Using Information Technology Techniques to Investigate and Develop Computing Teaching in Higher Education System (HE) in Libya.

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A thesis submitted in partial fulfilment of the requirements of Nottingham Trent University for the degree of Doctor of Philosophy

College of Science and Technology

Nottingham Trent University

2018

Abstract

This study investigated the development of the use of technology and pedagogy in computing education in the Libyan Higher Education System (LHES). A number of objectives guided this research: first, it explored teacher perceptions and understanding of using technology and pedagogy in the teaching process. Secondly, a new technological-pedagogical framework (Five-arrows framework) was developed. Further, the study investigated the effect of using different forms of information (visual - active information) in constructing the learning style instruments on the accuracy of measuring preferred learning styles. This study also developed the first Arabic Learning Style Instrument (ALSI). The instrument was used to develop an adaptive education system, which was used as an assisting system to support teachers in considering learner differences among students. The system was tested on three different courses.

In this research, 319 students, teachers and experts were involved, and mixed methods approach (quantitative and qualitative) was used. Learning style instruments, questionnaires, open-ended questions, documentary review and semi-structured interview methods were used to collect research data. Statistical data was analysed using the Statistical Package for the Social Sciences (SPSS). Pearson's Correlation, Chi-square and Paired T-Test were conducted to explore the association, dependency and difference of variables. In addition, Cronbach's Alpha, Content Validity Index (CVI), Classical Item Analysis (CIA), Test-Retest Reliability and Principal Component Analysis (PCA) were used to test the reliability and validity of instruments.

The statistical analysis revealed that the ALSI seems to be a suitable psychometric instrument to detect the learning style of Arab learners and cultures. The findings also revealed that the instrument content type has a significant effect on the accuracy of measuring preferred learning styles. No significant differences were found between males and females in terms of preferred learning styles. There was a significant positive correlation between the visual style and years of computer use. The results also showed that the dominant learning style of computer students in Libya is active/visual. The results also show that the performance of students who learnt using the adaptive system is significantly better than the achievement of other students who learnt the same educational content but without using the system. Thus, the study includes developing a new pedagogical framework (the Five-arrows framework), a learning style model and the first valid and reliable ALSI.

The study recommends conducting professional training sessions about use of technology and pedagogy in a teaching process in order to improve teacher understanding and attitudes towards using technology. There is also a need to consider the individual differences among the students and improve student awareness about their preferred learning style.

Copyright Statement

Acknowledgements

After sincerely thanking Allah for all blessings and bounties.

I would like to express my deepest gratitude to my supervisors: Dr. Steve Clark, Prof. Gren Ireson, and Prof Paul Evans, for whom any words are not enough to thank them.

A big “thank you” to my mother for her endless love, support and encouragement.

I would especially like to thank my wife and children for their support, encouragement, patience, love and standing by me during this journey.

Special thanks to all my family for their immeasurable support.

I would like to extend my deep thanks and gratitude to all of my colleagues and friends who support me during the journey of knowledge.

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Abbreviations

AEHS	Adaptive Educational Hypermedia Systems
AH	Adaptive Hypermedia
AHS	Adaptive Hypermedia Systems
ALE	Adaptive Learning Environment
ALSI	Arabic learning style instrument
CDT	Component Display Theory
CK	Content Knowledge
CM	Content Model
CVI	Content Validity Index
ET	Elaboration Theory
FCIT	Florida Centre for Instructional Technology
GSD	Gregorc Style Delineator
HE	Higher Education
ICT	Information and Communications Technologies
I-CVI	Item Content Validity Index
ILS	Index of Learning Style
IT	Information Technology
LAES	Libyan Adaptive Education System
LAMS	Learning Activity Management System
LHES	Libyan Higher Education System
LS	Learning Style
LSI	Learning Style Inventory
LSIs	Learning Style Instruments
MI	The theory of Multiple Intelligences
NTU	Nottingham Trent University
PCK	Pedagogical Content Knowledge
PEPS	Productivity Environmental Preference Survey
PK	Pedagogical Knowledge
PM	Pedagogical Model

S-CVI	Scale Content Validity Index
SPSS	Statistical Package for the Social Sciences
SST	School of Science and Technology
TCK	Technological Content Knowledge
TIM	Technology Integration Matrix
TK	Technological Knowledge
TPACK	Technological Pedagogical Content Knowledge
TPK	Technological Pedagogical Knowledge
TSM	Teaching Strategies Model
UM	User Model
PCA	Principal Component Analysis
MIDAS	Multiple Intelligence Developmental Assessment Scales
MISEI-R	Multiple Intelligences Self-Efficacy Inventory

Publications

The papers which resulted from this research and published in international conferences are listed below:

Published Papers:

- **Alzain, A.M.**, Clark, S. & Ireson, G, "Libyan Higher Education system, challenges and achievements", 6th International Conference on Engineering Education, ICEED-2014, Kuala Lumpur, Malaysia.

- **Alzain, A.M**., Clark, S., Ireson, G. & Jwaid, A., "A Study of the Reliability and Validity of the First Arabic Learning Styles Instrument (ALSI)", World Congress on Sustainable Technologies, WCST-2016, London, United Kingdom.

- **Alzain, A.M**., Ireson, G., Clark, S & Jwaid, A., "Learning Style Instruments and Impact of Content: A Qualitative Study", World Congress on Sustainable Technologies, WCST-2016, London, United Kingdom.

- **Alzain, A.M**., Clark, S., Ireson, G. & Jwaid, A., "LAES: An Adaptive Education System Based on Learners' Learning Styles", The 2nd International Conference on Knowledge Engineering and Applications, ICKEA 2017 , London, United Kingdom.

Under review

- **Alzain, A.M**., Clark, S., Ireson, G & Jwaid, A., "Adaptive education based on learning styles: are learning style instruments precise enough?", International Journal of Information and Learning Technology.

- **Alzain, A.M**., Ireson, G., Clark, S & Jwaid, A., "Learning style instruments: implications of content", International Journal of Sustainable Energy Development (IJSED).

In preparation

- **Jwaid, A.E**., Clark, S., Ireson, G & Alzain, A.M., A Study of the TPACK framework in Higher Education in a School of Science and Technology.

- **Jwaid A.E.**, Clark S., Ireson G & Alzain, A.M., "Novel framework for Teach Process Control Engineering by using The Concept of TPACK".

1. Chapter One: Introduction

1.1. Introduction

This chapter provides an overview of the basic information about the research and my motivation for the study including the learning style, adaptive education systems and the urgent need for more pedagogic research in technical subject areas. It will also present the significance of the study, and in turn, address the aims and objectives of the study, the research questions, the research hypotheses; and finally, explain in brief the research methodology and the structure of the PhD thesis.

1.2. Scope of the Study

This study was focused on exploring the situation of computing education in the Libyan Higher Education System (LHES) and more specifically, the technology and pedagogy in the teaching process, including teacher perceptions of using ICT in pedagogy, as explained in chapter 45.2. In particular, the study will seek to understand teacher attitudes towards using ICT in the teaching process, as well as the impact of age and teaching experience on the attitudes, perceptions and understanding of those teachers. This research is also focused on learning styles and how this can be incorporated into the learning environment in order to take into account the individual differences among learners. In addition, the study is also focused on adaptive education systems and how they can be employed to make learning easier for students, as well as improve the performance and engagement of students, and increasing the efficiency of learning.

1.3. Pedagogical Research: Concept, Need, and Aspects

"Pedagogy" is a term used to refer to the science of teaching (Simon, Moon 1994). More broadly, pedagogy refers to the study of learning, teaching, and assessment in an educational process, in different cultures and contexts (G. Brown, Edmunds 2011).

Although much pedagogical research has been carried out, especially in the developed countries, many researchers still think there is more work to be done in this field, especially in developing countries (Alzain, Clark et al. 2014). As a historical example, in 1981, Brian Simon published a paper entitled 'Why no pedagogy in England?' (Simon, Moon 1994). He claimed that education in England lacked a coherent and principled

pedagogy. In 2004, Robin Alexander revisited Brian Simon's 1981 judgment. Alexander stated that pedagogical research has progressed considerably since then (Alexander 2004). However, more research in pedagogy is continually needed for two main reasons: First, what is considered a good curriculum last year may not necessarily be a good curriculum this year. For instance, in the same context, the technology (used in education) that counted as a useful tool last year may not necessarily be worthwhile tool this year. What is classified as a successful course in one institution may be counted as an unsuccessful course in another institution where resources and qualifications are limited. Second, plenty of previous pedagogical research, whether 'old' or 'new', has not really incorporated into actual practice (G. Brown, Edmunds 2011).

