Learning outcomes</td>
<td>0.006</td>
</tr>
<tr>
<td>Intrinsic Motivation on Learning outcome</td>
<td>0.816</td>
</tr>
</tbody>
</table>

Step 5: Assess the predictive relevance $Q^2$

As shown in Figure 5.12, the $Q^2$ values of both endogenous variables are bigger than zero. Thus, the $Q^2$ value can be considered as evidence of the model’s predictive relevance regarding the latent endogenous constructs.

*Figure 5.12: $Q^2$ values including all constructs of the model*

Step 6: Effect sizes $q^2$

To complete the last step of assessing the structural model, the $q2$ effect size was calculated manually using the following formula: $q^2 = \frac{Q^2_{included} - Q^2_{excluded}}{1 - Q^2_{included}}$
Q^2_{\text{included}} are the Q^2 values that are shown in Figure 5.12. The Q^2_{\text{excluded}} values were obtained from re-estimating the research model after dropping a specific construct each time. For example, the construct’s intrinsic motivation was dropped to get the first value in Table 5.24 and the construct’s GBLS features were deleted to obtain the second value in Table 5.24. An identical omission distance D of 9 was used when computing the results of Q^2_{\text{excluded}} and Q^2_{\text{included}}.

**Table 5.24: Q^2 excluded values**

<table>
<thead>
<tr>
<th></th>
<th>Q^2 value when Intrinsic motivation is excluded</th>
<th>0.208</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Q^2 value when GBLS features are excluded</td>
<td>0.072</td>
</tr>
</tbody>
</table>

\[
\text{Learning Outcomes} = \frac{0.203 - 0.072}{1 - 0.203} = 0.164
\]

\[
q^2_{\text{GBLS Features } \rightarrow \text{Intrinsic Motivation}} = \frac{0.214 - 0.208}{1 - 0.214} = 0.007
\]

Based on the rule of thumb, the q^2 effect size indicates that intrinsic motivation has a large predictive relevance for learning outcomes, whereas the GBLS features have a small predictive relevance for intrinsic motivation.

**5.4.2.2.2 Testing for Mediation**

The research model assumed that intrinsic motivation mediates the relationship between the GBLS features and learning outcomes. The method of testing mediation in the Smart-PLS was explained in Chapter 4 (see Figure 4.2).

The first step is to test the indirect effect. The indirect effect from the GBLS features via intrinsic motivation to learning outcomes is significant, with \( \beta = 0.530 \) and \( t = 5.115 \) (p-value < 0.001), indicating that there is mediation. As the indirect relationship is significant, the second step is to test the significance of the direct effect; the direct effect from the GBLS features to learning outcomes is weak and not significant, with \( \beta = -0.067 \) and \( t = 0.399 \) (p-
value = 0.690). Following the meditation analysis procedures, it can be concluded that intrinsic motivation fully mediates the relationship between the GBLS features and learning outcomes.

5.4.3 Hypothesis Testing

This section will show the hypothesised paths to answer research question 3.

**H3.1: GBLS features have a direct positive effect on intrinsic motivation.**

The relationship between the GBLS features and intrinsic motivation is significant, with $\beta = 0.666$ and $t = 7.242$ (p-value < 0.001), indicating that the GBLS features have a direct positive influence on intrinsic motivation. In other words, a 100-point change in the GBLS features will bring a 66.6-point change in intrinsic motivation.

**H3.2: Intrinsic motivation has a direct positive effect on the learning outcomes.**

The relationship between intrinsic motivation and learning outcomes is significant, with $\beta = 0.797$ and $t = 6.278$ (p-value < 0.001), indicating that intrinsic motivation has a direct positive influence on the learning outcomes. It can also be interpreted that a 100-point change in intrinsic motivation will bring a 79.7 change in learning outcomes.

**H3.3: Intrinsic motivation mediates the influence of the GBLS features on learning outcomes.**

The results showed that intrinsic motivation fully mediates the effect between the GBLS features and learning outcomes, with $\beta = 0.531$ and $t = 5.088$ (p-value < 0.001).

**H3.4: Interactivity is a first-order factor of the GBLS features.**

Interactivity is a first-order factor of the GBLS features, with $\beta = 0.848$ and $t = 13.616$ (p-value < 0.001).
H3.5: Multimodality is a first-order factor of the GBLS features.
Multimodality is a first-order factor of the GBLS features, with $\beta = 0.861$ and $t = 18.945$ (p-value < 0.001).

H3.6: Interest/Enjoyment is a first-order factor of intrinsic motivation.
Interest/Enjoyment is a first-order factor of intrinsic motivation, with $\beta = 0.803$ and $t = 16.508$ (p-value < 0.001).

H3.7: Perceived competence is a first-order factor of intrinsic motivation.
Perceived competence is a first-order factor of intrinsic motivation, with $\beta = 0.551$ and $t = 3.382$ (p-value < 0.001).

H3.8: Pressure/Tension is a first-order factor of intrinsic motivation.
Pressure/Tension is a first-order factor of intrinsic motivation, with $\beta = 0.666$ and $t = 6.297$ (p-value < 0.001).

H3.9: Value/Usefulness is a first-order factor of intrinsic motivation.
Value/usefulness is a first-order factor of intrinsic motivation, with $\beta = 0.855$ and $t = 30.770$ (p-value < 0.001).

H3.10: Academic performance is a first-order factor of learning outcomes.
Academic Performance is not a first-order factor of learning outcomes, with $\beta = -0.158$ and $t = 0.664$ (p-value > 0.05).

H3.11: Perceived learning effectiveness is a first-order factor of learning outcomes.
Perceived Learning Effectiveness is a first-order factor of learning outcomes, with $\beta = 0.757$ and $t = 7.029$ (p-value < 0.001).
H3.12: Satisfaction is a first-order factor of learning outcomes.

Satisfaction is a first-order factor of learning outcomes, with $\beta = 0.884$ and $t = 17.399$ (p-value < 0.001).

Table 5.25: Summary of Structural model assessment results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Path Coefficient</th>
<th>T-Statistics values</th>
<th>P-values</th>
<th>Significance level</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>H3.1</td>
<td>GBLS Features have positive direct effect on Intrinsic Motivation.</td>
<td>0.666</td>
<td>7.242</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>H3.2</td>
<td>Intrinsic Motivation has positive direct effect on Learning Outcomes.</td>
<td>0.797</td>
<td>6.278</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>H3.3</td>
<td>Intrinsic Motivation mediate the influence of GBL’s Features on Learning Outcomes.</td>
<td>0.531</td>
<td>5.088</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>H3.4</td>
<td>Interactivity is a first-order factor of GBLS features.</td>
<td>0.484</td>
<td>13.258</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>H3.5</td>
<td>Multimodality is a first-order factor of GBLS Features.</td>
<td>0.861</td>
<td>18.873</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>H3.6</td>
<td>Interest/enjoyment is a first-order factor of Intrinsic Motivation.</td>
<td>0.803</td>
<td>16.998</td>
<td>0.000</td>
<td>***</td>
</tr>
<tr>
<td>H3.7</td>
<td>Perceived competence is a first-order factor of Intrinsic Motivation.</td>
<td>0.550</td>
<td>3.433</td>
<td>0.001</td>
<td>***</td>
</tr>
<tr>
<td></td>
<td>Hypothesis</td>
<td>Factor of Intrinsic Motivation</td>
<td>Coefficient</td>
<td>t-value</td>
<td>p-value</td>
</tr>
<tr>
<td>---</td>
<td>------------</td>
<td>--------------------------------</td>
<td>-------------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>H3.8</td>
<td>Pressure/Tension</td>
<td></td>
<td>0.666</td>
<td>6.234</td>
<td>0.000</td>
</tr>
<tr>
<td>H3.9</td>
<td>Value/Usefulness</td>
<td></td>
<td>0.855</td>
<td>30.883</td>
<td>0.000</td>
</tr>
<tr>
<td>H3.10</td>
<td>Academic Performance</td>
<td>First-order factor of Learning Outcomes</td>
<td>-0.158</td>
<td>0.679</td>
<td>0.497</td>
</tr>
<tr>
<td>H3.11</td>
<td>Perceived Learning Effectiveness</td>
<td>First-order factor of Learning Outcomes</td>
<td>0.756</td>
<td>6.884</td>
<td>0.000</td>
</tr>
<tr>
<td>H3.12</td>
<td>Satisfaction</td>
<td>First-order factor of Learning Outcomes</td>
<td>0.884</td>
<td>17.687</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Path significance Level:
* p< 0.05
** p< 0.01
*** p<0.001
(e.g. t > 1.96 at p < 0.05, t > 2.576 at p < 0.01, t > 3.29 at p < 0.001 for two-tailed tests)

### 5.5 Summary

This chapter presented the results of the data analysis that was performed to test the proposed hypotheses. First, this chapter presented the descriptive statistics of participants which included their use of computers and their experience with the GBLS mode. A low level of experience with the GBLS was reported. Second, this chapter presented the assessment of the hypothesis that answers question 1. The results showed that the GBLS has a positive influence on students’ learning outcomes. Third, this chapter reported the results for question 2. The outcomes indicated that the GBLS mode can serve all students with different learning styles and spatial
abilities. Fourth, this chapter reported the results of assessing the proposed research model that answers the question 3. The assessment included evaluating the measurement model, followed by evaluating the structural model. The results that are presented in this chapter will be discussed in Chapter 6.
Chapter 6. Discussion and Conclusion

6.0 Overview

This study was conducted to investigate the effectiveness of the GBLS mode. The main purpose of this research was broken down into more specific questions as follows. First, does the GBLS mode influence students’ learning outcomes? Second, will the GBLS mode be able to accommodate all students with different learning styles and spatial abilities? Third, how does the GBLS mode influence the learning outcomes? These three research questions were addressed in this research. This chapter discussed the outcomes of the study that were presented in Chapter 5. This chapter is divided into 4 sections: the first section discusses the answers to the research questions based on the research results; the second section outlines the research limitations and recommendations for future work; the third section highlights the research implications, while the fourth section underlines the research conclusions.

6.1 Discussion and Answering of the Research Questions

This section discusses the research results and provides the answers to the research questions based on the research outcomes.

6.1.1 Question 1: Does the GBLS mode influence students’ learning outcomes?

The current research yielded additional evidence that the GBLS mode can positively influence the learning outcomes of students. Students using the GBLS mode achieved higher scores in their overall learning outcomes than the students in the other two learning modes. In addition, the current research results showed that students in the GBLS mode outperformed students in the other learning groups for perceived learning effectiveness and satisfaction (affective learning outcomes). On the other hand, the current research found that there is no statistical significant difference in the academic performance (cognitive learning outcomes) between students in the GBLS, the CSL and the conventional learning modes. Although there were no
significant differences statistically in the academic performance between the three groups, the research did find differences in the research sample (see Figure 5.4). The students in the GBLS mode did better in the post-test than the students in the other learning modes. The results of the GBLS mode’s better cognitive outcomes were consistent with the results obtained by Chang et al. (2013) and Chao et al. (2013). This improvement of the students’ academic performance could be explained by Embodied Cognition Theory, which is a cognitive science theory that believes connecting cognitive tasks with the physical environment during learning can support concept understanding and learning for students (Chao et al., 2013).

The results of a higher level of perceived learning effectiveness with the GBLS mode indicated that the students believed that the GBLS mode could help them achieve a better understanding of the learning content, summarise the main ideas of the topic, as well as be more confident to express and discuss their ideas. The participants also declared that the GBLS mode experience has positively influenced their interests in the learning topic. These results could be explained through the interactivity, which is one of the main features of the GBLS mode. As such, this has proven that the interactive learning experience improves student skills such as problem-solving and critical thinking (Saye & Brush, 2001). Similarly, the results of a high level of satisfaction with the GBLS mode indicated that the students enjoyed the GBLS mode experience and that they were satisfied with the learning environment. These results matched those reported by Sommool, Battulga, Shih and Hwang (2013).

6.1.2 Question 2: Will the GBLS mode be able to accommodate all students with different learning styles and spatial abilities?

The second part of the research investigation showed that the GBLS mode could accommodate all learners with different learning styles and spatial abilities. These results met the requirements of the effective learning systems that were described by Langrick Hall and
Sanders (1997); they state that an effective education system should be able to accommodate all students with different individual characteristics. Lage, Platt and Treglia (2000) also emphasize that the failure to match a teacher’s instructing style and a pupil’s learning style can result in making the student less interested in the learning experience. From the research results, it could be concluded that the GBLS mode provided an inclusive classroom environment that fulfilled the needs of all learners with different learning styles and spatial abilities. These results can be explained by the multimodality, which represents one of the main features of the GBLS mode. Multimodality refers to the mode of interaction and knowledge representation that support learners’ full sensory capabilities which include visual, audio, kinaesthetic and haptic. In other words, a multimodal learning environment involves the idea of representing knowledge in various methods with the purpose of serving all students in the classroom with different learning styles (Birchfield et al., 2008).

6.1.3 Question 3: How does the GBLS mode influence the learning outcomes?

This study also investigated how the GBLS mode influences the learning outcomes by identifying the relevant latent variables and examining the relationship between those variables. A research model of three high-order constructs was introduced and analysed. For this part of the research, only the data that were collected from the GBLS mode participants were used to test the research model. The relationship between the GBLS features and intrinsic motivation, as well as the relationship between intrinsic motivation and learning outcomes were tested. The mediating effect of intrinsic motivation between the GBLS features and learning outcomes was also examined. The research model explained 56.8% of the variability in the learning outcomes. Table 5.25 presents a summary of the results of the hypothesised relations. However, this section will discuss and clarify those outcomes.
The results of the model analysis indicated that the GBLS features positively influence the students’ intrinsic motivation. These results are consistent with the findings of W.-J. Lee, Huang, Wu, Huang, & Chen (2012), whose Kinect-enhanced DLP was found to have a high positive impact on students’ intrinsic motivation. These results also supported the findings of previous studies in the TML field; for example, Lawlor, Marshall, and Tangney (2016) found that a team-based, technology-mediated model known as Bridge21, has a direct positive influence on students’ intrinsic motivation. However, the positive influence of the GBLS features on intrinsic motivation can be explained through interactivity and multimodality, which are the main features of the GBLS mode. According to (Homer et al., 2014), by giving students opportunities to participate and have control over their learning experiences, it assists in boosting their intrinsic motivation. As explained above, Kinect promotes an interactive learning environment that encourages students to participate and lead the learning experience. Multimodality has also been proven as an influence of intrinsic motivation. Valerio (2012) indicates that intrinsic motivation could be increased by delivering the learning content in different ways, so as to grab the attention of the learners.

The results of this study also showed that intrinsic motivation is positively related to the learning outcomes. These results support the models introduced by (Alavi & Leidner, 2001; Benbunan-Fich & Hiltz, 2003). In addition, these results also matched the findings of previous intrinsic motivation studies; for example, Pintrich et al. (2008) indicates that intrinsically motivated learners are more committed to achieving their learning goals. Other studies showed that students with high intrinsic motivation engage deeply in the learning materials, are curious, have more self-regulation and less avoidance behaviour, as well as that they are less likely to drop out of school (Hair et al., 2012; Tenenhaus et al., 2005; Wong, 2013).

On the other hand, this study showed that the GBLS features have no direct effect on the learning outcomes, but instead, it indirectly influences the learning outcomes via increasing the
intrinsic motivation of students. To put it in another way, this study indicated that intrinsic motivation mediates the effect of the GBLS features on the learning outcomes. These results supported Alavi and Leidner’s (2001) findings, which claimed that technology does not influence the learning outcomes, but that the features of the technology provide a unique instructional environment, that influences the psychological learning processes of students, which in turn positively influences the learning outcomes. These results provide an answer to the research question of how the GBLS mode positively influences learning outcomes. This study found that the GBLS features, which are interactivity and multimodality, provide an instructional learning environment that positively influences the psychological learning process of students. The improvement of students’ psychological learning processes, which is intrinsic motivation, leads to an improvement in the learning outcomes.

6.2 Research Limitations and Future Recommendations

There are three limitations of this study that should be considered. The first limitation is that the data collection took place during the last four weeks of the semester, where the students were busy submitting their assignments and getting ready for exams. As a result, this brought about a high dropout rate of the experiment, which forced the researcher to repeat the experiment several times with new participants, in order to achieve the targeted number of students for each group.

Second, the outcomes of this study were able to detect the positive influence of the GBLS mode on the students (affective learning outcomes), but it could not detect the GBLS mode’s influence on cognitive learning outcomes. These non-significant effects could have resulted from the short time period of the research experiment duration (one-day experiment). Therefore, long-term experimentation (for example, one-semester) with larger number of
participants is highly recommended in future studies, so as to perceive whether the GBLS mode will generate the same learning outcomes.

The third limitation is the distribution of males and females within the groups. The participants were randomly assigned to different groups, which resulted in an uneven number of males and females in some groups. For instance, the GBLS group has more females than males, whereas the CSL mode group has more males than females. Even though comparing different genders’ learning performance is not in the scope of this study, it is believed that having an unequal number of females and males might affect the outcomes of this study. Previous research have discovered that males are more keen to use e-learning and learning technology, as compared to their female counterparts (Broos, 2005; Ong & Lai, 2006). Therefore, controlling the gender type to be equal in each group is recommended in future research.

Finally, this study only focused on the influence of GBLs on intrinsic motivation, however, there are many other psychological learning processes such as (cognitive offloading, mental effort) that are as important as intrinsic motivation. Therefore, those factors should be investigated individually and eventually as a whole to understand the interaction of the factors in future work.

6.3 Research Implications

Despite the fact that this research was conducted for exploratory purposes, the outcomes of this research indicated some important implications that are worth discussing. First, this study provided a primary explanation of how the GBLS mode positively influences learning. Hence, these results can help GBLS application developers and instructors to focus more on the strengths of the GBLS mode. Second, the results of this research showed that the GBLS mode could serve the needs of all learners with different learning styles. These results can help improve teaching staff’s awareness of students’ differences, so that they consider all learning
styles (especially kinaesthetic learners) in their instruction design, in order to create an effective learning environment that does not neglect anyone.

6.4 Research Conclusions

At the beginning of this thesis, it was mentioned that a proper investigation into the effectiveness of the GBLS mode is needed. The literature of the knowledge area, specifically the research within the GBLS field, is still in its infancy stage. However, this study has offered an experimental investigation into the effectiveness of the GBLS mode with the guidance of some TML models. The findings of this study suggest that the learning outcomes of the GBLS mode outperformed the other two learning modes: the CSL mode and conventional learning mode. In addition, the results of this research also suggest that the GBLS mode can serve all learners with various learning styles and spatial abilities. Moreover, this study provides a conceptual model that basically explains how the GBLS mode influences learning outcomes. The conceptual model suggests that the GBLS features (interactivity and multimodality) can create an instructional learning environment that positively influences students’ intrinsic motivation. The increase of students’ intrinsic motivation will lead to an enhancement of the learning achievements of students. The findings of this study are important as they have experimentally proven the effectiveness of the GBLS mode and provided a scientific explanation as to how the GBLS mode positively influences learning outcomes.
References


Thelen, H. A. (1954). Dynamics of groups at work.


Appendixes

Appendix A: The initial questionnaire Arabic version

الاستبيان المبديي للمجموعات أ & ب & ج
عزيزي المشارك بالاستبيان

تم تصميم هذا الاستبيان لجمع المعلومات حول تجربتك مع نظام التعليم بالاشتراك. ويتكون هذا الاستبيان من خمسة أقسام:

أ. معلومات أساسية عن المشارك.

ب. اختبار الأسلوب التعليمي

ج. اختبار القدرات المكانية

هذا الاستبيان جزء من متطلبات نيل شهادة الدكتوراه في مجال تقنية المعلومات من جامعة مردوخ وبإشراف كل من الدكتور / كيفن ونق والدكتور / لنس فونق.

نأمل منكم التكرم بالمشاركة في هذه الدراسة من خلال إكمال الاستبيان المرفق والذي نأمل أن تشمل الإجابة عليه أكثر من 40 دقيقة. علماً بأن المشاركة في هذا الاستبيان هي عمل اختياري بحث، وبينما ندعوكم لإكمال الإجابة على هذا الاستبيان فإنه لديك الحرية المطلقة في التوقف عن إكمال الإجابة على إكمال الحاجة ملحة لذلك. تجدر الإشارة هنا بأن هذا الاستبيان قد حصل على موافقة لجنة أخلاقيات البحث العلمي بجامعة مردوخ ولن يتم وضع أي بيانات شخصية تدل في أي جزء من أجزاء الاستبيان كما أضمن لك أن بياناتك الشخصية لن يتم نشرها في مخرجات هذه الدراسة بما فيها من النتائج وسوف تحتفظ بسرية كاملة ولن يحق لأحد سوى الباحث ومشرفيه الإطلاع عليها.
يرجى كتابة الرقم السري الخاص بك في هذا المربع:

القسم أ: معلومات أساسية

هذا القسم من الاستبيان يجمع بعض المعلومات الأساسية عنك. الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

1. كم عمرك؟
   - □ 26
   - □ (22-26)
   - □ (18-22)
   - □ (26+)

2. الجنس؟
   - □ أنثى
   - □ ذكر

3. ما هو القسم الذي تدرس فيه؟
   - □ الكيمياء
   - □ الرياضيات
   - □ الحاسوب
   - □ الجيوفيزياء
   - □ الأحياء
   - □ أخرى، يرجى ذكرها ...............

القسم ب: اختبار الأسلوب التعليمي

القسم ج: اختبار القدرات المكانية
Appendix B: The initial questionnaire English version

Initial Questionnaire for Group A, B and C
Dear Participant:

This questionnaire has been designed to test your learning style and your spatial ability level. This questionnaire consists of three sections:

A. Demographic and Background Information

B. Learning style inventory

C. Spatial ability test

Completion of this questionnaire is entirely voluntary. Your participation in this questionnaire is totally anonymous and no personal details are being collected or used. You can change your mind, withdraw your consent, and stop participating at any time; but once your survey has been submitted it may not be possible to withdraw your participation. All information provided will be treated as confidential by the researcher and will not be released to a third party unless required to do so by law. All findings of this study may be published and that no information which can specifically identify you will be published.

If you have any questions about this study, please feel free to contact me (Moamer Shakroum, M.shakroum@murdoch.edu.au, Mobile: +614 51511631), or my supervisors (Associate Professor Dr Kevin Wong, k.wong@murdoch.edu.au, +618 93606100). If you wish to talk to an independent person about your concerns, you can contact Murdoch University’s Human Research Ethics Committee on +618 9360 6677 or email ethics@murdoch.edu.au.
Please write down your Secret Number (Randomly assigned number) in this Box:  

Section A: Demographic and Background Information
This section of the questionnaire is designed to collect some basic demographic and background information about you. Please select and tick (√) only one answer for each of the following questions.

1. How old are you?
   - [ ] 18-22
   - [ ] 22-26
   - [ ] 26+

2. What is your gender?
   - [ ] Female
   - [ ] Male

3. Which school are you studying in:
   - [ ] Computer Science
   - [ ] Mathematics
   - [ ] physics
   - [ ] Geology
   - [ ] Biology science
   - [ ] chemistry science
   - [ ] others, please specify ..............................

Section B: Learning Style
This section of the questionnaire is designed to determine your learning style.

Section C: Spatial ability test
This section of the questionnaire is designed to determine your spatial ability level.
Appendix C: The pre-test Arabic version

الاختبار القبلي للمجموعات أ، ب و ج
يرجى كتابة الرقم السري الخاص بك في هذا المرفق:

تعليمات: هذا الاختبار لتقييم معلوماتك في موضوع "مقدمة في علم الفلك و حساب الزمن" الرجاء الإجابة على جميع الأسئلة التالية. لديك 10 دقائق قراءة الأسئلة. ثم لديك 30 دقيقة للإجابة على الأسئلة.

القسم (أ): الاختيار من متعدد

القسم (أ): الرجاء اختيار ووضع علامة (√) أمام الإجابة الصحيحة لكل سؤال من الأسئلة التالية:

1. مقدار الوقت الذي يستغرقه أي نجم ليقطع دائرة الزوال مرتين هو:

   (أ) 23 ساعة و 56 دقيقة
   (ب) 24 ساعة
   (ج) 365.25 يوما
   (د) 12 عاما
   (ه) 26000 عاما

2. أي من العبارات التالية حول اليوم الشمسي و اليوم الفلكي غير صحيحة؟

   (أ) اليوم الشمسي اطول بـ 4 دقائق من اليوم الفلكي
   (ب) اليوم الشمسي عبارة عن أكثر من 360 درجة من دوران الأرض.
   (ج) اليوم الفلكي هو الوقت الذي يستغرقه نجم لعمل دورة واحدة في سمائنا
   (د) اليوم الشمسي هو الوقت الذي تستغرقه الشمس لعمل دورة واحدة في سمائنا
   (ه) اليوم الشمسي هو الوقت الذي يستغرقه القمر لعمل دورة واحدة في سمائنا

3. أي مما يلي هو السبب الذي يجعل اليوم الشمسي أطول من اليوم الفلكي؟

   (أ) الحركة البدارية لمحور الأرض
   (ب) ميل محور الأرض
(ج) التأثير المشترك لدوران الأرض حول محورها ودورانها حول الشمس (د) السنة على الأرض لا تساوي رقم غير صحيح من أيام الأرض (ه) الأرض تتحرك حول الشمس حركة غير دائرية

4. بيلغ متوسط طول اليوم الشمسي:

(أ) 23 ساعة و 56 دقيقة (ب) 24 ساعة (ج) 365.25 يوما (د) 12 عاما (ه) 26000 عاما

5. الشهر القمري أطول من الشهر الفلكي بسبب:

(أ) القمر يكمل دورة من المراحل القمرية قبل أن يكمل دورة كاملة حول الأرض (ب) القمر يتم أكثر من دورة كاملة حول الأرض لكي يستطيع اكتمال دورة من المراحل القمرية (ج) القمر يدور حول الأرض أسرع من دوران الأرض حول الشمس (د) القمر يدور حول الأرض أسرع من دوران الأرض حول نفسها (ه) يعتبر الشهر القمري على دوران القمر، في حين يعتبر الشهر الفلكي على دوران الأرض.