Research in pedagogy could be conducted in different areas such as:

- Investigating existing practices of teaching and learning and developing new ones;
- Exploring existing methods of assessment and developing new ones;
- Applying existing techniques to a new practice;
- Conducting empirical studies that can enhance the practices of teaching and learning.

Such research is often performed using technology to achieve its aims, which are investigating and developing more effective methods of learning and teaching. This leads us to the following topic, which discusses the role of Information and Communication Technology (ICT), in education.

1.4. Information and Communication Technology (ICT) and Education

In recent years, ICT has been extensively used in processes of education. To date, many researchers have investigated the impact of ICT, including computers, internet, mobiles and tablets on student performance and engagement. Results of several studies report that integration of ICT into the educational process has made a significant contribution, and played an important role in enhancing the quality of education, particularly owing to ICT abilities to motivate the students and support the teachers (Zhang, Ordóñez de Pablos et al. 2012, Drigas, Ioannidou et al. 2014, Özyurt, Özyurt 2015, Sung, Chang et al. 2016, Gikas,

Grant 2013, Jalil, Beer et al. 2015, Crowther 2007, Crowther 2006). ICT could do that in several ways such as:

- Facilitating resource accessibility;
- Developing basic skills;
- Providing good training;
- Enhancing student interaction;
- Supporting teacher collaboration;
- Saving teaching time.

Haddad and Draxler list five different levels where the technology can be used in the process of education (Haddad, Draxler 2002):

- Presentation;
- Demonstration;
- Drill and practice;
- Interaction;
- Collaboration.

Many researchers mentioned that although technology generally has positive effects on education, it is arguable that it may also sometimes cause problems due to misuse. Therefore, many researchers state that using new technologies in teaching requires comprehensive knowledge (Jwaid 2016, Schacter 1999, Sahin 2011). Thus, education policies should consider training issues to ensure the correct use of technology. In this context, Meenakshi (2013) explains that the effectiveness of using ICT techniques in education completely relies on the purpose of using these techniques, and how the people are going to use it. He also explained that the reason behind that is "one technique does not fit everybody and everywhere" (Meenakshi 2013). Therefore, to overcome these problems, a novel pedagogical technological framework and adaptive educational system are developed in this thesis. Adaptive education systems have significant advantages and benefits not only for students but also for teachers and institutions. They improve the accessibility to the instructional resources, which corresponding students need and, they provide the teachers with a sound understanding about their students, and how they prefer to learn. Adaptive education systems also can help institutions and governments to solve problems that might arise from the increased number of students and shortage of qualified teachers as well as the lack of resources (Weller 2007).

1.5. Teaching and Learning Frameworks

Effective teaching requires the use of different types of knowledge including technological and pedagogical knowledge (Jwaid 2016). In order to get a clear insight into the available teaching and learning frameworks that can be used to improve computing education, in the literature, a number of teaching frameworks of integrated technology and pedagogy are discussed (see section 2.3).

Based on the literature review as well as investigating the current situation and practices in terms of computer education in LHES, a novel framework (the Five-arrows Framework) is developed to provide teachers and students with the most suitable content and technology that could be used to enhance student performance (see section 4.2).

1.6. Motivation of Study

This research brings together a number of different topics from two disciplines, which are computer science and pedagogy. Whilst adaptive hypermedia systems are considered one of the research topics in computer science, the learning style is considered one of the key research topics in pedagogy. In order to set the pace for the discussion, the researcher will begin with adaptive hypermedia systems, and then move to the second topic, which is learning styles.

1.6.1. Adaptive Hypermedia Systems (AHS)

Adaptive Hypermedia (AH) is a research field with a relatively short history beginning in the early 1990s (Brusilovsky 2001). Generally, the concept of AHS is centred on two main topics, which are adaptation and hypermedia. Hypermedia can be presented as a developed version of hypertext, which is defined as non-sequential chunks of text that are connected by links. Hypermedia extends the concept of hypertext by using not only text format but also other formats of media such as graphics, pictures, audio and video (N. Stash 2007). Therefore, hypermedia can be seen as non-sequential chunks of different formats of text and media, which are connected by links. Using these links, the users can move from one chunk to another in a controllable way. Therefore, this strategy can be harnessed to determine the system behaviour and represent the information in a suitable manner for each single user. This procedure is often called personalisation and it aims to overcome the problems that arise from the individual differences among users. These differences in

previous knowledge and preferences might make the same task easier for some users and more difficult for others. Therefore, to consider these differences, adaptive hypermedia systems have brought together hypermedia and user modelling (N. Stash 2007, Brusilovsky 2001, Brusilovsky 1998); this strategy allowed these systems to achieve the adaptation process.

In computer sciences, any system can be considered as an adaptive system if the system can adapt or change its behaviour including the content and activities for each individual type of user. Therefore, to achieve the adaptation process, the adaptive systems depend on some of the user aspects that are built up and are stored in a User Model (UM).

The educational generation of adaptive hypermedia systems is called Adaptive Educational Hypermedia System (AEHS). This generation was designed with the purpose of considering the individual differences among the learners, and how they prefer to receive and interact with the new information. This leads to the notion of learning styles.

1.6.2. Learning Styles

Research on education has indicated that students have different abilities and needs, and learn in different ways. For example, the students with visual preferences tend to gain more knowledge from the materials that depend on the visual forms of information, whereas the same material will be more useful for the learners with verbal preferences if these materials are represented using text and audio. Moreover, some students tend to learn more through ‘doing’, whereas others prefer to ‘think and reflect’ about these things. These preferences are called learning styles (Franzoni, Assar et al. 2008, Alshammari 2016, Alzain, Clark et al. 2016).

Although various definitions of learning style are provided by a number of researchers, there is no specific universal definition that has been determined. These various definitions are generally tackling the preferences of learners in terms of receiving new information and interacting with it (Truong 2016, Hawk, Shah 2007). See Chapter 2, section 2.4 for more detail on the concept of learning style.

Although it is arguable that the matching of teaching style with the student preferred learning style will improve the learning outcomes (Alzain et al. 2014, Felder, Spurlin 2005, Franzoni-Velázquez, Cervantes-Pérez et al. 2012, Franzoni et al. 2008, Miller 2005,

Thomas, Ratcliffe et al. 2002); it is quite clear that many researchers believe that students should know more details about their preferred learning styles because that will help them to be more attracted, engaged and motivated in educational sessions (Akasah, Alias 2010, Felder, Spurlin 2005, N. Fleming, Baume 2006, N. Othman, Amiruddin 2010, Truong 2016, Herod 2004, Alshammari 2016).

The learning style models and instruments have been extensively used in the adaptive education system in order to know how learners prefer to learn (Alzain, Ireson et al. 2016, Özyurt, Özyurt 2015, Truong 2016).

Integrating Learning Style into an Adaptive Education Systems

The concept of learning styles has been harnessed in most AEHS for the purpose of building up a knowledge about the students and how they prefer to learn (Truong 2016, Özyurt, Özyurt 2015, Graf, Liu et al. 2009, Liegle, Janicki 2006). This knowledge is usually collected throughout psychometric questionnaires called learning style instruments, and then used to adapt the content based on it (N. Stash 2007). Results of several studies reveal that integration of learning styles into the educational environment has had a positive effect on student performance (Özyurt, Özyurt et al. 2014, Shaw 2012, Truong 2016). However, in this research, the literature review reveals that the field of learning styles and adaptive education systems still needs further research and investigation; for example, in a recent study, Truong (2016) reviewed 51 related studies, which were published from 2004 to 2014, and reported that "*Nevertheless, even though there are several predictors that have been taken into account, none of the papers found in this review manages to compare the power of different attributes in predicting learning styles. The finding of such comparisons can play an important role in improving the performance and efficiency of different prediction and classification models*" (Truong 2016).

The literature review also revealed that none of the existing Learning Style Instruments, LSIs, were constructed using different forms of information. In other words, all of the existing LSIs were constructed using only one form of information, which is the "textual form", and this might be leading to a bias for a specific style of learners, as the textual form of information is more suitable, motivating and accessible to the students who have verbal preferences (Alzain et al. 2016). This situation encouraged the researcher to investigate the effect of using different formats of information (figures, charts, equations)

in constructing the instruments of learning styles, and investigating the effect of that on the accuracy, efficiency and effectiveness of these instruments. As a result, a new LSI was developed, using different forms of information with the purpose of solving problems that might arise from using only the textual form to build such instruments. For more details see subsection 4.4.2 and 5.3.