6. ما هو الوقت الذي يمكن قراءته مباشرة من الساعة الشمسية؟

(أ) الوقت الشمسي الظاهري (ب) متوسط الوقت الشمسي (ج) الوقت القياسي (د) وقت التوقيت الصيفي (ه) الوقت الفلكي
7. جميع العبارات التالية صحيحة. أي من العبارات تفسر سبب اختلاف متوسط التوقيت الشمسي عن التوقيت الشمسي الظاهري؟

أ) طول اليوم الشمسي ليس 24 ساعة بالضبط دائمًا
ب) زمن دوران الأرض في الواقع هو حوالي 23 ساعة و 56 دقيقة وليس 24 ساعة
ج) محور الأرض يتغير (الحركة البدارية) في مدة 26000 سنة
د) الشمس تمد دائرة الزوال في أوقات مختلفة على خطوط طول مختلفة في نفس المنطقة الزمنية
ه) مسار الشمس في السماء يعتمد على كل من دوائر العرض والتاريخ

8. أي مما يلي هو سبب السنة الكبيسة؟

أ) الحركة البدارية لمحور الأرض
ب) ميل محور الأرض
ج) التأثير المشترك لدوران الأرض حول محورها ودورانها حول الشمس
د) السنة على الأرض لا تساوي رقم غير صحيح من أيام الأرض
ه) الأرض تحرك حول الشمس حركة غير دائرية

9. التقويم الميلادي يحتوي سنوات كبيسة بسبب:

أ) أن عدد الأيام الفلكية في السنة أكثر بيوم واحد من الأيام الشمسية
ب) السنة المدارية تكون أكثر بقليل من 365 يومًا
ج) هناك فرق بين السنة الفلكية والسنة المدارية
د) في منطقة الحضيض في مدرا الأرض تقل سرعة دوران الأرض
10. استناداً للتقويم الميلادي الحالي، أي من السنوات التالية ليست سنة كبيسة؟

( ) عام 2000
( ) عام 2004
( ) عام 2008
( ) عام 2012

( ) جميع ما سبق هي سنوات كبيسة

11. الشمس ترتفع من الشرق وسوف تكون على دائرة خط الزوال الخاص بك خلال ساعتين. ما هو الوقت الآن؟

( ) قبل 02:00 صباحاً
( ) قبل 02:00 مساءً
( ) قبل 10:00 صباحاً
( ) قبل 10:00 مساءً

( ) الظهر

12. ما هي زاوية الساعة لنجم يعبر دائرة خط الطول الخاص بك؟

( ) 6 ساعات
( ) 0 ساعة
( ) 6 ساعات

( ) ذلك يعتمد على دائرة العرض الخاص بك

13. يظهر القطب السماوي الجنوبي على دائرة خط الطول الخاص بك على ارتفاع 30 درجة في الجنوب. أين أنت؟

( ) دائرة العرض = 30 درجة جنوباً
ب) دائرة العرض = 60 درجة جنوبًا

ج) دائرة العرض = 30 درجة شمالًا

د) دائرة العرض = 60 درجة شمالًا

ه) الدائرة القطبية الجنوبية

14. أي من العبارات التالية تمثل أفضل وصف لمدار السرطان؟

أ) هو أي مكان يتميز بمناخ حار جدا دائمًا

ب) هو اسم آخر لخط الاستواء

ج) هو المكان الذي تظهر فيه الشمس ثابتة دائمًا في السماء

د) هو المكان الذي تكون الشمس في الظهر عمودية في يوم الانقلاب الصيفي

ه) هو المكان الذي تكون الشمس في الظهر عمودية في يوم الامتداد الربيعي

15. لنفترض أن التاريخ هو 21 مارس والشمس تمر خلال منطقة الذروة الخاصة بك في ظهر. أين أنت؟

أ) خط الاستواء

ب) مدار السرطان

ج) مدار الجدي

د) الدائرة القطبية الشمالية

ه) الدائرة القطبية الجنوبية

16. لنفترض أن التاريخ هو 21 مارس والشمس تمر دائرة خط الزوال الخاصة بك على ارتفاع 23.5 درجة في الشمال. أين أنت؟
17. لنفترض أن التاريخ هو 21 يونيو والشمس لا تغرب أبدا بمجرد وصولها للأفق الشمالي الخاص بك عند منتصف الليل. أين أنت؟

( ) خط الاستواء
( ) مدار السرطان
( ) مدار الجدي
( ) الدائرة القطبية الشمالية
( ) الدائرة القطبية الجنوبية

18. أي مما يلي يفسر لماذا الملاحين قبل بضع مئات من السنين وجدوا أنه من الصعب جدا تحديد خط الطول مقارنة بتحديد دائرة العرض الخاصة بهم؟

( ) يتطلب تحديد خط الطول تقنيات رياضية و التي لم تكن معروفة في ذلك الوقت
( ) تحديد خطوط الطول من دون الآلات الحديثة يتطلب أن تكون قادرا على رؤية القمر
( ) يتطلب تحديد خط الطول قياسات دقيقة للزوايا في السماء أكثر مما يتطلب تحديد خط العرض
( ) يتطلب تحديد خطوط الطول وجود ساعة دقيقة
19. كلا من العبارات التالية صحيحة. أي مما يلي يعني دليلا على أن مدار الأرض ليس دانريا تمامًا؟

أ) تغير حجم الشمس الزاوي على مدار السنة
ب) فصول الأرض ليست تماما بنفس الطول
ج) في أمريكا الشمالية، شهر 6 أكثر سخونة من شهر واحد
د) كل من أ & ج
ه) كل من أ & ب

القسم (ب): أسئلة الصواب والخطأ

القسم (ب): ضع علامة (√) أمام الإجابة الصحيحة وعلامة (×) أمام الإجابة الخاطئة.

20. لا يهم أين تعيش على الأرض، باستثناء القطبين، خط الطول الخاص بك يمتد من اتجاه الجنوب خلال نقطة الذروة الخاصة بك في اتجاه الشمال على افقك.

21. التقويم الميلادي يعتمد على طول السنة المدارية بدلا من السنة النجمية.

22. جميع الاتجاهات تكون جنوبا من القطب الشمالي.

23. احداثيات الشمس في الكرة السماوية تتغير من يوم إلى آخر.

24. لا يهم أين تعيش على الأرض، الشمس دائما تشرق وتغرب كل يوم.

25. لا يهم أين تعيش على الأرض، الشمس تكون دائما عمودية في الظهيرة.

26. على خط الاستواء، طول الأيام والليالي دائما 12 ساعة في أي وقت من السنة.

27. تتكون السنة في القطب الجنوبي من 6 شهور من الظلام و 6 أشهر من ضوء النهار.
Appendix D: The pre-test English version

Pre-test for groups A, B and C
Instructions: This test is to assess your knowledge in the topic of “Introduction to the solar system and time measurement” Please answer all questions in part A and Part B. You have 10 minutes to read the questions, then you have 30 minutes to answer the questions.

Please choice and tick (√) only one correct answer for each of the following questions.

Section A: Multiple Choice Questions

1) The amount of time between successive passes of any given star across the meridian is
   a) 23 hours 56 minutes. (   )
   b) 24 hours. (   )
   c) 365.25 days. (   )
   d) 12 years. (   )
   e) 26,000 years. (   )

2) Which of the following statements about sidereal and solar days is not true?
   a) A solar day is 4 minutes longer than a sidereal day. (   )
   b) A solar day represents more than 360° of rotation for Earth. (   )
   c) The time it takes for a star to make one circuit of our sky is one sidereal day. (   )
   d) The time it takes for the Sun to make one circuit of our sky is one solar day. (   )
   e) The time it takes for the Moon to make one circuit of our sky is one solar day. (   )

3) Which of the following is the reason for the solar day being longer than a sidereal day?
   a) Precession of Earth's axis (   )
   b) The tilt of Earth's axis (   )
   c) The combined effect of the rotation of Earth and its orbit about the Sun. (   )
   d) Earth year being a non-integer number of Earth days (   )
   e) The non-circular orbit of Earth around the Sun (   )
4) The average length of a solar day is
   a) 23 hours 56 minutes. (   )
   b) 24 hours. (   )
   c) 365.25 days. (   )
   d) 12 years. (   )
   e) 26,000 years. (   )

5) The lunar month is longer than the sidereal month because
   a) The Moon completes the cycle of lunar phases before it completes a full orbit around
      Earth. (   )
   b) The Moon has to complete more than one full orbit around Earth to complete the
      cycle of lunar phases. (   )
   c) The Moon orbits Earth faster than Earth orbits the Sun. (   )
   d) The Moon orbits Earth faster than Earth rotates. (   )
   e) The lunar month is based on the Moon's orbit, while the sidereal month is based on
      Earth’s orbit. (   )

6) What kind of time can be read directly from a sundial?
   a) Apparent solar time (   )
   b) Mean solar time (   )
   c) Standard time (   )
   d) Daylight saving time (   )
   e) Sidereal time (   )

7) All the following statements are true. Which one explains why mean solar time differs
   from apparent solar time?
   a) The length of a solar day is not always exactly 24 hours. (   )
   b) Earth's rotation period is actually about 23 hours 56 minutes, not 24 hours. (   )
   c) Earth's axis processes with a period of 26,000 years. (   )
   d) The Sun reaches the meridian at different times at different longitudes within the
      same time zone. (   )
   e) The path of the Sun through the sky depends on both latitude and date. (   )
8) Which of the following is the reason for the leap years?
   a) Precession of Earth's axis (   )
   b) The tilt of Earth's axis (   )
   c) The combined effect of the rotation of Earth and its orbit about the Sun (   )
   d) Earth year being a non-integer number of Earth days (   )
   e) The non-circular orbit of Earth around the Sun (   )

9) Our calendar has **leap years** because
   a) There is one more sidereal day in a year than solar days. (   )
   b) A tropical year is slightly more than 365 days. (   )
   c) There is a difference between a sidereal year and a tropical year. (   )
   d) The perihelion of Earth's orbit is slowly advancing. (   )

10) Based on our current Gregorian calendar, which of the following years is **not** a leap year?
    a) 2000 (   )
    b) 2004 (   )
    c) 2008 (   )
    d) 2012 (   )
    e) All of the above are leap years. (   )

11) The Sun is rising in the east and will be on your meridian in 2 hours. What time is it?
    a) 2 A.M. (   )
    b) 2 P.M. (   )
    c) 10 A.M (   )
    d) 10 P.M (   )
    e) Noon (   )

12) What is the hour angle of a star crossing your meridian?
    a) -6 hours (   )
    b) 0 hours (   )
    c) 6 hours (   )
    d) It depends on your latitude. (   )
    e) It depends on the right ascension of the star. (   )
13) The south celestial pole appears on your meridian at an altitude of 30° in the south. Where are you?

a) Latitude = 30°S ( )
b) Latitude = 60°S ( )
c) Latitude = 30°N ( )
d) Latitude = 60°N ( )
e) The South Pole ( )

14) Which of the following best describes the Tropic of Cancer?

a) It is any place where it is always very warm. ( )
b) It is another name for the equator. ( )
c) It is a place where the Sun appears to remain stationary in the sky. ( )
d) It is a place where the Sun is directly overhead at noon on the summer solstice. ( )
e) It is a place where the Sun is directly overhead at noon on the spring equinox. ( )

15) Suppose the date is March 21 and the Sun passes through your zenith at noon. Where are you?

a) The equator ( )
b) The Tropic of Cancer ( )
c) The Tropic of Capricorn ( )
d) The Arctic Circle ( )
e) The Antarctic Circle ( )

16) Suppose the date is March 21 and the Sun crosses your meridian at an altitude of 23.5° in the north. Where are you?

a) The equator ( )
b) The Tropic of Cancer ( )
c) The Tropic of Capricorn ( )
d) The Arctic Circle ( )
e) The Antarctic Circle ( )
17) Suppose the date is June 21 and the Sun never sets, just touching your northern horizon at midnight. Where are you?

a) The equator (   )
b) The Tropic of Cancer (   )
c) The Tropic of Capricorn (   )
d) The Arctic Circle (   )
e) The Antarctic Circle (   )

18) Which of the following explains why navigators a few hundred years ago found it much more difficult to determine their longitude than their latitude?

a) Determining longitude requires mathematical techniques that were not known at the time. (   )
b) Determining longitude without modern instruments requires being able to see the Moon. (   )
c) Determining longitude requires much more precise measurements of angles in the sky than does latitude. (   )
d) Determining longitude requires having an accurate clock. (   )

19) All the following are true. Which of the following gives evidence that Earth's orbit is not perfectly circular?

a) The Sun's angular size changes throughout the year. (   )
b) Earth's seasons are not of exactly equal length. (   )
c) In North America, it is hotter in July than January. (   )
d) Both A and C (   )
e) Both A and B (   )

Section A: True and false Questions

20) No matter where you live on Earth, except the poles, your meridian extends from due south on your horizon, through your zenith, to due north on your horizon.

a) TRUE (   )
b) FALSE (   )

21) Our calendar is based on the length of the tropical year rather than the sidereal year.

a) TRUE (   )
b) FALSE (   )
22) All directions are south from the North Pole.
   a) TRUE (   )
   b) FALSE (   )

23) The celestial coordinates of the Sun change from day to day.
   a) TRUE (   )
   b) FALSE (   )

24) No matter where you live on Earth, the Sun always rises and sets each day.
   a) TRUE (   )
   b) FALSE (   )

25) No matter where you live on Earth, the Sun is always directly overhead at noon.
   a) TRUE (   )
   b) FALSE (   )

26) On the equator, days and nights are always 12 hours long, no matter what time of year.
   a) TRUE (   )
   b) FALSE (   )

27) A year at the South Pole consists of 6 months of darkness and 6 months of daylight.
   a) TRUE (   )
   b) FALSE (   )
Appendix E: The post-test Arabic version

الاختبار البعدي للمجموعات أ، ب و ج
يرجى كتابة الرقم السري الخاص بك في هذا المربع:

تعليمات: هذا الاختبار لتقني معلوماتك في موضوع "مقدمة في علم الفلك و حساب الزمن" الرجاء الإجابة على جميع الأسئلة التالية. لديك 10 دقائق لقراءة الأسئلة، ثم لديك 30 دقيقة للإجابة على الأسئلة.

القسم (أ): الاجابة اختيار ووضع علامة (√) أمام الإجابة الصحيحة لكل سؤال من الأسئلة التالية:

القسم (أ) اختيار من متعدد

1. أي مما يلي هو السبب الذي يجعل اليوم الشمسي أطول من اليوم الفلكي؟
   (أ) الحركة البدارية لمحور الأرض
   (ب) ميل محور الأرض
   (ج) التأثير المشترك لدوران الأرض حول محورها ودورانها حول الشمس
   (د) السنة على الأرض لا تساوي رقم غير صحيح من أيام الأرض
   (ه) الأرض تتحرك حول الشمس حركة غير دائرية

2. يبلغ متوسط طول اليوم الشمسي:
   (أ) 23 ساعة و 56 دقيقة
   (ب) 24 ساعة
   (ج) 365.25 يوما
   (د) 12 عاما
   (ه) 26000 عاما

3. الشهر القمري أطول من الشهر الفلكي بسبب:
   (أ) القمر يكمل دورة من المراحل القمرية قبل أن يكمل دورة كاملة حول الأرض
   (ب) القمر يتم أكثر من دورة كاملة حول الأرض لكي يستطيع اكمال دورة من المراحل القمرية
   (ج) القمر يدور حول الأرض أسرع من دوران الأرض حول الشمس
   (د) القمر يدور حول الأرض أسرع من دوران الأرض حول نفسها
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(5) يعتمد الشهر القمري على دوران القمر، في حين يعتمد الشهر الفلكي على دوران الأرض.

4. ما هو الوقت الذي يمكن قراءته مباشرة من الساعة الشمسية؟

(أ) الوقت الشمسي الظاهري
(ب) متوسط الوقت الشمسي
(ج) الوقت الفلكي
(د) الوقت التوقيت الصيفي
(ه) الوقت الفلكي

5. جميع العبارات التالية صحيحة. أي من العبارات تفسر سبب اختلاف متوسط التوقيت الشمسي عن التوقيت الشمسي الظاهري؟

(أ) طول اليوم الشمسي ليس 24 ساعة بالضبط دائماً
(ب) زمن دوران الأرض في الواقع هو حوالي 23 ساعة و 56 دقيقة وليس 24 ساعة
(ج) محور الأرض يتغير (الحركة البدارية) في مدة 26000 سنة
(د) الشمس تمر بدائرة الزوال في أوقات مختلفة على خطوط طول مختلفة في نفس المنطقة الزمنية
(ه) مسار الشمس في السماء يعتمد على كل من دوائر العرض والتاريخ

6. أي مما يلي هو سبب السنة الكبيسة؟

(أ) الحركة البدارية لمحور الأرض
(ب) ميل محور الأرض
(ج) التأثير المشترك لدوران الأرض حول محورها ودورانها حول الشمس
(د) السنة على الأرض لا تساوي رقم غير صحيح من أيام الأرض
(ه) الأرض تتتحرك حول الشمس حركة غير دائرية

7. التقويم الميلادي يحتوي سنوات كبيسة بسبب:

(أ) أن عدد الأيام الفلكية في السنة أكثر بيوم واحد من الأيام الشمسية
(ب) السنة المدارية تكون أكثر بقليل من 365 يوماً
ج) هناك فرق بين السنة الفلكية والسنة المدارية

د) في منطقة الحضيض في مدرا الأرض تقل سرعة دوران الأرض

8. يظهر القطب السماوي الجنوبي على دائرة خط الطول الخاص بك على ارتفاع 30 درجة في الجنوب. أين أنت؟

أ) دائرة العرض = 30 درجة جنوبًا

ب) دائرة العرض = 60 درجة جنوبًا

ج) دائرة العرض = 30 درجة شمالًا

د) دائرة العرض = 60 درجة شمالًا

ه) القطب الجنوبي

9. أي من العبارات التالية تمثل أفضل وصف لمدار السرطان؟

أ) هو مكان يتميز بمناخ حار جدا دائمًا

ب) هو اسم آخر لخط الاستواء

ج) هو المكان الذي يظهر فيه الشمس ثابتة دائما في السماء

د) هو المكان الذي تكون الشمس في الظهر عمودية في يوم الاقطال الصيفي

ه) هو المكان الذي تكون الشمس في الظهر عمودية في يوم الاعتدال الربيعي

10. لنفترض أن التاريخ هو 21 مارس والشمس تمر خلال منطقة الذروة الخاص بك في الظهر. أين أنت؟

أ) خط الاستواء

ب) مدار السرطان

ج) مدار الجدي

د) الدائرة القطبية الشمالية

ه) الدائرة القطبية الجنوبي
11. لنفترض أن التاريخ هو 21 مارس والشمس تعبر دائرة خط الزوال الخاصة بك على ارتفاع 23.5 درجة في الشمال. أي رقم؟

أ) خط الاستواء
ب) مدار السرطان
ج) مدار الجدي
د) الدائرة القطبية الشمالية
ه) الدائرة القطبية الجنوبي

12. استنادا للتقويم الميلادي الحالي، أي من السنوات التالية ليست سنة كبيسة؟

أ) عام 2000
ب) عام 2004
ج) عام 2008
د) عام 2012
ه) جميع ما سبق هي سنوات كبيسة

13. أي مما يلي يفسر لماذا الملاحين قبل بضع مئات من السنين وجدوا أنه من الصعب جدا تحديد خط الطول مقارنة بتحديد دائرة العرض الخاصة بهم؟

أ) يتطلب تحديد خط الطول تقنيات رياضية و التي لم تكون معروفة في ذلك الوقت
ب) تحديد خطوط الطول من دون الآلات الحديثة يتطلب أن تكون قدرا على رؤية القمر
ج) يتطلب تحديد خط الطول قياسات دقيقة للزوايا في السماء أكثر مما يتطلب تحديد خط العرض
د) يتطلب تحديد خطوط الطول وجود ساعة دقيقة
14. الشمس ترتفع من الشرق وسوف تكون على دائرة خط الزوال الخاص بك خلال سعتين. ما هو الوقت الان؟

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<tr>
<td>ب</td>
<td>02:00 مساءا</td>
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<td>ج</td>
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<td>د</td>
<td>10:00 مساءا</td>
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<td>الظهر</td>
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15. ما هي زاوية الساعة لنجم يعبر دائرة خط الطول الخاص بك؟

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<td>ج</td>
<td>6 ساعات</td>
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<td>د</td>
<td>ذلك يعتمد على دائرة العرض الخاص بك</td>
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16. لنفترض أن التاريخ هو 21 يونيو والشمس لا تغرب ابدا بمجرد وصولها للأفق الشمالي الخاص بك عند منتصف الليل. أين أنت؟

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<td>ب</td>
<td>مدار السرطان</td>
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<td>ج</td>
<td>مدار الجدي</td>
<td>(   )</td>
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<tr>
<td>د</td>
<td>الدائرة القطبية الشمالية</td>
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<td>ه</td>
<td>الدائرة القطبية الجنوبية</td>
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17. كلاً من العبارات التالية صحيحة. أي مما يلي يعني دليلا على أن مدار الأرض ليس دائريا تماما؟

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<td>تغير حجم الشمس الزاوي على مدار السنة</td>
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<tr>
<td>ب</td>
<td>فصول الأرض ليست تماما بنفس الطول</td>
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<tr>
<td>ج</td>
<td>في أمريكا الشمالية، شهر 6 أكثر سخونة من شهر واحد</td>
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19. أي من العبارات التالية حول اليوم الشمسي و اليوم الفلكي غير صحيحة؟

أ) اليوم الشمسي اطول بـ 4 دقائق من اليوم الفلكي
ب) اليوم الشمسي عبارة عن أكثر من 360 درجة من دوران الأرض.
ج) اليوم الفلكي هو الوقت الذي يستغرقه نجم لعمل دورة واحدة في سمانتانا
د) اليوم الشمسي هو الوقت الذي تستغرقه الشمس لعمل دورة واحدة في سمانتانا
ه) اليوم الشمسي هو الوقت الذي يستغرقه القمر لعمل دورة واحدة في سمانتانا

القسم (ب): أسئلة الصواب والخطأ

القسم (ب): ضع علامة (√) أمام الإجابة الصحيحة و علامة (×) أمام الإجابة الخاطئة.

20. لا يهم أين تعيش على الأرض، باستثناء القطبين، خط الطول الخاص بك يمتد من اتجاه الجنوب خلال نقطة الذروة الخاصة بك في اتجاه الشمال على افقك. (√)
21. التقويم الميلادي يعتمد على طول السنة المدارية بدلاً من السنة النجمية. (×)
22. جميع الاتجاهات تكون جنوباً من القطب الشمالي. (√)
23. أحداثيات الشمس في الكرة السماوية تتغير من يوم إلى آخر. (×)
24. لا يهم أين تعيش على الأرض، الشمس دائما تشرق و تتغيب كل يوم. (√)
لا يهم أين تعيش على الأرض، الشمس تكون دائما عمودية في الظهيرة. (25)

على خط الاستواء، طول اليوم والليل يبلغ دائما 12 ساعة في أي وقت من السنة. (26)

تتكون السنة في القطب الجنوبي من 6 أشهر من النهار و 6 أشهر من الظلام. (27)
Appendix F: The post-test English version

Post-test for groups A, B and C
Instructions: This test is to assess your knowledge in the topic of “Introduction to the solar system and time measurement.” Please answer all questions in part A and Part B. You have 10 minutes to read the questions, then you have 30 minutes to answer the questions.

Please choice and tick (√) only one correct answer for each of the following questions.

Section A: Multiple Choice Questions

1) Which of the following explains why navigators a few hundred years ago found it much more difficult to determine their longitude than their latitude?
   a) Determining longitude requires mathematical techniques that were not known at the time. (   )
   b) Determining longitude without modern instruments requires being able to see the Moon. (   )
   c) Determining longitude requires much more precise measurements of angles in the sky than does latitude. (   )
   d) Determining longitude requires having an accurate clock. (   )

2) All the following are true. Which of the following gives evidence that Earth's orbit is not perfectly circular?
   a) The Sun's angular size changes throughout the year. (   )
   b) Earth's seasons are not of exactly equal length. (   )
   c) In North America, it is hotter in July than January. (   )
   d) Both A and C (   )
   e) Both A and B (   )

3) The amount of time between successive passes of any given star across the meridian is
   a) 23 hours 56 minutes. (   )
   b) 24 hours. (   )
   c) 365.25 days. (   )
   d) 12 years. (   )
   e) 26,000 years. (   )

4) Which of the following statements about sidereal and solar days is not true?
a) A solar day is 4 minutes longer than a sidereal day. ( )
b) A solar day represents more than 360° of rotation for Earth. ( )
c) The time it takes for a star to make one circuit of our sky is one sidereal day. ( )
d) The time it takes for the Sun to make one circuit of our sky is one solar day. ( )
e) The time it takes for the Moon to make one circuit of our sky is one solar day. ( )

5) Which of the following is the reason for the solar day being longer than a sidereal day?
   a) Precession of Earth's axis ( )
   b) The tilt of Earth's axis ( )
   c) The combined effect of the rotation of Earth and its orbit about the Sun. ( )
   d) Earth year being a non-integer number of Earth days ( )
   e) The non-circular orbit of Earth around the Sun ( )

6) The average length of a solar day is
   a) 23 hours 56 minutes. ( )
   b) 24 hours. ( )
   c) 365.25 days. ( )
   d) 12 years. ( )
   e) 26,000 years. ( )

7) The lunar month is longer than the sidereal month because
   a) The Moon completes the cycle of lunar phases before it completes a full orbit around Earth. ( )
   b) The Moon has to complete more than one full orbit around Earth to complete the cycle of lunar phases. ( )
   c) The Moon orbits Earth faster than Earth orbits the Sun. ( )
   d) The Moon orbits Earth faster than Earth rotates. ( )
   e) The lunar month is based on the Moon's orbit, while the sidereal month is based on Earth's orbit. ( )

8) What kind of time can be read directly from a sundial?
   a) Apparent solar time ( )
   b) Mean solar time ( )
   c) Standard time ( )
   d) Daylight saving time ( )
   e) Sidereal time ( )
9) All the following statements are true. Which one explains why mean solar time differs from apparent solar time?

a) The length of a solar day is not always exactly 24 hours. (   )
b) Earth's rotation period is actually about 23 hours 56 minutes, not 24 hours. (   )
c) Earth's axis processes with a period of 26,000 years. (   )
d) The Sun reaches the meridian at different times at different longitudes within the same time zone. (   )
e) The path of the Sun through the sky depends on both latitude and date. (   )

10) What is the hour angle of a star crossing your meridian?

a) -6 hours (   )
b) 0 hours (   )
c) 6 hours (   )
d) It depends on your latitude. (   )
e) It depends on the right ascension of the star. (   )

11) Which of the following best describes the Tropic of Cancer?

a) It is any place where it is always very warm. (   )
b) It is another name for the equator. (   )
c) It is a place where the Sun appears to remain stationary in the sky. (   )
d) It is a place where the Sun is directly overhead at noon on the summer solstice. (   )
e) It is a place where the Sun is directly overhead at noon on the spring equinox. (   )

12) Suppose the date is March 21 and the Sun passes through your zenith at noon. Where are you?

a) The equator (   )
b) The Tropic of Cancer (   )
c) The Tropic of Capricorn (   )
d) The Arctic Circle (   )
e) The Antarctic Circle (   )

13) Which of the following is the reason for the leap years?

a) Precession of Earth's axis (   )
b) The tilt of Earth's axis (   )
c) The combined effect of the rotation of Earth and its orbit about the Sun (   )
d) Earth year being a non-integer number of Earth days (   )
e) The non-circular orbit of Earth around the Sun (   )
14) Our calendar has *leap years* because

a) There is one more sidereal day in a year than solar days. (         )
b) A tropical year is slightly more than 365 days. (         )
c) There is a difference between a sidereal year and a tropical year. (         )
d) The perihelion of Earth's orbit is slowly advancing. (         )

15) Based on our current Gregorian calendar, which of the following years is *not* a leap year?

a) 2000 (         )
b) 2004 (         )
c) 2008 (         )
d) 2012 (         )
e) All of the above are leap years. (         )

16) The Sun is rising in the east and will be on your meridian in 2 hours. What time is it?

a) 2 A.M. (         )
b) 2 P.M. (         )
c) 10 A.M (         )
d) 10 P.M (         )
e) Noon (         )

17) Suppose the date is March 21 and the Sun crosses your meridian at an altitude of 23.5° in the north. Where are you?

a) The equator (         )
b) The Tropic of Cancer (         )
c) The Tropic of Capricorn (         )
d) The Arctic Circle (         )
e) The Antarctic Circle (         )

18) The south celestial pole appears on your meridian at an altitude of 30° in the south. Where are you?

a) Latitude = 30°S (         )
b) Latitude = 60°S (         )
c) Latitude = 30°N (         )
d) Latitude = 60°N (         )
e) The South Pole (         )
19) Suppose the date is June 21 and the Sun never sets, just touching your northern horizon at midnight. Where are you?

a) The equator (   )
b) The Tropic of Cancer (   )
c) The Tropic of Capricorn (   )
d) The Arctic Circle (   )
e) The Antarctic Circle (   )

Section A: True and false Questions

20) No matter where you live on Earth, except the poles, your meridian extends from due south on your horizon, through your zenith, to due north on your horizon.

a) TRUE (   )
b) FALSE (   )

21) Our calendar is based on the length of the tropical year rather than the sidereal year.

a) TRUE (   )
b) FALSE (   )

22) All directions are south from the North Pole.

a) TRUE (   )
b) FALSE (   )

23) The celestial coordinates of the Sun change from day to day.

a) TRUE (   )
b) FALSE (   )

24) No matter where you live on Earth, the Sun always rises and sets each day.

a) TRUE (   )
b) FALSE (   )
25) No matter where you live on Earth, the Sun is always directly overhead at noon.
   
   a) TRUE (   )
   b) FALSE (   )

26) On the equator, days and nights are always 12 hours long, no matter what time of year.
   
   a) TRUE (   )
   b) FALSE (   )

27) A year at the South Pole consists of 6 months of darkness and 6 months of daylight.
   
   a) TRUE (   )
   b) FALSE (   )
Appendix G: The final questionnaire Arabic version for Group A
عزيزي المشارك بالاستبيان

تم تصميم هذا الاستبيان لجمع المعلومات حول تجربتك مع نظام التعلم بالاشارات. ويكون هذا الاستبيان من خمسة أقسام:

أ. استخدام الكمبيوتر.