The literature review also reveals that very few studies have been conducted in the Arab region, and also revealed that there is no learning style instrument that has been written in the Arabic language, to be applied for Arab culture (Al-Jojo 2012, Abdelsalam 2013, Özyurt, Özyurt 2015, Alzain et al. 2016). This encouraged the researcher to design and develop the first reported Arabic Learning Style Instrument, ALSI, which will be integrated into the new adaptive educational system. The new system will be used, as an educational tool to assist the teachers and students by providing the instructional material and activities that match the needs of students, as covered in section 4.5.

1.7. Learning Style and Adaptive Educational Systems: A Need for Research

Although learning style was defined more than half a century ago, and a number of studies have been conducted during this period, many key issues are still under discussion (Graf 2007), some of these issues are explained in detail in subsections 2.4.3 and 2.4.4. Furthermore, integrating learning styles in adaptive educational systems to achieve the adaptation process is a ‘hot’ research area, which still requires more research (Truong 2016).

In terms of the Arab samples, the research on learning styles, and integrating it into adaptive education systems is not sufficient. See section 2.9 for more details. Moreover, there is no research concentrated specifically on designing and producing a new learning style instrument for Arab communities and culture (Alzain et al. 2016).

1.8. A Need for Pedagogical Research in the Libyan Higher Education System (LHES)

Higher Education (HE) systems in many developed countries have seen a significant amount of pedagogic research in technical subject areas (Granić, Mifsud et al. 2009), but in

Libya as well as many other Arab countries, this work is still in its infancy. A recent study conducted by Alzain, Clark and Ireson has indicated that there are many gaps in the knowledge base (Alzain et al. 2014), for example, the use of technology in teaching and learning as well as the training of academic staff (Tamtam, Gallagher et al. 2011, Rhema, Miliszewska et al. 2013).

As explained above in section 1.7, the learning style is one key pedagogical research area that still requires more research (Özyurt, Özyurt 2015, Truong 2016).In Libya as well as in most other Arab countries this work is also still in its infancy (Abdelsalam 2013, Al-Jojo 2012, Essaid El Bachari, El Hassan Abelwahed, El Adnani 2011). This situation encouraged the researcher to explore the impact of harnessing the learning style as well as adaptive education systems on student performance and engagement in LHES. Therefore, this research brings together two different topics from computer science and pedagogy disciplines, namely the adaptive education systems from the research topic of computer science, and learning styles which is one of the main research topics in pedagogy.

1.9. A Need for ICT and AES in the Libyan Higher Education System (LHES)

Like other states in the North of Africa and the Arab region, people in Libya consider ICT an integral part of their lifestyle (Elkaseh, Wong et al. 2016, Kenan, Pislaru et al. 2013, Swesi 2012). For example, in Libya, the number of internet users rapidly increased to 2.8 million (42.8 % of the population) by June 2016 from 954,275 in 2012 (Miniwatts). Therefore, this rapid increase in the use and importance of ICT encouraged officials to harness it in the education field, including discovering new ways of knowledge creation, presentation, delivery and management. Although these efforts started in the mid 1990s, this work is still in early stages because it has been conducted without proportionate changes in academic work practices as well as with a limited connection to skilled specialists in ICT (A. E. Elzawi 2015).

In recent research conducted in Libya, Rhema and Miliszewska stated that ICT can play a significant role in reconstructing the education system and improving its quality as well as developing student skills and performance (Rhema, Miliszewska 2012), especially as the students and teachers have a strong positive behavioural intention to use ICT in their teaching and learning (Swesi 2012).

More recently, Elzawi (2015) demonstrated that Libyan universities and institutes needed to improve the use of ICT in learning and teaching (A. E. Elzawi 2015). Many reasons have hastened the need for using ICT in LHES; these include the international standards and global technological changes, lack of resources and educational materials as well as the increasing numbers of students who enrol against a decreased number of qualified tutors.

1.10. Research Aims and Objectives

This research has two main aims, which are respectively: (1) investigating how to improve the learning process outcomes in terms of computer education in the Libyan Higher Education System; (2) investigating how to improve the efficiency and effectiveness of learning style instruments, and to produce the first learning style instrument for Arab communities. The sequence of theoretical and practical lessons of computing teaching and the pedagogical approaches may be processed to produce an efficient framework using the following objectives:

- Investigating the current literature in terms of best practice in computing teaching;
- Investigating the current literature in terms of learning style models and learning style instruments as well as adaptive education systems;
- Investigating the current practices in terms of computing teaching in LHES as well as teacher attitudes towards using technology in education;
- Designing a new technological pedagogical framework, based on the above;
- Designing a new learning style model and instrument, based on the above;
- Validating the new instrument;
- Investigating the preferred learning styles of computing students in LHES;
- Designing and programing a new adaptive education system based on the new instrument;
- Testing the new framework in case studies using the new adaptive system;
- Adapting the framework based on feedback;
- Producing recommendations for implementing the amended framework.

1.11. Research Questions

This research addresses the following questions:

1. What are teacher needs in terms of using technology and pedagogy in the teaching process?
2. What is the teacher perception about using technology in the education process?
3. What are the current practices in computing teaching in the LHES?
4. Is there any association between teacher age, experience and using technology and pedagogy in the education process?
5. How can we develop the first Arabic Learning Style Instrument, ALSI?
6. How can we validate the new ALSI?
7. What are the preferred learning styles of Libyan students?
8. Is there any difference between the preferred learning styles of Libyan students and the other students around the world?
9. To what extent are the existing learning style instruments precise in measuring the preferred learning styles of students?
10. To what extent are the use of visual and active content in instruments affecting measurement of the learning styles?
11. What is the impact of using the Libyan Adaptive Education System (LAES) on the performance of students?

1.12. Research Hypotheses

This research aims to improve the outcomes of computer education in LHES by investigating the current situation, and harnessing the technological pedagogical frameworks as well as ICT techniques. As a result of this, a new pedagogical framework, a new learning style model and a new adaptive education system are developed. However, the question remains as to whether the outcomes of this research positively affect the performance of the student. In order to get some insights into the outcomes of this

research, empirical experiments were conducted. Mainly, these experiments investigated the following:

1. The current situation of computing education in LHES including teaching strategies, pedagogical approaches as well as using technology in teaching processes;
2. The efficiency of existing LSIs: impact of using different forms of information (visual and active) for building these instruments, and impact of that on the accuracy of measurements;
3. Investigating the dominant learning styles of computing students in LHES compared with the results of similar studies around the world;
4. Impact of using the adaptive educational environment on the performance and engagement of students.

1.12.1. Hypotheses of Investigating the Current Situation of LHES

In this experiment, data was collected from 46 computer teaching staff members across 3 faculties from Misurata University and 2 higher education institutes (polytechnics) and an exploratory statistical analysis of this data was conducted in order to find out whether there was any statistical evidence to not rejecting any of the following hypotheses:

- Hypotheses 1:
  - **(H_0)**: there is no significant correlation between the years of teaching experience and using technology and pedagogy in education;
  - **(H_1)**: there is a significant correlation between the years of teaching experience and using technology and pedagogy in education;
- Hypotheses 2:
  - **(H_0)**: there is no significant correlation between the age of the teacher and using technology and pedagogy in education;
  - **(H_1)**: there is a significant correlation between the age of the teacher and using technology and pedagogy in education;
- Hypotheses 3:
  - **(H_0)**: there is no significant correlation between the years of teaching experience and teaching approach;

- **(H_1)**: there is a significant correlation between the years of teaching experience and teaching approach;

- Hypotheses 4:
  - **(H_0)**: there is no significant correlation between the age of the teacher and teaching approach.
  - **(H_1)**: there is a significant correlation between the age of the teacher and teaching approach.

The results of this section will be presented in detail in Chapter 5, in subsections 5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.2.7 and are mainly covered in (Alzain et al. 2014).

1.12.2. Hypotheses of Investigating the Impact of Using Visual and Active Forms of Information for Building the Instruments of Learning Styles, and Impact of that on the Accuracy of Measurement

In this experiment, data was collected from 50 students currently enrolled in three modules at Nottingham Trent University; out of the 50 students who agreed to engage, 10 were female and 40 male. 6 participants were studying at postgraduate level and the other 44 students were undergraduates. The data was analysed thoroughly to find out whether there was any statistical evidence to not reject any of the following hypotheses:

- Hypotheses 5:
  - **(H_0)**: constructing the instruments of learning style using the visual and active content will not impact the measuring of learning preferences;
  - **(H_1)**: constructing the instruments of learning style using the visual and active content will impact the measuring of learning preferences;
- Hypotheses 6:
  - **(H_0):** there is no significant differences in terms of learning style between males and females;
  - **(H_1):** there is significant differences in terms of learning style between males and females;

- Hypotheses 7:
    - **(H_0):** there is no significant correlation between learning styles and years of computer use;
    - **(H_1):** there is a significant correlation between learning styles and years of computer use;
- Hypotheses 8:
    - **(H_0):** there is no significant correlation between the dimensions of learning styles.
    - **(H_1):** there is a significant correlation between the dimensions of learning styles.

The results of this section will be presented in detail in Chapter 5, section 5.5, and partially covered in (Alzain et al. 2016)

1.12.3. Hypotheses of Investigating the Preferred Learning Style of Computing Students in LHES Compared with the Results of Similar Studies around the World

In this experiment, data was collected from 111 students enrolled at Misurata University in Libya, and out of the 111 students who agreed to engage, 81 were female and 30 male. Data was also collected from 50 students from Nottingham Trent University, and out of the 50 students, 10 were female and 40 male.

The data was analysed thoroughly, and the results were compared with the findings of similar studies to find out whether there was any evidence to not reject any of the following hypotheses:

- Hypotheses 9:
    - **(H_0):** there is no significant difference in terms of the preferred learning styles between the Libyan students and NTU students;
    - **(H_1):** there is a significant difference in terms of the preferred learning styles between the Libyan students and NTU students;
- Hypotheses 10:
    - **(H_0):** there is no significant difference in terms of the preferred learning styles between the Libyan students and Arab students;

- **(H_1):** there is a significant difference in terms of the preferred learning styles between the Libyan students and Arab students;

- Hypotheses 11:
  - **(H_0):** there is no significant difference in terms of the preferred learning styles between the Libyan students and overseas students.
  - **(H_1):** there is significant difference in terms of the preferred learning styles between the Libyan students and overseas students.

The results of this section will be presented in detail in Chapter 5, section 5.4.

1.12.4. Hypotheses of Applying the New Technological Pedagogical Framework Using the Adaptive System

40 students from the Faculty of Education and the Faculty of Information Technology at Misurata University participated in this study and and three experiments were conducted.

In order to explore whether there was any statistical evidence to not reject any of the following hypotheses, a thorough statistical analysis was conducted.

- Hypotheses 12:
  - **(H_0):** there is no significant difference in terms of the knowledge gained between students who learn using the new adaptive system and students who learn without it;
  - **(H_1):** there is a significant difference in terms of the knowledge gained between students who learn using the new adaptive system and students who learn without it;
- Hypotheses 13:
  - **(H_0):** there is no significant correlation between dimensions of learning style.
  - **(H_1):** there is a significant correlation between dimensions of learning style.

The results of this section will be presented in detail in Chapter 5, section 5.6, and partially covered in (Alzain, Clark et al. 2017).

1.13. Definitions of Concepts

Throughout the research, a number of key concepts have been used, and these concepts are defined below in order to help the readers to understand them and how they were used in the context of this research.

Learning Style (LS): The learning style was defined as "*The characteristic strengths and preferences in the ways individuals take in and process information*" (Hawk, Shah 2007).

Information and Communications Technology (ICT): This is defined as various groups of technological resources and materials that allow users to build, store, share, disseminate, store and manage information (Meenakshi 2013).

Adaptive Education Systems (AES): These systems are defined as educational systems that provide the users with the educational materials and activities that are especially adapted to their preferences, goals, experiences or knowledge of the subject (N. Stash 2007, Brusilovsky 2001, Brusilovsky 1998).

Canned Text (CT): Canned text was defined as a *"technique by which the designer of the system identifies keywords and explanations for these keywords at the time the product is being designed and implemented"* (Tomic, Horvat et al. 2012).

1.14. Research Methodology

Although the methodology that was employed in this research will be presented in detail in Chapter 3, in this section we will address this methodology within the context of the research questions and aims. The main stages of the research methodology will be as follows:

Stage 1:

- Exploring the literature and previous related work including technological pedagogical frameworks, learning style models, learning style instruments and adaptive education systems. See Chapter 2.

Stage 2:

- Investigating the current situation of the LHES in terms of using technology and pedagogy in education process, teacher attitudes towards using ICT in the education process and teacher needs and perceptions. For more details see Chapter 5 section 5.2;
- Designing a new pedagogical technological framework based on the above, this framework provides a clear idea regarding using technology in the educational process. See subsection 4.1 in Chapter 4.

Stage 3:

- Developing a new learning style model. See section 4.3 in Chapter 4;
- Developing the first Arabic learning style instrument. See section 4.4 in Chapter 4;
- Validating this instrument. See sections 5.3 and 5.3.2 in Chapter 5.

Stage 4:

- Developing a new adaptive education system using the new learning style instrument. See Chapter 4 section 4.5.

Stage 5:

- Applying the new pedagogical framework using the adaptive education system. See Chapter 5 section 5.6.

1.15. Research Summary

Table 1: Summary of Research.

	Research phases				
	Phase 1: Literature review	Phase 2: Investigating the current situation of Libyan higher education system	Phase 3: Developing a new learning style model and instrument	Phase 4: Developing a new adaptive education system	Phase 5: Implementing the new framework using the new adaptive education system
Aim	In order to get more insights and details about the research.	In order to get more insights and details about the teacher qualifications and to what extent they are familiar with using technology in the teaching process as well as the problems and challenges that they are facing.	Designing a new learning style model and learning style instrument which fit the needs of the study.	Developing new adaptive education systems, to use it later as an educational tool.	Investigating the results of applying the new pedagogical framework and impact of that on the performance of students.
Methodology	Exploring literature and previous related work including pedagogical technological frameworks, learning style models, learning style instruments and adaptive education systems and Libyan context	Exploring teacher perceptions and attitudes using questionnaires and conducting some statistical analysis including descriptive analysis, and variables correlation.	Developing the first Arabic learning style instrument based on the new learning model and investigating its reliability and validity.	Designing and developing new adaptive education system based on the new learning style instrument.	Comparing the learning outcomes and performance of students who learn using the adaptive system with the students who learn without it.
Results	- Acquiring new knowledge about this kind of research. - Getting a clear idea about the research environment.	Designing new pedagogical technological framework (based on phase 1 &2).	New learning style model as well as the first valid and reliable Arabic learning style instrument.	Adaptive education system.	Experimental evidence about adapting to the learning styles.

1.16. Structure of the Thesis

This thesis comprises of six chapters including this introduction (Chapter 1). The literature review (Chapter 2) attempts to provide a sound understanding regarding several key concepts including technological pedagogical frameworks, learning style models, learning style instruments and adaptive education systems. The methodology (Chapter 3) discusses the used methodology, research approaches and research design, and the chapter also provides a justification for chosen approaches and a description of experiment design. The following chapter (Chapter 4) discusses the initial development of a pedagogical technological framework, learning style model, learning style instrument and adaptive education system. Chapter 5 presents the results of a number of studies that investigated the current situation of Libyan Higher Education System, the reliability and validation of the first Arabic learning style instrument, investigating the preferred learning styles of Libyan students compared with the others in the Arab region and around the world, investigating the efficiency and effectiveness of the existing learning style instruments, as well as evaluating the impact of using adaptive education systems on the performance of student. The last chapter (Chapter 6) concludes this thesis by summarising the original outcomes and highlighting the implications, contribution and limitations of this research, in addition to discussing the possible avenues for future research.

2. Chapter Two: Literature Review

2.1. Introduction

The process of learning has been described as a process of acquiring new knowledge and interacting with this knowledge (Alshammari 2016, Jonassen 1991, Felder, Silverman 1988). Traditionally, this knowledge was delivered to the learners by instructors in classrooms. Nowadays, more and more techniques could be used to enhance and support the learning process. Technology has been considered one of the most important tools that can support the education process by offering greater potential and new learning environments (Zhang et al. 2012, Drigas et al. 2014, Rhema, Miliszewska 2010).

This thesis focuses on integrating a learning style instrument into adaptive education systems, and to harness these systems to assist and support the education process in order to enhance the outcomes of computing teaching, especially in the Libyan Higher Education System. This chapter will discuss these concepts and provide more details about the related literature.

First, an overview of the LHES will be provided including the use of technology and pedagogy in the education process as well as its challenges. Moreover, a number of well-known technological/pedagogical frameworks, learning style models and learning style instruments will be described. The chapter will also provide an idea about the adaptation methods and techniques. Finally, the chapter will conclude with similar studies and adaptive education systems.