ب. فاعلية التعلم المدركة

ج. مستوى الرضا

د. الدافع الداخلي

د. مواصفات نظام التعلم بالاشارات

هذا الاستبيان جزء من متطلبات نيل شهادة الدكتوراه في مجال تقنية المعلومات من جامعة مردوخ، ويشمل كل من الدكتور/ كيفن ونق والدكتور/ لنس فونق.

نأمل منكم التكرم بالمشاركة في هذه الدراسة من خلال تعبئة الاستبيان المرفق، ونأمل أن لا تشغلك الإجابة عليه أكثر من 20 دقيقة. لذا، نحن ندعمك لإكمال الإجابة على هذا الاستبيان في الوقت المقدر من الحاجة لل بهذا الاستبيان.

إذا، في مدة الخدمة المطلقة في التوقف عن إكماله، نحن نقدر الحاجة بل ولا تجدر الإشارة هنا بأن هذا الاستبيان قد حصل على موافقة لجنة أخلاقيات البحث العلمي بجامعة مردوخ، ولن يتم وضع أي بيانات شخصية تدل على المشارك في أي جزء من أجزاء الاستبيان كما أضمن لك أن بياناتك الشخصية لن يتم نشرها في مخرجات هذه الدراسة بما فيها من النتائج. وسوف تحاول بسرية كاملة وحيد بحث لأحد سواي الباحث ومشرفك الإطلاع عليها.
يرجى كتابة الرقم السري الخاص بك في هذا المربع:

القسم A: استخدام الكمبيوتر

هذا القسم من الاستبيان يجمع بعض المعلومات عن استخدامك للكمبيوتر. الرجاء اختيار ووضع علامة (✓) إمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

1. هل لديك جهاز كمبيوتر في المنزل؟
   نعم □ لا □

2. أي من الخيارات التالية يصف معدل استخدامك للكمبيوتر في المنزل أو في الجامعة؟
   دائمًا □ كثيرًا □ احيانًا □ نادرا □ لا استخدمه

3. أي من الخيارات التالية يصف خبرتك في استخدام الكمبيوتر؟
   ليس لدي خبرة □ مبتدئ □ متوسط □ متقدم

4. أي من الخيارات التالية يصف استخداماتك للكمبيوتر في المنزل أو الجامعة؟ (يمكنك اختيار أكثر من إجابة)
   اللعب □ الإنترنت □ الطباعة ومعالجة النصوص □ التعلم والتدريب □ بريد الكتروني □ أخرى، يرجى ذكرها ...

5. هل تعرف أسلوب التعلم باستخدام نظام الإشارات قبل المشاركة في هذه الدراسة؟
   لم أكن أعرف شيئاً عن التعلم باستخدام نظام الإشارات □
   كان لدي بعض المعرفة عن أسلوب التعلم باستخدام نظام الإشارات □
   أنا أعرف كثيرًا عن أسلوب التعلم باستخدام نظام الإشارات □
   كنت لي بعض التجارب مع أسلوب التعلم باستخدام نظام الإشارات من قبل □

6. هل ترغب في استخدام أسلوب التعلم باستخدام نظام الإشارات في المستقبل؟
   نعم □ لا □

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القسم ب: فاعلية التعلم المدركة

هذا القسم من الاستبيان يجمع بعض المعلومات عن أدراكك للفاعلية التعليمية لنظام التعليم باستخدام الأشكال. الرجاء اختيار ووضع علامة √ أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملاحظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = أوافق، 5 = أوافق بشدة.

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<td>1. لقد أصبحت مهتماً أكثر بهذا الموضوع الدراسي</td>
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<td>2. لقد تعلمت قدرًا كبيرًا من المعلومات الحقيقية في هذا الموضوع الدراسي</td>
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<td>3. لقد فهمت جيد المفاهيم الأساسية لهذا الموضوع الدراسي</td>
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<td>4. لقد أصبحت لدي القدرة على تعريف الأفكار الرئيسية لهذا الموضوع الدراسي</td>
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<td>5. لقد أصبحت مهتمًا والدي حافز لمعرفة المزيد ومناقشة الموضوعات ذات الصلة بهذا الموضوع الدراسي</td>
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<td>6. لقد أصبحت قادرًا على تلخيص واستنتاج ما تعلمته من الأنشطة التعليمية كانت مفيدة</td>
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<td>7. اصبحت لدي القدرة لمناقشة هذا الموضوع الدراسي بشكل أوضح</td>
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<td>8. مهارتي في التفكير الناقد زادت</td>
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<td>9. تحسنت قدرتي على دمج الحقائق وتطوير فكرة عامة عن الموضوع من المواضيع من المواد الدراسية.</td>
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<td>10. لقد أصبحت أكثر ثقة في التعبير عن أفكاري</td>
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القسم ج: الرضا

هذا القسم من الاستبيان يجمع بعض المعلومات عن رضاك عن نظام التعلم باستخدام الاشارات. الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملاحظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = موافق، 5 = أوافق بشدة.

<table>
<thead>
<tr>
<th>الرضا</th>
<th>5</th>
<th>4</th>
<th>3</th>
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<tbody>
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<td>البند</td>
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</tr>
<tr>
<td>1</td>
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<td></td>
<td></td>
<td>√</td>
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<td>√</td>
</tr>
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<td></td>
<td>√</td>
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</tr>
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<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>√</td>
</tr>
</tbody>
</table>
القسم الثاني: الدافع للتعلم

هذا القسم من الاستبيان يجمع بعض المعلومات عن تأثير نظام التعليم باستخدام الإشارات على دافعيك الداخلي للتعلم.

الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملاحظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = موافق، 5 = أوافق بشدة.

<table>
<thead>
<tr>
<th>الدافع للتعلم</th>
<th>البند</th>
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<tr>
<td>الاهتمام / الاستمتاع</td>
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<tr>
<td>لقد استمتعت بتجربة التعليم باستخدام نظام التعليم باستخدام الإشارات</td>
<td>1</td>
</tr>
<tr>
<td>إذا اعتقد أن أسلوب التعليم باستخدام نظام الإشارات أسلوب تعليمي ممتع</td>
<td>2</td>
</tr>
<tr>
<td>إذا اعتقد أن أسلوب التعليم باستخدام نظام الإشارات أسلوب تعليمي ممل</td>
<td>3</td>
</tr>
<tr>
<td>إذا اعتقد أن أسلوب التعليم باستخدام نظام الإشارات لم يلفت انتباهي نهائيا</td>
<td>4</td>
</tr>
<tr>
<td>إذا اعتقد أن أسلوب التعليم باستخدام نظام الإشارات يمكن وصفه بال매ير للاهتمام</td>
<td>5</td>
</tr>
<tr>
<td>بينما كنت استخدام نظام التعليم باستخدام الإشارات كنت أفكر كم هو ممتع التعلم بهذا النظام</td>
<td>6</td>
</tr>
<tr>
<td>الكفاءة المعرفية</td>
<td></td>
</tr>
<tr>
<td>اعتقد أنني جيد جدا في استخدام نظام التعليم باستخدام الإشارات</td>
<td>7</td>
</tr>
<tr>
<td>اعتقد أنني جيد جدا في استخدام نظام التعليم باستخدام الإشارات مقارنة مع زملائي.</td>
<td>8</td>
</tr>
<tr>
<td>بعد تجربة النظام لفترة بسيطة شعرت أنني قادر على استخدامه بكفاءة</td>
<td>9</td>
</tr>
<tr>
<td>أنا راض عن أدائي في استخدام هذا النظام</td>
<td>10</td>
</tr>
<tr>
<td>بعد تجربة النظام اعتقد أنني لا أستطيع استخدامه بشكل جيد</td>
<td>11</td>
</tr>
<tr>
<td>القيمة / الفائدة</td>
<td></td>
</tr>
<tr>
<td>إذا اعتقد أن أسلوب التعليم باستخدام نظام الإشارات سيعود علي بعض الفوائد</td>
<td>12</td>
</tr>
<tr>
<td>إذا اعتقد أن أسلوب التعليم باستخدام نظام الإشارات مفيد جدا للتعلم</td>
<td>13</td>
</tr>
<tr>
<td>إذا استعد لمستخدم أسلوب التعليم باستخدام نظام الإشارات مرة أخرى لائي</td>
<td>14</td>
</tr>
</tbody>
</table>

الثقة، فإن هذا النظام مستورد منежية شرعي.
انا اعتقد ان اسلوب التعلم باستخدام نظام الاشارات سيساعدني لاتعلم أكثر

انا اعتقد أن اسلوب التعلم باستخدام نظام الاشارات سيعود بالنفع علي

انا اعتقد أن اسلوب التعلم باستخدام نظام الاشارات نظام تعليمي مهم.

الضغط / التوتر

لم أشعر بالتوتر نهائي عند استخدام نظام التعلم باستخدام الاشارات

لقد شعرت بالتوتر عند استخدام نظام التعلم باستخدام الاشارات

لقد كنت مرталحا جدا عند استخدام نظام التعلم باستخدام الاشارات

لقد كنت قلقا جدا عند استخدام نظام التعلم باستخدام الاشارات

القسم ج: مواصفات نظام التعلم باستخدام الاشارات

هذا القسم من الاستبيان يجمع بعض المعلومات عن تجربتك مع نظام التعلم باستخدام الاشارات. الرجاء اختيار وضع علامة (√) امام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملحوظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محيد، 4 = موافق، 5 = أوافق بشدة.

التفاعلية

ال Bronze المزدوج نظام التعليم باستخدام نظام الاشارات يخلق و يهئ  جو تفاعلي بين الطلاب و المعلم.

ال بند 1

ال لون المتباين نظام التعليم باستخدام نظام الاشارات يخلق و يهئ بيئة مناسبة للعمل الجماعي.

ال بند 2

ال تعدد الوسائط

ال Bronze المزدوج نظام التعليم باستخدام نظام الاشارات يعرض المواد التعليمية بطرق منوعة (صوت، صورة، فيديو).

ال بند 1

ال تعدد الوسائط

ال Bronze المزدوج نظام التعليم باستخدام نظام الاشارات يعرض المواد التعليمية بطرق منوعة مما يجعل المعلومات المعقدة اسهل للفهم.

ال بند 2

ال تعدد الوسائط

ال Bronze المزدوج نظام التعليم باستخدام نظام الاشارات يعرض المواد التعليمية بطرق عرض المواد التعليمية بطرق منوعة شد انتباهي و حفزني للتعلم أكثر.

ال بند 3
Appendix H: The final questionnaire Arabic version for Group B

الاستيبيان النهائي للمجموعة ب
عزيزي المشارك بالاستبيان

تم تصميم هذا الاستبيان لجمع المعلومات حول تجربتك مع التعلم باستخدام برنامج المحاكاة على الكمبيوتر. ويتكون هذا الاستبيان من ثلاثة أقسام:

أ. استخدام الكمبيوتر.

ب. فاعلية التعلم المدركة.

ج. مستوى الرضا.

عندما تبدأ المشاركة في هذه الدراسة من خلال تعبئة الاستبيان المرفق والذي نأمل أن تشملة إجابة عليه أكثر من 10 دقائق، فلديك الحرية المطلقة في تتوقف عن إكمال الإجابة في أي استبيان. إن برنامج الاستبان قد حصل على موافقة لجنة أخلاق البحث العلمي بجامعة مردوخ ولن يتم وضع أي بيانات شخصية تدل على المشارك في أي استبان منها. نأمل منكم التكرم بالمشاركة في هذه الدراسة من خلال تعبئة الاستبيان المرفق والذي نأمل أن تشمله إجابة عليه أكثر من 10 دقائق.