2.2. Libyan Context

Education systems around the world have attracted researcher attention in the last few decades due to the need to improve the level of competence of educators. Yet, undoubtedly, education systems in most developing countries suffer from a lack of rigorous research, particularly in terms of integrating technology with instruction. For instance, "*teachers to be successful in their career, they need to develop themselves in pedagogy, technology, and their content areas, by using information and communication technologies*" (Sahin 2011).

Although Libya has a high literacy rate (Rhema, Miliszewska 2010), it is quite clear that its higher education system is still encountering many challenges (Tamtam et al. 2011, Rhema, Miliszewska 2010). Libya is one of the richest North African countries, with huge natural resources, yet Libyan officials have had problems in establishing a satisfactory education system. The Libyans widely agree that the decision makers, in terms of higher education, should adopt a clear policy to improve the level of education across the country (Alzain et al. 2014).

The education system in Libya consists of four levels. Firstly, children from 3 to 5 years may enrol in pre-school, which is an optional stage aimed at preparing children for school. Secondly, there is the basic education stage, which is compulsory and free, and lasts nine years from age 6 to 15. The third level is secondary education, which is three years long and prepares students for the subsequent higher education stage, comprising of university faculties and vocational institutes. The last stage involves advanced studies, and includes Masters and PhD degree courses. (Tamtam et al. 2011, Alzain et al. 2014). See Figure 1.

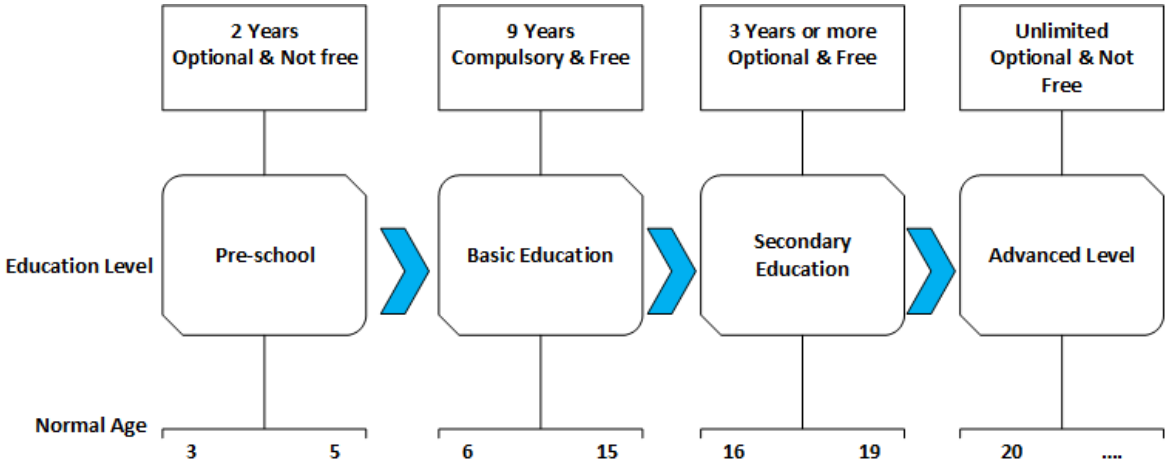

Figure 1: Structure of the Education System in Libya.

2.2.1. Using Technology in the Education Process in LHES

A well-developed infrastructure could support the process of education. However, according to Rhema and Miliszewska, not only the cultural and linguistic background of students and instructors, but also the undeveloped technological infrastructure, are the most important challenges that confront the use of technology in the teaching process in Libya (Rhema, Miliszewska 2010). However, to avoid the problems that might arise from the

misuse of technology in education, the researchers think that the teachers should acquire a comprehensive knowledge about the technology before they can use it in their teaching (Sahin 2011, Schacter 1999, Jwaid 2016). Thus, education policy should consider training issues to ensure the correct use of technology.

2.2.2. Staff Training in LHES

Although the Ministry of Higher Education in Libya has sponsored many academic staff members, sending them abroad to acquire the needed knowledge, it is clear that the academic staff of LHE still suffer from a lack of professional development and training (Tamtam et al. 2011).

According to Tamtam et al, a possible reason for the LHE deteriorating was a lack of training for academic staff (Tamtam et al. 2011). Therefore, professional training courses would be useful to teachers, because it would help them to keep pace with the ever-changing pedagogy and technology.

2.2.3. LHES and Relationship with other Sectors

In general, universities in developed countries have mutually-beneficial cooperation arrangements with many organisations, such as research centres and, private sector companies, and key players in the job market. This relationship could support all of them in achieving their aims. In 2011, Tamtam et al, indicated that the higher education administrators in Libya have not succeeded in establishing sufficient cooperation with these vital sectors, inside or outside the country (Tamtam et al. 2011).

2.2.4. Challenges of Libyan Higher Education System

Resources used in teaching are one of the most important factors that affect the success of the teaching process. The higher education system in Libya has faced a significant lack of resources, for many reasons, such as the country's wide geographical area, lack of qualified academic staff, annually increasing numbers of students (Tamtam et al. 2011), and recently, political instability. Therefore, it is clear that many researchers, including (A. Othman, Pislaru, Kenan, and Impes 2013a), (Rhema, Miliszewska 2010), (Jwaid, Clark et al. 2014), (Tamtam et al. 2011) and (Kenan, Pislaru 2012), have agreed that the LHES is facing the following challenges:

- The need to adopt a clear and common policy to improve the level of education in order to achieve the aims of the education process;
- The use of traditional methods for teaching and assessment that ignore student needs;
- The lack of adopting new strategies of human resources development;
- The isolated nature of the education system due to insufficient cooperation between universities and other vital sectors;
- The lack of material resources that support the success of the teaching process;
- The lack of long-term staff training plans.

2.2.5. Learning Style and Education Process in LHES

Students usually have different styles of learning due to the diversity of their abilities and needs, where some may prefer some approaches over others. Thus, Franzoni et al. think that, "*If the teaching style employed closely matches the student preferred style of acquiring knowledge, learning becomes easier and more natural, results improve and learning time is reduced*" (Franzoni et al. 2008). According to Othman et al, traditional teaching styles are still mainly applied in LHES for three reasons: increasing student numbers, lack of teaching staff training and lack of financial support (A. Othman et al. 2013a). Therefore, to improve teaching process outcomes, more developed teaching tools should be harnessed and these tools have to consider the individual differences between the students.

2.3. Technological/Pedagogical Frameworks

2.3.1. The Technological Pedagogical and Content Knowledge (TPACK)

In 2006, Mishra and Koehler developed the TPACK framework (Mishra, Koehler 2006) based on the concept of Pedagogical Content Knowledge of (Shulman 1986). The TPACK was described as a "*framework to understand and describe the kinds of knowledge needed by a teacher for effective pedagogical practice in a technology enhanced learning environment*" (Koehler, Mishra 2009, Jwaid et al. 2014). Therefore, the TPACK refers to the knowledge of teachers, which is used to integrate technology into the teaching process for all contents. As shown in Figure 2, the three basic domains of the TPACK framework

are technology, pedagogy and content. These domains overlap to form another four subdomains, namely Technological Pedagogical Knowledge (TPK), Technological Content Knowledge (TCK), Pedagogical Content Knowledge (PCK) and TPACK.

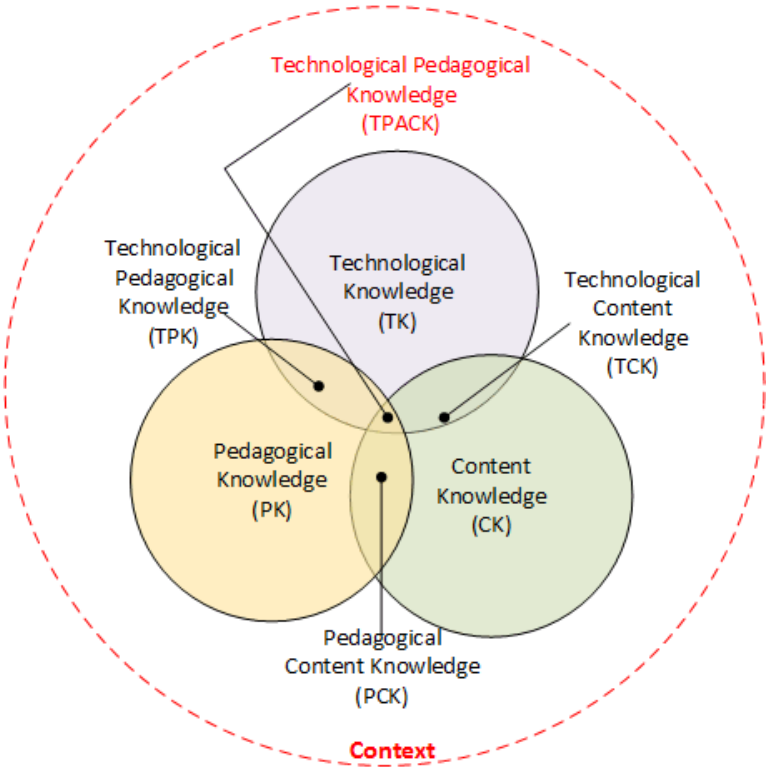

Figure 2: TPACK Framework (amended based on Archambault and Barnett, 2010).

2.3.2. The Technology Integration Matrix (TIM) Framework

TIM (Technology Integration Matrix) is a technological pedagogical framework produced by the Florida Centre for Instructional Technology (FCIT) in 2005/2006 to help the teachers of 'K-12' level in terms of using technology for enhancing learning. This framework is a two-dimension matrix, where the first dimension represents five levels of technology integration (entry, adoption, adaptation, infusion, and transformation), and the second dimension represents the characteristics of meaningful learning environments of these levels. The overlapping of the two dimensions produces a matrix of 25 cells (Harmes, Welsh et al. 2016). More details about the TIM are available at (Florida Centre for Instructional Technology, http://fcit.usf.edu/matrix/matrix.php , accessed 28/11/2016).

2.4. Learning Styles

In general, the concept of learning style is centred on two main topics, which are learning and style. The "learning" refers to the process of knowledge acquisition through receiving new information and interaction with it (Felder, Silverman 1988). "Style" refers to the manner or way in which people go about a certain issue. Consequently, the concept of style in the learning process indicates the fact that students differ in the way they receive new information and how they interact with that information (Sewall 1986). According to Felder, the learning style is defined as "*the characteristics, strengths and preference in the way people receive and process information*" (Felder 1996) (Franzoni-Velázquez et al. 2012).

2.4.1. Previous Learning Style Models

Over the last few decades, a number of learning style models and instruments have been developed. In this section, five well-known models are investigated for comparison purposes (Hawk, Shah 2007).

VARK Learning Style Model

The VARK (**V**isual, **A**ural, **R**ead and Write, **K**inesthetic) Model was extended from the VAK model by Neil Fleming in 2006 (N. Othman, Amiruddin 2010). Fleming introduces the learning style as "*an individual's characteristics and preferred ways of gathering, organizing, and thinking about information*" (N. D. Fleming 2006). Therefore, the VARK is a sensory model focused on the manner in which learners prefer to receive and deliver new knowledge. Figure 3 illustrates the VARK Model.

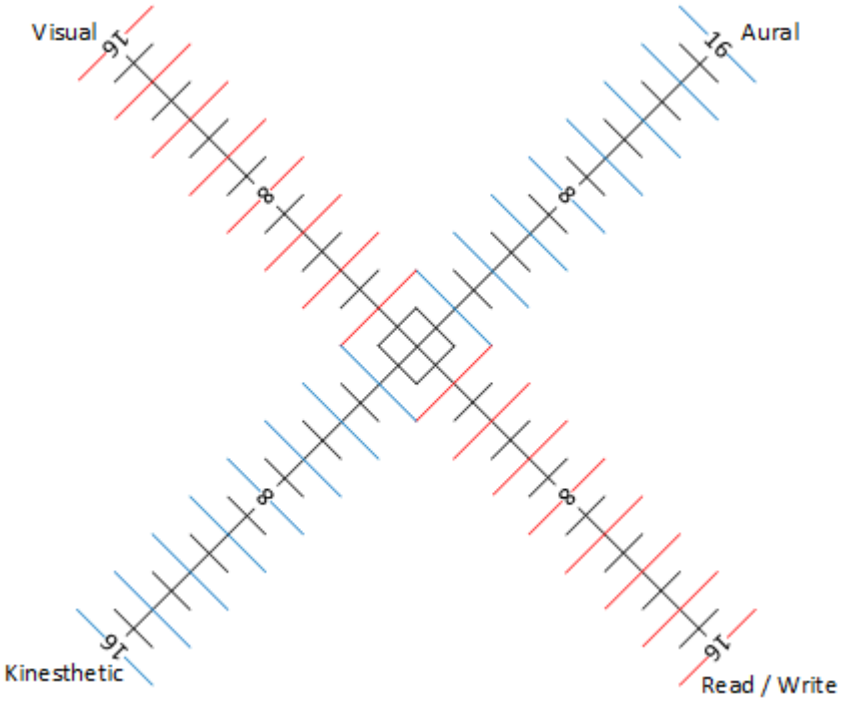

Figure 3: VARK Model (amended based on Fleming, 2006).

Based on the VARK model, learners could be classified as following (Hawk, Shah 2007, N. Othman, Amiruddin 2010):

- Visual: visual students respond strongly to visual resources, including charts, pictures, diagrams, maps, flow charts and highlighted text. They also prefer to draw things, maps and charts to deliver information to others.
- Aural: aural students get more from listening, discussion, chatting and records. They also prefer to talk to others and discuss with them to explain facts.
- Read and Write: these learners seem to be more comfortable with written resources so, they prefer textbooks and lecture notes.
- Kinesthetic: kinesthetic students tend to use practical resources such as exercises and case studies. They also prefer doing things to get information about it.

The VARK Questionnaire is available at (www.vark-learn.com). It includes sixteen questions, and for each question, there are four answers, which correspond to the tendencies in VARK Model (Visual, Verbal, Read/Write and Kinesthetic) and the participant needs to select one answer or more, which translates to his/her perception. Questions that do not apply could be ignored.

Felder–Silverman Learning and Teaching Style Model

The Felder–Silverman Learning and Teaching Style Model was developed by Felder and Silverman in 1988 and appears to be more applicable to the context of engineering education. It also proposes classifying teaching methods according to learning style poles by providing a parallel teaching style (Felder, Silverman 1988). This model introduced the learning style as "*the characteristic strengths and preferences in the ways individuals take in and process information*" (Hawk, Shah 2007). Figure 4 illustrates the Felder and Silverman Model.

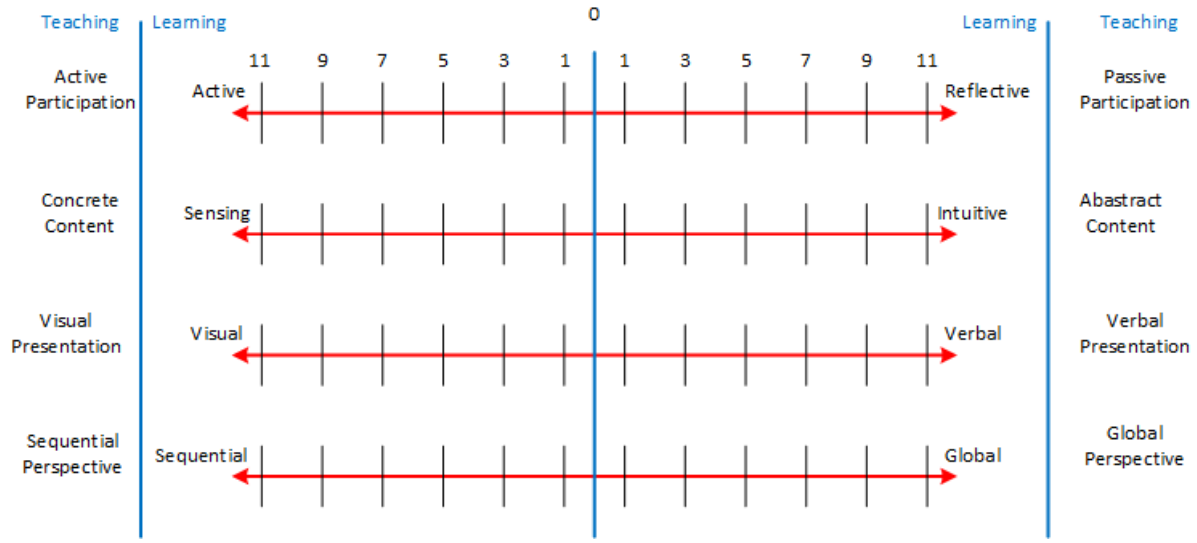

Figure 4: Felder – Silverman Model (amended based on Hawk, 2007).

The Felder–Silverman Model classifies the learners as follows (Felder, Silverman 1988, Franzoni et al. 2008):

- Sensing: sensors get more from facts and experimentation and they are more comfortable with detailed data.
- Intuitive: they respond strongly to theories, symbols, less detailed data and they are less patient with timed tests.
- Visual: visual learners prefer sight in receiving new information. Therefore, they get more from pictures, figures, charts... etc.
- Verbal: verbal learners prefer to receive new information verbally. Therefore, they get more from the discussion, records, chatting and reading.