نأمل منكم التكرم بالمشاركة في هذه الدراسة من خلال تعبئة الاستبيان المرفق والذي نأمل أن تشمله إجابة عليه أكثر من 10 دقائق. فلديك الحرية المطلقة في تتوقف عن إكمال الإجابة في أي استبيان. إن برنامج الاستبان قد حصل على موافقة لجنة أخلاق البحث العلمي بجامعة مردوخ ولن يتم وضع أي بيانات شخصية تدل على المشارك في أي استبان منها. نأمل منكم التكرم بالمشاركة في هذه الدراسة من خلال تعبئة الاستبيان المرفق والذي نأمل أن تشمله إجابة عليه أكثر من 10 دقائق.
يرجى كتابة الرقم السري الخاص بك في هذا المربع:

القسم: استخدام الكمبيوتر

هذا القسم من الاستبيان يجمع بعض المعلومات عن استخدامك للكمبيوتر. الرجاء اختيار ووضع علامة (✓) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

1. هل لديك جهاز كمبيوتر في المنزل؟
   [ ] نعم  [ ] لا

2. أي من الخيارات التالية يصف معدل استخدامك للكمبيوتر في المنزل أو الجامعة؟
   [ ] دائمًا  [ ] كثيرًا  [ ] احيانًا  [ ] نادراً  [ ] لا استخدمه

3. أي من الخيارات التالية يصف خبرتك في استخدام الكمبيوتر؟
   [ ] ليس لدي خبرة  [ ] مبتدئ  [ ] متوسط  [ ] متقدم

4. أي من الخيارات التالية يصف استخداماتك للكمبيوتر في المنزل أو الجامعة؟ (يمكنك اختيار أكثر من إجابة)
   [ ] العاب  [ ] الإنترنت  [ ] طباعة ومعالجة النصوص  [ ] البريد الإلكتروني  [ ] التعلم والتدريب  [ ] أخرى، يرجى ذكرها .........
القسم ب: فاعلية التعلم المدركة

هذا القسم من الاستبيان يتميز بعض المعلومات عن فاعلية التعلم باستخدام البرامج الحكائية على الكمبيوتر.

الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملاحظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = أوافق، 5 = أوافق بشدة.

<table>
<thead>
<tr>
<th>البدن</th>
<th>فاعلية التعلم المدركة</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>لديه أكثر مهتماً بهذا الموضوع الدراسي</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>تعلم معلومات كبيرة من المعلومات الحقيقية في هذا الموضوع الدراسي</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>فهمت الجيد المفاهيم الأساسية لهذا الموضوع الدراسي</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>لدي القدرة على تعريف الأفكار الرئيسية لهذا الموضوع الدراسي</td>
<td></td>
</tr>
<tr>
<td></td>
<td>أصبحت مهتماً ولدي حافز لمعرفة المزيد ومناقشة الموضوع ذات الصلة بهذا الموضوع الدراسي</td>
<td></td>
</tr>
<tr>
<td></td>
<td>أصبحت قادرًا على تلبية واستنتاج ما تعلمت</td>
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</tr>
<tr>
<td>11</td>
<td>الأنشطة التعليمية كانت مفيدة</td>
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</tr>
<tr>
<td>10</td>
<td>أصبحت قادرًا على معرفة ومناقشة هذا الموضوع الدراسي بشكل أوضح</td>
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</tr>
<tr>
<td>9</td>
<td>مهارة في التفكير النقدي زادت</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>تحسنت قدرتي على دمج الحفاظ وتطوير فكرة عامة عن الموضوع</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>أصبحت قادرًا على تلبية واستنتاج ما تعلمت</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>القدرة على التنفيذ النشط زادت</td>
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</tr>
<tr>
<td>4</td>
<td>أصبحت قادرًا على نتيجة في التعبير عن أفكاري</td>
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</tr>
<tr>
<td>3</td>
<td>استمرار في التعلم المتكيف</td>
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</tr>
<tr>
<td>2</td>
<td>تحسنت قدرتي على دمج الحفاظ وتطوير فكرة عامة عن الموضوع</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>أصبحت قادرًا على تلبية واستنتاج ما تعلمت</td>
<td></td>
</tr>
</tbody>
</table>

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القسم ج: الرضا

هذا القسم من الاستبيان يجمع بعض المعلومات عن رضاك عن نظام التعلم باستخدام الاشارات. الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملحوظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = موافق، 5 = أوافق بشدة.

<table>
<thead>
<tr>
<th>الرقم</th>
<th>الرضا</th>
<th>البند</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>أنا راض عن هذه التجربة التعليمية</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>التعلم باستخدام برنامج المحاكاة على الكمبيوتر يقدم مجموعة متنوعة من المواد التعليمية</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>أنا لا أعتقد أن التعلم باستخدام برنامج المحاكاة على الكمبيوتر سيفيدني في تحقيق التعلم</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>أنا راض مع المعلومات الفورية التي اكتسبتها من خلال التعلم بهذا النظام</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>أنا راض عن أساليب التدريس في هذا النظام</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>أنا راض عن بيئة التعلم في هذا النظام</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>أنا راض بصورة عامة عن فاعلية التعلم بهذا النظام</td>
<td></td>
</tr>
</tbody>
</table>
Appendix I: The final questionnaire Arabic version for Group C
عزيزي المشارك بالاستبيان

تم تصميم هذا الاستبيان لجمع المعلومات حول تجاربك مع التعلم بالأسلوب التقليدي. يتكون هذا الاستبيان من ثلاثة أقسام:

أ. استخدام الكمبيوتر.

ب. فاعلية التعلم المدركة.

ج. مستوى الرضا.

هذا الاستبيان جزء من متطلبات نيل شهادة الدكتوراه في مجال تقنيات المعلومات من جامعة مردوخ. وبإشراف كل من الدكتور / كيفن ونق والدكتور / لنس فونق.

نأمل أن تكون المشاركة في هذه الدراسة من خلال تعبئة الاستبيان المرفق والذي نأمل أن تتم بشكل شامل على أكثر من 20 دقيقة. أما بالنسبة للمشارك في هذا الاستبيان، فإنها يجب أن تكون جزءًا من منظورك على إكمال الإجابة على هذا الاستبيان في التوقف عن إكمال الإجابة إذا كانت الحاجة ملحة لذلك. تجدر الإشارة هنا بأن هذا الاستبيان قد حصل على موافقة لجنة أخلاقيات البحث في جامعة مردوخ. ولن يتم وضع أي بيانات شخصية تدل على المشارك في أي جزء من أجزاء الاستبيان. كما اضمن لك أن بياناتك الشخصية ستكون جزءًا من مخرجات هذه الدراسة بما فيها من النتائج وسوف تحافظ بصورة كاملة ولن يعدين أحد سوى الباحث ومشرفين الاطلاع عليها.
القسم: استخدام الكمبيوتر

يرجى كتابة الرقم السري الخاص بك في هذا المربع: 

هذا القسم من الاستبيان يجمع بعض المعلومات عن استخدامكم للكمبيوتر. الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

1. هل لديك جهاز كمبيوتر في المنزل؟
   □ نعم □ لا

2. أي من الخيارات التالية يصف معدل استخدامكم للكمبيوتر في المنزل أو في الجامعة؟
   □ دائمًا □ كثيرًا □ احيانًا □ نادرا □ لا يستخدمه

3. أي من الخيارات التالية يصف خبرتك في استخدام الكمبيوتر؟
   □ ليس لدي خبرة □ مبتدئ □ متوسط □ متقدم

4. أي من الخيارات التالية يصف استخدامكم للكمبيوتر في المنزل أو الجامعة؟ (يمكنك اختيار أكثر من إجابة)
   □ العاب □ الإنترنت □ طباعة ومعالجة النصوص □ بريد الكتروني □ التعلم والتدريب □ أغراض أخرى، يرجى ذكرها: ...........................................
القسم ب: فاعلية التعلم المدركة

هذا القسم من الاستبيان يجمع بعض المعلومات عن ادراكك لفاعلية التعلم بالأسلوب التقليدي. الرجاء اختيار ووضع علامة (√) أمام إجابة واحدة فقط لكل سؤال من الأسئلة التالية:

ملاحظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = موافق، 5 = أوافق بشدة.

<table>
<thead>
<tr>
<th>البند</th>
<th>فاعلية التعلم المدركة</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>لقد أصبحت مهتماً أكثر بهذا الموضوع الدراسي</td>
</tr>
<tr>
<td>2</td>
<td>لقد تعلمت قدرًا كبيرًا من المعلومات الحقيقية في هذا الموضوع الدراسي</td>
</tr>
<tr>
<td>3</td>
<td>لقد فهمت جيد المفاهيم الأساسية لهذا الموضوع الدراسي</td>
</tr>
<tr>
<td>4</td>
<td>لقد أصبحت لدى القدرة على تعريف الأفكار الرئيسية لهذا الموضوع الدراسي</td>
</tr>
<tr>
<td>5</td>
<td>لقد أصبحت مهتمًا ولدي حافز لمعرفة المزيد ومناقشة الموضوعات ذات الصلة بهذا الموضوع الدراسي</td>
</tr>
<tr>
<td>6</td>
<td>لقد أصبحت قادراً على تلخيص واستنتاج ما تعلمت</td>
</tr>
<tr>
<td>7</td>
<td>الالنشطة التعليمية كانت مفيدة</td>
</tr>
<tr>
<td>8</td>
<td>أصبحت لدي القدرة لمناقشة هذا الموضوع الدراسي بشكل أوضح</td>
</tr>
<tr>
<td>9</td>
<td>مهارة في التفكير النقدي زادت</td>
</tr>
<tr>
<td>10</td>
<td>تحسنت قدرتي على دمج الحقائق وتطوير فكرة عامة عن الموضوع من المواد الدراسية</td>
</tr>
<tr>
<td>11</td>
<td>لقد أصبحت أكثر ثقة في التعبير عن أفكاري</td>
</tr>
</tbody>
</table>
القسم: الرضا

هذا القسم من الاستبيان يجمع بعض المعلومات عن رصاك عن التعلم بالأسلوب التقليدي. الرجاء اختيار ووضع علامة.

(√) ملاحظة: 1 = لا أوافق بشدة، 2 = لا أوافق، 3 = محايد، 4 = موافق، 5 = أوافق بشدة.

<table>
<thead>
<tr>
<th>الرضا</th>
<th>البند</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

1. أنا راض عن هذه التجربة التعليمية
2. التعلم باستخدام التعلم بالأسلوب التقليدي يقدم مجموعة متنوعة من المواد التعليمية.
3. أنا لا أعتقد التعلم بالأسلوب التقليدي سيفيدني في تحقيق التعلم.
4. أنا راض مع المعلومات الفورية التي اكتسبتها من خلال التعلم بالأسلوب التقليدي.
5. أنا راض عن أساليب التدريس في الأسلوب التقليدي.
6. أنا راض عن بيئة التعلم في التعلم في الأسلوب التقليدي.
7. أنا راض بصفة عامة عن فاعلية التعلم بالأسلوب التقليدي.
Appendix J: The final questionnaire English version for Group A (GBLS mode)

Final Questionnaire for Group A (GBL system)
Dear Participant:

This questionnaire has been designed to collect information about your experience with the GBL system. The information includes your experience with the GBL system, the effect of this learning environment on your intrinsic motivation and self, your satisfaction and your perception on learning. This questionnaire consists of five sections:

A. Computer usage

B. Perceived learning effectiveness

C. Satisfaction

D. Intrinsic motivation

E. GBL system’ features.

Completion of this questionnaire is entirely voluntary. Your participation in this questionnaire is totally anonymous and no personal details are being collected or used. You can change your mind, withdraw your consent, and stop participating at any time; but once your survey has been submitted it may not be possible to withdraw your participation. All information provided will be treated as confidential by the researcher and will not be released to a third party unless required to do so by law. All findings of this study may be published and that no information which can specifically identify you will be published.

If you have any questions about this study, please feel free to contact me (Moamer Shakroum, M.shakroum@murdoch.edu.au, Mobile: +614 51511631), or my supervisors (Associate Professor Dr Kevin Wong, k.wong@murdoch.edu.au, +618 93606100). If you wish to talk to an independent person about your concerns, you can contact Murdoch University’s Human Research Ethics Committee on +618 9360 6677 or email ethics@murdoch.edu.au.
Please write down your Secret Number (Randomly assigned number) in this Box: [ ]

**Section A: Computer usage**

This section of the questionnaire collects some information about your computer usage experience. Please select and tick (√) only one answer for each of the following questions.

1. Do you have a computer at home?
   - [ ] Yes
   - [ ] No

2. How often do you use computers at home or at school?
   - [ ] Always
   - [ ] Frequently
   - [ ] Sometimes
   - [ ] Seldom
   - [ ] Never

3. Which statement best describes your level of experience of using computer?
   - [ ] None
   - [ ] Beginner
   - [ ] Intermediate
   - [ ] Advanced

4. In what way, do you use computer at home or at university? (tick √ all appropriate answers)
   - [ ] Word processing
   - [ ] Drill-and-practice
   - [ ] Internet
   - [ ] Electronic mail
   - [ ] Games
   - [ ] Others, please specify: ------------

5. Did you know about “Gesture-Based Learning” before taking this lesson?
   - [ ] I knew nothing about Gesture-based Learning.
   - [ ] I had some knowledge about Gesture-Based Learning.
   - [ ] I had lots of knowledge about Gesture-Based Learning.
   - [ ] I had some experiences with Gesturebased Learning applications.

6. Would you like to use Gesture-Based Learning in the future?
   - [ ] Yes
   - [ ] No
### Section B: Perceived learning effectiveness

This section investigates your perception on learning with Gesture-Based learning system. Please select and tick (✓) **only one answer** for each of the following questions.