- Active: active learners get more from practical lessons and practices, and they also prefer to work in groups.
- Reflective: reflective learners get more from theoretical lessons and they also prefer to work individually.
- Sequential: they prefer to learn in a sequential manner according to logically consecutive steps and they also prefer tackling the complexity in a steady progress.
- Global: global learners usually do not depend on a clear sequence in progressing because they are able to link and integrate ideas to form overall concepts.

The Index of Learning Style (ILS) is a web-based instrument available at (www.ncsu.edu/felder-public/ILSpage.html) and this questionnaire contains 44 questions covering the four basic dimensions of the model. Each of the 11 questions provides metrics for only one dimension and participants are allowed to choose only one answer for each question.

Kolb Experiential Learning Theory

The Kolb Experiential Learning Theory addresses experience as a source of learning and development. This theory considers learning as creating new knowledge through the transformation of experience and defines the learning style as "*generalized differences in learning orientation based on the degree to which people emphasize the four modes of the learning process*" (Kolb 2014).

As illustrated in Figure 5, Kolb represents the learning process in a cycle consisting of four modes. This cycle usually starts with Experience (CE), and respectively moves to Reflective Observation (RO), Abstract Conceptualization (AC) and then Active Experimentation (AE).

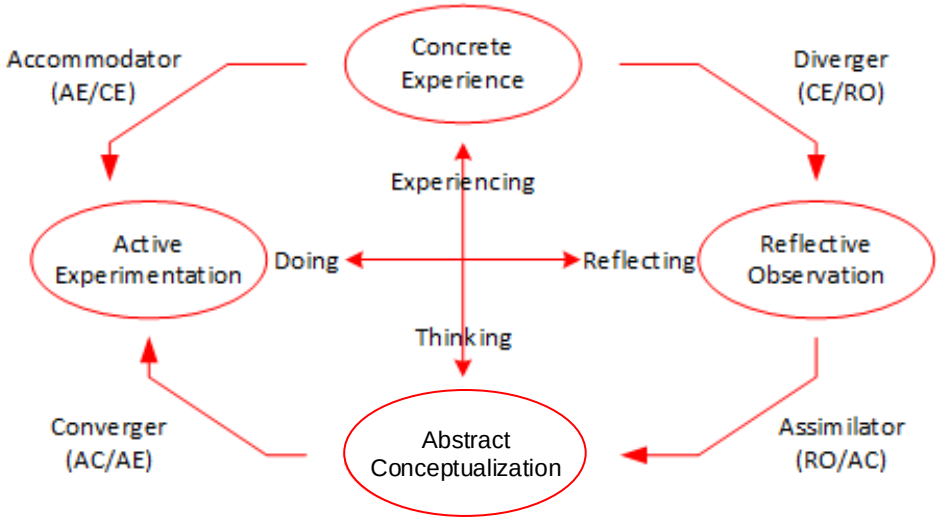

Figure 5: Kolb Experiential Learning Model (adapted from Kolb, 2014).

According to the Kolb model, there are four learning styles resulting from combining the preferences of adjacent poles in the experiential learning cycle (Hawk, Shah 2007), thus learners could be classified as follows (Hawk, Shah 2007, Kolb 2014):

- Divergers (combination of Concrete Experience (CE) and Reflective Observation (RO)): learners with this preference seem to be more imaginative, emotional and they prefer to work in groups.
- Assimilators (combination of Abstract Conceptualization (AC) and Reflective Observation (RO)): they have the ability to deal with a wide range of information, rearrange it logically and they seem to be more inductive.
- Convergers (combination of Abstract Conceptualization (AC) and Active Experimentation (AE)): convergers learning preference is more active, and learners who have this preference usually gain more knowledge from technical and practical tasks.
- Accommodators (combination of Concrete Experience (CE) and Active Experimentation (AE)): learners with this style usually depend on others to get information and tend to adopt an intuitive approach to solving problems rather than logical analysis.

The Learning Style Inventory (LSI) is an instrument designed by Kolb to help people with how to learn from experience. This instrument contains twelve items and participants have

to rank-order four alternatives, which correspond to the four learning styles (Hawk, Shah 2007); more details about the LSI are available at (learningfromexperience.com).

Gregorc Learning Style

The Gregorc Learning and Teaching Style Model was built based on phenomenological research. In other words, Gregorc argues that individuals have different mental qualities, which focus and interact with the things that are more appropriate to them, and these qualities are related to perception, ordering, processing and relationships (Hawk, Shah 2007).

Gregorc defines learning style as "*distinctive and observable behaviours that provide clues about the mediation abilities of individuals, how their minds relate to the world and, consequently, how they lear*n" (Gregorc 1979). Figure 6 illustrates the Gregorc Learning Style Model.

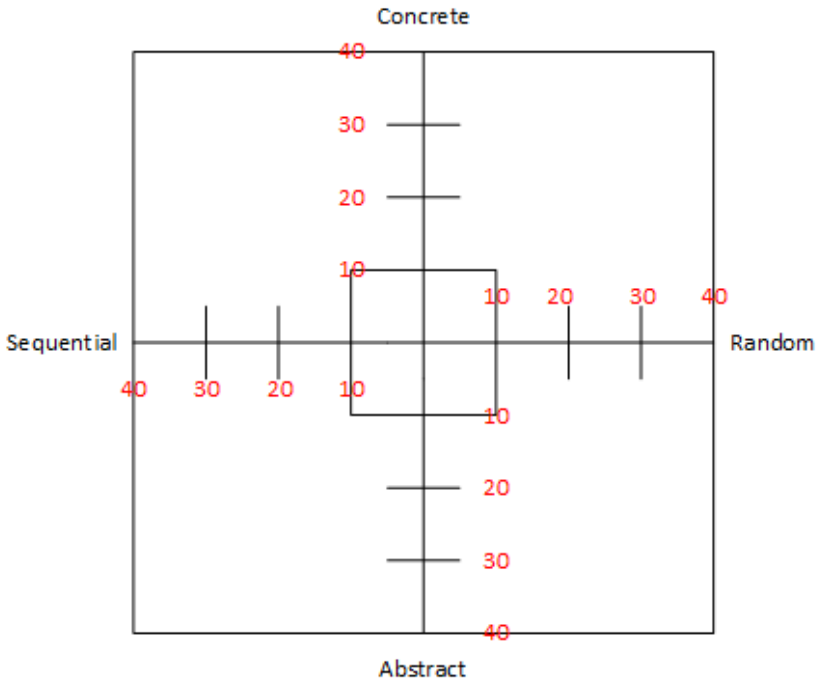

Figure 6: Gregorc Learning Model (amended from Hawk, 2007).

As illustrated in Figure 6, perception and ordering abilities have been presented by two orthogonal dimensions and combining adjacent abilities results in the following Learning Styles (Gregorc, Ward 1977):

- Abstract Sequential (AS): learners with this preference are able to obtain information from visual and verbal resources. They like the logical sequence of thinking and progress.
- Abstract Random (AR): this type of learner receives more from others behaviour, so they like to work in groups; they also like to address facts that are presented in an unstructured manner.
- Concrete Sequential (CS): people with this preference prefer concrete materials that are related to the real world and presented in linear sequential order.
- Concrete Random (CR): this type of learner is characterized by a strong ability to investigate unstructured problems by using concepts and experience. They seem to be active and intuitive learners.

The Gregorc Style Delineator (GSD) instrument provides metrics for an individual in each of the four previous learning styles, namely AS, AR, CS and CR. More details about this instrument are available at (www.gregorc.com).

Dunn – Dunn Learning Style Model

This model defines learning style as "*the way in which individuals begin to concentrate on, process, internalize, retain new and difficult information*" (Dunn 1990). Dunn and Dunn claim that the learning style contains five dimensions, which are an Environmental dimension, an Emotional dimension, a Sociological dimension, a Physiological dimension and a Psychological dimension. These dimensions involve a number of supportive factors within each of them. Figure 7 represents the Dunn and Dunn Model.