**Note:** 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

<table>
<thead>
<tr>
<th>Item</th>
<th>Perceived learning effectiveness</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I gained more interest in the topic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>I learned a great deal of factual information in this topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>I gained a good understanding of the basic concepts of the topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>I learned to identify the central issues of the topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>I was interested and stimulated to learn more and discuss related topics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>I was able to summarise and conclude what I learned</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>The learning activities were meaningful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>8</td>
<td>I developed the ability to communicate clearly about the subject.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>9</td>
<td>My skill in critical thinking was increased</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>10</td>
<td>I improved my ability to integrate facts and develop generalisation from the course material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>11</td>
<td>I gained more confident in expressing ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>
Section C: Satisfaction

This section investigates your satisfaction with Gesture-Based Learning system. Please select and tick (✓) only one answer for each of the following questions.

Note: 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

<table>
<thead>
<tr>
<th>Item</th>
<th>Satisfaction</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I was satisfied with this learning experience.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A wide variety of learning materials were provided in this GBL system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I don’t think that GBL system would benefit my learning achievement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I was satisfied with the immediate information gained over this GBL system.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5</td>
<td>I was satisfied with the instruction method in this GBL system</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I was satisfied with GBL learning environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>7</td>
<td>I was satisfied with the overall learning effectiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section C: Intrinsic motivation

This section investigates the influence of GBL system on your intrinsic motivation. Please select and tick (✓) *only one answer* for each of the following questions.

**Note:** 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

<table>
<thead>
<tr>
<th>NO</th>
<th>Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Interest/Enjoyment</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>I enjoyed learning using GBL system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>This GBL system was fun to use for learning.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I thought this was a boring learning system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>This GBL system did not hold my attention at all.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5</td>
<td>I would describe this GBL system as very interesting.</td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>6</td>
<td>While I was using this GBL system, I was thinking about how much I enjoyed it.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Perceived Competence</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I think I am pretty good at this GBL system</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>8</td>
<td>I think I did pretty well using GBL system compared to other learning methods.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>9</td>
<td>After trying this GBL system for a while, I felt pretty competent.</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>10</td>
<td>I am satisfied with my performance at this GBL system.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>This was a learning system I couldn’t use well.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Value/Usefulness</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>12</td>
<td>I believe this activity could be of some value to me.</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>13</td>
<td>I think that using GBL system is useful for learning.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>14</td>
<td>I would be willing to use GBL system again because it has some value to me.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
I think using this GBL system could help me to learn more.

I believe learning using GBL system could be beneficial to me.

I think this is an important learning system,

Pressure/Tension

I did not feel nervous at all while using GBL system.

I felt very tense while using GBL system

I was very relaxed in using GBL system.

I was anxious while working on the GBL system.

Section C: GBL system’ features

This section investigates your experience with the GBL system’s features. Please select and tick (✓) only one answer for each of the following questions.

Note: 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

<table>
<thead>
<tr>
<th>Item</th>
<th>Interactivity</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Gesture-Based learning system enables interactive communication between instructor and students</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>2</td>
<td>The Gesture-based learning system enables interactive communication among students.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>3</td>
<td>The communicational tools in the Gesture-based learning system are effective for group work.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>Item</td>
<td>Multimodality</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
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</tr>
<tr>
<td>5</td>
<td>The GBL system offers multimedia (audio, video, and text) types of learning material presentations.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>GBL presents learning a variety of presentation modes which makes complex information easier to comprehend.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The representation of learning material in various ways has attracted my attention and motivates me.</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Appendix K: The final questionnaire English version for Group B (CSL mode)

Final questionnaire for group B
Dear Participant:

This questionnaire has been designed to collect information about your experience with the Desktop simulation learning. The information includes the effect of this learning environment on your satisfaction and your perception on learning. This questionnaire consists three sections:

A. Computer usage.

B. Perceived learning effectiveness

C. Satisfaction

Completion of this questionnaire is entirely voluntary. You participation in this questionnaire is totally anonymous and no personal details are being collected or used. You can change your mind, withdraw your consent, and stop participating at any time; but once your survey has been submitted it may not be possible to withdraw your participation. All information provided will be treated as confidential by the researcher and will not be released to a third party unless required to do so by law. All findings of this study may be published and that no information which can specifically identify you will be published.

If you have any questions about this study, please feel free to contact me (Moamer Shakroum, M.shakroum@murdoch.edu.au, Mobile: +614 51511631), or my supervisors (Associate Professor Dr Kevin Wong, k.wong@murdoch.edu.au, +618 93606100). If you wish to talk to an independent person about your concerns, you can contact Murdoch University’s Human Research Ethics Committee on +618 9360 6677 or email ethics@murdoch.edu.au.
Please write down your Secret Number (Randomly assigned number) in this Box: 

Section A: Computer usage

This section of the questionnaire collects some information about your computer use and computer experience. Please select and tick (√) only one answer for each of the following questions.

1. Do you have a computer at home?
   - [ ] Yes
   - [ ] No

2. How often do you use computers at home or at school?
   - [ ] Always
   - [ ] Frequently
   - [ ] Sometimes
   - [ ] Seldom
   - [ ] Never

3. Which statement best describes your level of experience of using computer?
   - [ ] None
   - [ ] Beginner
   - [ ] Intermediate
   - [ ] Advanced

4. In what way do you use computer at home or at university? (tick √ all appropriate answers)
   - [ ] Word processing
   - [ ] Drill-and-practice
   - [ ] Internet
   - [ ] Electronic mail
   - [ ] Games
   - [ ] Others, please specify: ---------
Section B: Perceived learning effectiveness

This section investigates your perception on learning with Desktop simulation learning mode. Please select and tick (✓) only one answer for each of the following questions.

Note: 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

<table>
<thead>
<tr>
<th>Item</th>
<th>Perceived learning effectiveness</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I gained more interest in the topic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I learned a great deal of factual information in this topic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I gained a good understanding of the basic concepts of the topic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I learned to identify the central issues of the topic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I was interested and stimulated to learn more and discuss related topics</td>
<td></td>
<td></td>
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<tr>
<td>6</td>
<td>I was able to summarise and conclude what I learned</td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>7</td>
<td>The learning activities were meaningful</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>8</td>
<td>I developed the ability to communicate clearly about the subject</td>
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<td></td>
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<tr>
<td>9</td>
<td>My skill in critical thinking was increased</td>
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<td>I improved my ability to integrate facts and develop generalisation from the course material</td>
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<td>11</td>
<td>I gained more confident in expressing ideas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Section C: Satisfaction**

This section investigates your satisfaction with Desktop simulation learning mode. Please select and tick (✓) **only one answer** for each of the following questions.

**Note:** 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

<table>
<thead>
<tr>
<th>Item</th>
<th>Satisfaction</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I was satisfied with this learning experience.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A wide variety of learning materials were provided in this Desktop simulation learning mode.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I don’t think that Desktop simulation learning mode would benefit my learning achievement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I was satisfied with the immediate information gained over this Desktop simulation learning mode.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I was satisfied with the instruction method in Desktop simulation learning mode</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I was satisfied with Desktop simulation mode environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I was satisfied with the overall learning effectiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix L: The final questionnaire English version for Group C (Conventional Learning mode)

Final questionnaire for group C
Dear Participant:

This questionnaire has been designed to collect information about your experience with the Conventional learning mode. The information includes the effect of this learning environment on your satisfaction and your perception on learning. This questionnaire consists three sections:

A. Computer usage.

B. Perceived learning effectiveness

C. Satisfaction

Completion of this questionnaire is entirely voluntary. Your participation in this questionnaire is totally anonymous and no personal details are being collected or used. You can change your mind, withdraw your consent, and stop participating at any time; but once your survey has been submitted it may not be possible to withdraw your participation. All information provided will be treated as confidential by the researcher and will not be released to a third party unless required to do so by law. All findings of this study may be published and that no information which can specifically identify you will be published.

If you have any questions about this study, please feel free to contact me (Moamer Shakroum, M.shakroum@murdoch.edu.au, Mobile: +614 51511631), or my supervisors (Associate Professor Dr Kevin Wong, k.wong@murdoch.edu.au, +618 93606100). If you wish to talk to an independent person about your concerns, you can contact Murdoch University’s Human Research Ethics Committee on +618 9360 6677 or email ethics@murdoch.edu.au.
Section A: Computer usage

This section of the questionnaire collects some information about your computer use and computer experience. Please select and tick (√) only one answer for each of the following questions.

1. Do you have a computer at home?
   - Yes
   - No

2. How often do you use computers at home or at school?
   - Always
   - Frequently
   - Sometimes
   - Seldom
   - Never

3. Which statement best describes your level of experience of using computer?
   - None
   - Beginner
   - Intermediate
   - Advanced

4. In what way, do you use computer at home or at university? (tick √ all appropriate answers)
   - Word processing
   - Drill-and-practice
   - Internet
   - Electronic mail
   - Games
   - Others, please specify: ------------
### Section B: Perceived learning effectiveness

This section investigates your perception on learning with Conventional learning mode. Please select and tick (✓) **only one answer** for each of the following questions.

**Note:** 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree.

<table>
<thead>
<tr>
<th>Item</th>
<th>Perceived learning effectiveness</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I gained more interest in the topic</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>I learned a great deal of factual information in this topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I gained a good understanding of the basic concepts of the topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I learned to identify the central issues of the topic.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I was interested and stimulated to learn more and discuss related topics.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I was able to summarise and conclude what I learned.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The learning activities were meaningful.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>I developed the ability to communicate clearly about the subject.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>My skill in critical thinking was increased.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>I improved my ability to integrate facts and develop generalisation from the course material.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>I gained more confident in expressing ideas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Section C: Satisfaction

This section investigates your satisfaction with Conventional learning mode. Please select and tick (✓) **only one answer** for each of the following questions.

**Note:** 1= Strongly Disagree, 2=Disagree, 3=Neutral, 4=Agree, 5=Strongly Agree

<table>
<thead>
<tr>
<th>Item</th>
<th>Satisfaction</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I was satisfied with this learning experience.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>A wide variety of learning materials were provided in this Conventional Learning mode.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>I don’t think that Conventional Learning mode would benefit my learning achievement</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>I was satisfied with the immediate information gained over this Conventional Learning mode.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I was satisfied with the instruction method in Conventional Learning mode.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>I was satisfied with Conventional Learning environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>I was satisfied with the overall learning effectiveness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix M: Information Letter for student in English

Information Letter for student
Investigating the Effectiveness of Gesture Based Learning (GBL) System

**Researcher:** Moamer Shakroum

**Dear** students

You are invited to participate in this study.

**Background**

Research has shown that the Gesture-based systems have a great potential to be used in the classrooms in the next few years. A few studies have been conducted to investigate the effectiveness of using Gesture Based systems in learning. We are interested to further investigate the effectiveness of Gesture-based Learning (GBL) system. So we are inviting you to participate in this study over the next few weeks (from 1st of May 2015 to 15th of August 2015).

This study is part of my Doctor of Information Technology, supervised by Associate Professor Dr Kevin Wong and Associate Professor Dr Lance Fung at Murdoch University.

**Aim of the Study**

The main aim of this research is to investigate the effectiveness of the GBL system. We would like to know whether there are benefits to you from learning using GBL system.

**What Does Your Participation Involve?**

If you decide to participate in this study, you will be asked to participate in the following:

1. You will be randomly assigned to one of the three focus groups. These focus groups are differentiate by the three learning modes:

<table>
<thead>
<tr>
<th>Group</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Gesture-Based Learning (GBL) system</td>
</tr>
<tr>
<td>Group B</td>
<td>Desktop simulation learning mode</td>
</tr>
<tr>
<td>Group C</td>
<td>Conventional learning mode</td>
</tr>
</tbody>
</table>
2. All participants in the three groups will be asked to sit approximately 30 mins pre-test and complete the initial questionnaire which will take approximately 30 – 40 minutes.
3. All participants will be asked to undertake a lecture using one of the three learning modes based on the group that they assigned to, the lecture duration is 90 minutes.
4. After having received the treatment, all participants will be asked to sit a 30 mins post-test.
5. All participants in the three groups will be asked to complete the final questionnaire which will take approximately 20 minutes.
6. Breaks and refreshments will be supplied in between the sessions.
7. At the end of the experiment, all booklets will be gathered by the researcher and transferred to the place where the data will be analysed.

Voluntary Participation and Withdrawal from the Study

It is important that you understand that your involvement is this study is voluntary. While we would be pleased to have your participation, we respect your right to decline. There will be no consequences to you if you decide not to participate, and this will not affect your treatment / service. If you decide to discontinue participation at any time, you may do so without providing an explanation. If you withdraw, all information you have provided will be destroyed. Withdrawal requested will be permitted at any stage of the experiment before the post-test booklet and final questionnaire are returned. It is impossible to withdraw after this stage because there is no identity recorded against the post-test booklet and the final questionnaire.

Your privacy

Your privacy is very important to us. Your participation in this study and any information will be treated in a confidential manner. Your name and identifying details will not be used in any publication arising from the research. Following the study the data will be kept in an unidentified format, in a locked cabinet in the office of the Chief Investigator.
Possible Benefits

Despite the fact that there are no direct benefits to the participants, the participants will be gain indirect benefits as results of participating in this study such as:

- You will get a chance to engage in a new learning experience using different learning technologies.
- A summary of the final findings will be available on Murdoch university website after the data has been analysed. However, the link to the findings summary will be sent to you if requested.
- If we are able to take the findings of this small study and link them with a wider study, the result may be valuable information for others. It may lead of the effectiveness of GBL system and increase the possibility of implementing it in the future.
- We will be interested to see if you experience any other benefits from participating in this study.

Possible Risks

There are no specific risks anticipated with participating in this study. However, if you find that you are becoming distressed or experience any kind of discomfort, you will be advised to receive support from the researcher or alternatively, we will arrange for you to see a counselor at no expense to you.

Questions

If you would like to discuss any aspect of this study please feel free to contact either the researcher or his supervisor Associate professor Dr. Kevin Wong. Either of us would be happy to discuss any aspect of the research with you.

Once we have analysed the information from this study, If you have requested, we can send the summary of our findings to you. You can expect to receive this feedback in a year from completing the experiment.
We would like to thank you in advance for your assistance with this research project. We look forward to hearing from you soon.

If you are happy to participate in the study, please complete the attached consent letter and email it to the researcher at M.shakroum@murdoch.edu.au. If you are not willing to participate, you can dispose all materials.

Moamer Shakroum
Doctoral Candidate
School of Engineering and Information Technology
Phone: (+61) 451511631
Email M.shakrooma@murdoch.edu.au

Associate Professor Dr. Kevin Wong
Principal Supervisor
School of Engineering and Information Technology
Phone: (+61) 8 9360610
Email: K.wong@murdoch.edu.au

This study has been approved by the Murdoch University Human Research Ethics Committee (Approval xxx/xxx). If you have any reservation or complaint about the ethical conduct of this research, and wish to talk with an independent person, you may contact Murdoch University’s Research Ethics Office (Tel. 08 9360 6677 (for overseas studies, +61 8 9360 6677) or e-mail ethics@murdoch.edu.au). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.
Appendix N: The Consent Form for students in English

The Consent Form for students
1. I agree voluntarily to take part in this study.

2. I have read the Information Sheet provided and have been given a full explanation of the purpose of this study, the procedures involved and of what is expected of me.

3. I understand that I will be asked to support the researcher by:

   - I will be randomly assigned to one of the three focus groups. These focus groups are three learning modes:

<table>
<thead>
<tr>
<th>Group</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group A</td>
<td>Gesture-Based Learning (GBL) System</td>
</tr>
<tr>
<td>Group B</td>
<td>Desktop simulation learning Mode</td>
</tr>
<tr>
<td>Group C</td>
<td>Conventional Learning Mode</td>
</tr>
</tbody>
</table>

   - I will be asked to sit approximately 30 mins pre-test and complete the initial questionnaire which will take approximately 30 – 40 minutes.

   - I will be asked to undertake a lecture using one of the three learning modes based on the group that I have been assigned to, the lecture duration is 90 minutes.

   - After having received the treatment, I will be asked to sit a 30 mins pot-test.

   - I will be asked complete the final questionnaire which will take approximately 20 minutes.

4. The researcher has answered all my questions and has explained possible problems that may arise as a result of my participation in this study.

5. I understand I am free to withdraw from the study at any time without needing to give any reason.
6. I understand I will not be identified in any publication arising out of this study.
7. I understand that my name and identity will be stored separately from the data, and these are accessible only to the investigators. All data provided by me will be analysed anonymously using code numbers.
8. I understand that all information provided by me is treated as confidential and will not be released by the researcher to a third party unless required to do so by law.

Name of participant: __________________________

Signature of Participant: ___________ Date: ……/……/……

I confirm that I have provided the Information Letter concerning this study to the above participant; I have explained the study and have answered all questions asked of me.

Signature of researcher: __________________________ Date: ……/……/……

Please write down your email address if you are interested to receive the summary of final findings of this study (No individual results will be disclosed to anybody)

Your email address: __________________________

Or

Your postal address: __________________________
Appendix O: Information Letter for student in Arabic

معلومات عن الدراسة
الباحث: معمر علي أحمد شكروم
أعزائي الطلبة و الطالبات
السلام عليكم و رحمة الله وبركاته
خلفية الدراسة:
أظهرت الأبحاث أن أنظمة التحكم بالإشارة مثل جهاز (الكنكت) له إمكانات كبيرة يمكن تسخيرها واستعمالها في مجال التعليم في السنوات القليلة المقبلة. عدد قليل من الدراسات أجريت للتحقق من فعالية استخدام أنظمة التحكم بالإشارة في مجال التعليم. هذه الدراسة تأتي في ضوء هذا السياق للتحقق من فعالية استخدام أنظمة التحكم بالإشارة في الفصول الدراسية. لذلك نحن ندعوكم للمشاركة في تجربة علمية لجمع بيانات خاصة بهذه الدراسة والتي سوف تنطلق في الفترة ما بين 01-05-2015 إلى 15-08-2015.
هذه الدراسة هي جزء من متطلبات الحصول على درجة الدكتوراه في مجال تقنية المعلومات، التي يشرف عليها الأستاذ الدكتور كيفن ونغ والأستاذ الدكتور لانس فونغ من جامعة ميردوخ بغرب استراليا.
ما هي أهداف الدراسة؟
الهدف الرئيسي من هذا البحث هو دراسة فعالية استخدام أنظمة التحكم بالإشارة في التعليم من خلال تحديد مدى تأثير هذه الإمكانات على مستوى التحصيل الدراسي لطلاب السنة الأولى من المرحلة الجامعية. من خلال هذه الدراسة نود أن نعرف ما هي الفوائد الناتجة عن استخدام هذه أنظمة في الفصول الدراسية.
ما الذي يتضمنه مشاركتكم في الدراسة؟
إذا قررت المشاركة في هذه الدراسة، سوف يطلب منك الباحث ما يلي:
1. سيتم وировка عشوائياً في واحدة من ثلاث مجموعات تعليمية. هذه المجموعات هي عبارة عن ثلاث أنماط تعليمية مختلفة كالتالي:

<table>
<thead>
<tr>
<th>المدة الدراسة</th>
<th>النمط التعليمي</th>
<th>اسم المجموعة</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 دقيقة</td>
<td>التعلم باستخدام نظم الإشارة إلى الكمبيوتر</td>
<td>المجموعة A</td>
</tr>
<tr>
<td>90 دقيقة</td>
<td>التعلم باستخدام برامج المحاكاة على الكمبيوتر</td>
<td>المجموعة B</td>
</tr>
<tr>
<td>90 دقيقة</td>
<td>التعلم التقليدي</td>
<td>المجموعة C</td>
</tr>
</tbody>
</table>
2. سيطلب من جميع المشاركين في المجموعات الثلاثة اكمال الاختبار القبلي والذي سيستغرق حوالي 30 دقيقة و كمال الاستبيان الأول الذي سيستغرق حوالي 30 - 40 دقيقة.
3. سيطلب من جميع المشاركين في المجموعات الثلاثة اكمال الاختبار البعدي الذي سيستغرق حوالي 30 دقيقة.
4. بعد أن تلقى المحاضرة سيطلب من جميع المشاركين اكمال الاستبيان النهائي والذي سيستغرق حوالي 20 دقيقة.

200
سيتم منح المشاركين استراحة من حين الي اخر وستتم تقديم افطار للمشاركين.

ما هي طبيعة المشاركة في الدراسة؟

نود ان نحيطكم علمًا أن مشاركتكم في هذه الدراسة تطوعية واختيارية. سيكون من دواعي سرورنا قبولكم المشاركة ودعم هذه الدراسة ولكن في الوقت نفسه نحن نحترم حقكم في رفض المشاركة من دون أي طلب لشرح أسباب الرفض.

كيف سيتم التعامل مع خصوصيتك أثناء وبعد الدراسة؟

خصوصيتك مهمة جدا بالنسبة لنا. سيتم التعامل مع مشاركتكم في هذه الدراسة وأي معلومات تقدمها بطريقة سرية. لن يتم استخدام أسماء أو تفاصيل عن أي شخص في أي مطبوعة ناتجة عن هذه الدراسة. وبعد انتهاء الدراسة سيتم الاحتفاظ بكافة البيانات في شكل مشفر في خزانة مغلقة في مكتب المشرف الإداري (الدكتور كفن ونق).

ما هي الفوائد المحتملة من المشاركة في هذه الدراسة؟

ان مشاركتكم في هذه الدراسة قد ينتج عنها العديد من الفوائد للمؤسسة والعاملين بها، هذه الفوائد تشمل:

1. سوف يقوم الباحث بالاشادة بالمؤسسة التعليمية في الصفحات الأولى من اطروحته العلمية (الدكتوراه).

2. سوف يقوم الباحث بالاشادة بجهودكم في جميع المنشورات من أوراق علمية و مؤتمرات علمية.

3. سوف يقوم الباحث بالاشادة بجهودكم في جميع المنشورات من أوراق علمية و مؤتمرات علمية.

4. سوف يقوم الباحث بالتحكم في الحصول على ملخص نتائج الدراسة و نسخ من جميع الأوراق البحثية.

5. ان مساهمكم في انجاح هذه الدراسة سيكون له اثر طيب في المساهمة في التحقق من كفاءة استخدام هذه النظام التعليمي الجديد والذين بدوره قد يؤدي الى الرفع من مستوى التحصيل العلمي للطلاب من خلال استخدام هذه التقنية في الفصول الدراسية في المستقبل القريب.

هل يوجد مخاطر محتملة من المشاركة في هذه الدراسة؟

كباحث أود اعلامكم بأنه لا يوجد أي مخاطر محتملة قد تنتج من المشاركة في هذه الدراسة سواء للأشخاص أو للمؤسسة التعليمية. ومع ذلك، إذا كانت لديكم أي استفسارات أو مخاوف الرجاء الاتصال بالباحث (معمر شكورم) وسوف يقوم بالرد الشافٍ و السريع على جميع تساؤلائكم.
الاستفسارات و التساؤلات:

إذا كنت ترغب في مناقشة أي جانب من جوانب هذه الدراسة لا تتردد في الاتصال إما بالباحث (معمر شكروم)

الهاتف: 65 893602865 (61+) أو علي الهاتف المحول: 16116315451(61+)

البريد الإلكتروني: M.shakroum@murdoch.edu.au

أو يمكنك الاتصال بالمشرف الإكاديمي الدكتور كيفن ونغ على هاتف رقم: 6010 89360 (61+)

البريد الإلكتروني: K.wong@murdoch.edu.au

الباحث و المشرف سيكونان سعديان لمناقشة أي جانب من جوانب هذه الدراسة معك.

عندما ينتهي تحليل البيانات المجمعة من هذه الدراسة، سيقوم الباحث بارسال ملخص من نتائج الدراسة اليكم إذا طلبت ذلك. من المتوقع الانتهاء من تحليل النتائج في غضون سنة من إنجاز هذه التجربة العلمية.

و في الختام أمل أن تكون قد شملت لكم في هذه الرسالة أهداف الدراسة بشكل جيد. عليه، إذا كنت متفقين بالمشاركة ودعم هذه الدراسة نأمل منكم توقيع خطاب الموافقة الموقوف طي هذه الرسالة وارسله أو تسليمه إلي الباحث.

شكرًا لكم حسن تعاونكم ودعمكم للدراسة سلفا ونتطلع لاستلام ردكم قريبا.

و السلام عليكم ورحمة الله وبركاته

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Appendix P: The Consent Form for students in Arabic

خطاب موافقة علي المشاركة في الدراسة
1. أنا وأتفقت طوعاً على المشاركة في هذه الدراسة.

2. لقد قرأت رسالة معلومات الدراسة المقدمة من قبل الباحث وأعطيت شرحاً وافية عن العرض من هذه الدراسة والإجراءات وما هو متوقع مني في هذه الدراسة.

3. أنا أعرف جيداً أن الباحث سوف يطلب مني التالي:
   ً. سيطلب مني عشاننيا في واحدة من ثلاث مجموعات تعليمية. هذه المجموعات هي عبارة عن ثلاث امتدادات مختلفة:
   
<table>
<thead>
<tr>
<th>مدة المحاضرة</th>
<th>النمط التعليمي</th>
<th>الاسم المجموعة</th>
</tr>
</thead>
<tbody>
<tr>
<td>90 دقيقة</td>
<td>التعليم باستخدام نظام الإشارة</td>
<td>المجموعة أ</td>
</tr>
<tr>
<td>90 دقيقة</td>
<td>التعليم باستخدام برنامج المحاكاة على الكمبيوتر</td>
<td>المجموعة ب</td>
</tr>
<tr>
<td>90 دقيقة</td>
<td>التعليم التقليدي</td>
<td>المجموعة ج</td>
</tr>
</tbody>
</table>

   ج. سوف يطلب مني حضور محاضرة واحدة من الثلاث الامتدادات التعليمية أعلاه وذالك على حسب المجموعة التي وضعني فيها، ونسبة المحاضرة 90 دقيقة.

   خ. بعد تلقيي المحاضرة سوف يطلب مني اكمال الاختبار البعدي الذي سيستغرق حوالي 30 دقيقة.

   خ. سوف يطلب مني اكمال الاستبيان النهائي الذي سيستغرق حوالي 40 دقيقة.

4. أنا أعرف أنه سيتم تشغيل أسيما بشكل منفصل عن البيانات المجمعة، ولكن الباحث فقط يمكنه الاطلاع على اسمي. وسيتم تحليل جميع البيانات التي قدمتها بشكل منفصل باستخدام أرقام سرية.

5. أنا أعرف أنه لايتم تحديد هوائي في أي مطبوعة ناتجة عن هذه الدراسة.

6. أنا أعرف أنه لايتم تحديد هوائي في أي مطبوعة ناتجة عن هذه الدراسة.

7. أنا على دراية أنه سيتم تخزين اسمي بشكل منفصل عن البيانات المجمعة، ولكن الباحث فقط يمكنه الاطلاع على اسمي. وسيتم تحليل جميع البيانات التي قدمتها بشكل منفصل باستخدام أرقام سرية.

8. أنا على دراية أن جميع المعلومات التي قدمتها سيتم التعامل معها بسرية من قبل الباحث ولن يتم مشاركتها مع طرف ثالث إلا إذا طلب ذلك بموجب القانون.

اسم المشارك:-----------------------------------------------
توقيع المشارك:-----------------------------------------------
التاريخ:     /     / 2015
يرجى كتابة عنوان البريد الإلكتروني الخاص بك إذا كنت ترغب في تلقي ملخص النتائج النهائية لهذه الدراسة.

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أؤكد أنني قدمت خطاباً معلوماتاً عن الدراسة للمشارك أعلاه. وقد شرحت له أهداف الدراسة واجبت على كافة الأسئلة التي طرحها على.

توقيع الباحث:

التاريخ: / / 2015