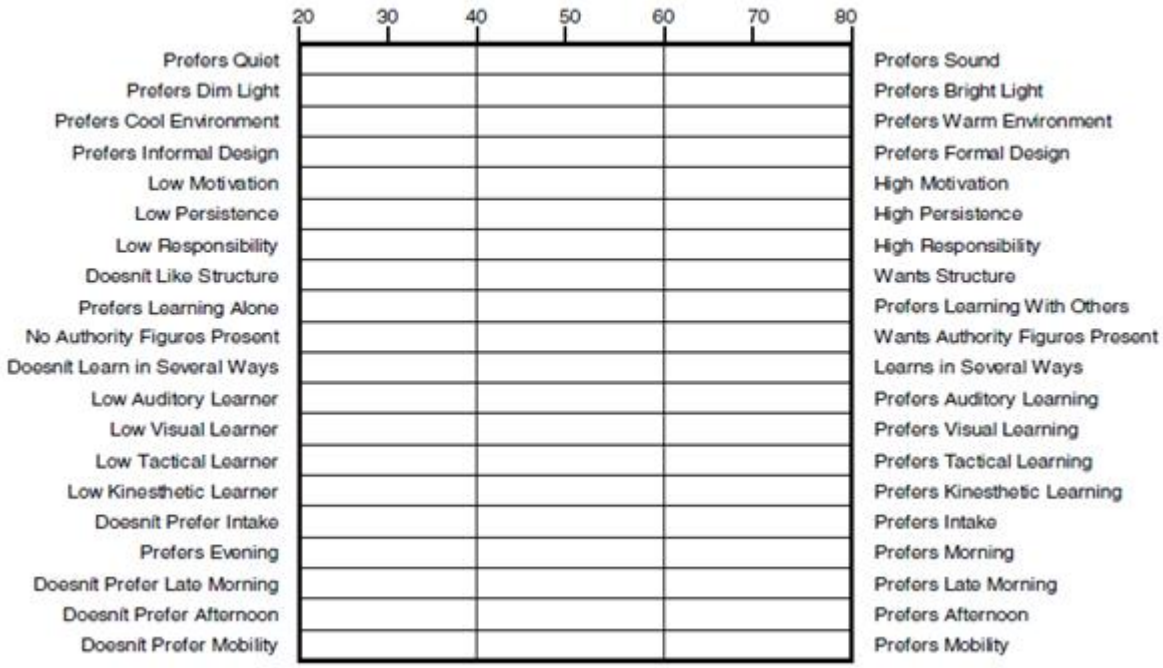

Figure 7: Dunn and Dunn Learning Model (adapted from Hawk, 2007).

Dunn and Dunn designed the learning styles questionnaire as an instrument to determine the preferred learning style of children. However, this instrument was extended to produce a learning style inventory, which was presented in three versions. The adult's version is called Productivity Environmental Preference Survey (PEPS) (Riding, Rayner 2013).

The (PEPS) helps students to know how they learn best, by providing metrics to student preferences in terms of Environmental, Emotional, Sociological, Physiological and Psychological dimensions. Each dimension includes a number of factors. For example, the environmental dimension considers noise, temperature and light.

Gardner's Theory of Multiple Intelligences

In 1983, Howard Gardner introduced his theory that investigated the distinction of human abilities. Howard defined intelligence as "*a bio-psychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture*" (Gouws 2007).

The theory of Multiple Intelligences (MI) depends on two basic principles which are: first, individuals have unique and different abilities, strengths and weaknesses in terms of

intelligence; second, no single person can understand everything. Therefore, according to this theory, there are eight intelligences (Hernández-Torrano, Ferrándiz et al. 2013):

- Verbal-linguistic intelligence, using words effectively.
- Logical-mathematical intelligence, dealing with numbers efficiently.
- Musical intelligence, interacting with sound smartly.
- Spatial intelligence, prefer pictures, images and shapes.
- Naturalistic intelligence, observing patterns of the natural world smartly.
- Bodily-kinaesthetic intelligence, using the body in a distinct way.
- Interpersonal intelligence, dealing with people effectively.
- Intrapersonal intelligence, good in self-knowledge and self-management.

Torrano et al. think traditional psychometric instruments or questionnaires can assess only a small part of individual abilities. As measuring the abilities depends on differentiated aspects of intelligence, these aspects should cover any area in which the individuals can show their strengths (Hernández-Torrano et al. 2013); however, a number of self-report intelligence instruments were built based on MI theory, such as Multiple Intelligence Developmental Assessment Scales (MIDAS), Student Multiple Intelligence Profile(SMIP) (Chan 2001, Chan 2003) , and Multiple Intelligences Self-Efficacy Inventory (MISEI-R) (Perez, Cupani 2008).

2.4.2. Summary of Learning Style Comparisons

The similarities and differences amongst learning style models are highlighted in Table 2.

Table 2: Differences and Similarities of Learning Styles.

Model	Definition of Learning Style	Number of dimensions	Joint-dimensions	Instrument	Availability	Content	Instrument mechanism
VARK	"*An individual's characteristics and preferred ways of gathering, organizing, and thinking about information*" (Hawk, Shah 2007)	2	2	VARK Questionnaire	Free	Textual information	Select one or more answer from the four alternatives
Felder–Silverman	"*The characteristic strengths and preferences in the ways individuals take in and process information*" (Hawk, Shah 2007)	5	3	Index of Learning Style (ISL)	Free	Textual information	Select only one answer from two alternatives
Kolb	"*Generalized differences in learning orientation based on the degree to which people emphasize the four modes of the learning process*" (Kolb 2014)	2	2	Learning Style I inventory (LSI)	Not free	Textual information	Rank-order set of items
Gregorc	"*Distinctive and observable behaviours that provide clues about the mediation abilities of individuals and how their minds relate to the world and, therefore, how they learn*" (Gregorc 1979)	4	2	Gregorc Style Delineator (GSD)	Not free	Textual information	Rank-order set of items
Dunn-Dunn	"*The way in which individuals begin to concentrate on, process, internalize, and retain new and difficult information*" (Dunn 1990)	5	2	Productivity Environmental Preference Survey (PEPS)	Not free	Textual information	Likert-type scale

Before providing some insights into the new learning style model (See Chapter 4, section 4.3), it is necessary for a number of important points to be noted:

- **Content of existing instruments**:
  - ✓ All of the existing learning style instruments were built using only the textual form of information, which is considered more accessible to verbal learners than others (Alzain et al. 2016). Consequently, these instruments might be more suitable and motivating for the verbal type of students than others. Therefore, more investigation will be presented in Chapter 5, section 5.5;
- **Mechanism of instruments:**
  - ✓ Selecting only one answer from a set of alternatives, which correspond to different modes. This method seems to be inconsistent with the argument that states that learning styles are not (either/or) classification, because learners could be classified as having aspects of visual and verbal learning or active and passive learning at the same time;
  - ✓ Selecting more than one answer from a set of alternatives, which correspond to different styles. This method could not be fully precise, because this makes the selected answers have the same weight of significance statistically, while learners could fall under both poles of one dimension but with varying degrees of preference;
  - ✓ Ranking a set of alternatives without the possibility of giving the same level of ranking for more than one alternative at the same time could be a restrictive method.

2.4.3. Misuse of Learning Styles

Although the research in the field of learning styles began in the mid twentieth century, the researchers believe that many students and teachers still have a lack of understanding of learning styles. For example, Dunn et al stated that great dangers might be faced as a result of learning style misuse (Dunn, DeBello et al. 1981), and in relation to this some important points need to be clarified:

- Dimensions of learning styles must not be treated as opposites because learners could be classified into both poles of a dimension at the same time. For example, a good number of students work very well both alone and in a team;
- Learning style is not a static behaviour. Therefore, learner tendencies might be changed by exposing the learner continually to an educational environment that matches their weaknesses;
- Student preferences in the same dimension are different. For example, visual students could have a pure, moderate or mild tendency.

2.4.4. Learning Style and Researcher Disagreements

Although learning style was defined more than half a century ago, it is quite clear that there is a notable disagreement among researchers about a number of key points related to the concept of learning style, because they vary both personally and psychologically (Graf 2007). According to Leite, Svinicki and Shi, "*The disagreement on the definition of learning style has resulted in a body of research that is very fragmented, using different instruments to measure different constructs under the heading of learning styles*" (Leite, Svinicki et al. 2010).

One of the basic differences in this area is about the considerations that should be included in the concept of learning style. Whereas some researchers argue that learning style should include all factors that could affect the learning, some think that only perceptual factors should be considered under the concept of learning style (Leite et al. 2010), and that has affected the dimensionality of learning style models. For example, in 1987, Keefe mentioned that learning style should cover cognitive, affective and physiological behaviour (Keefe 1987). In this context, Dunn, Beaudry and Klavas argue that learning style should include at least four dimensions, namely Cognitive, Affective, Physiological and Psychological dimension (Dunn, Beaudry et al. 2002); this is further supported by (Drago, Wagner 2004).

As noted previously, there is still little agreement about a number of key issues related to learning style. However, what is striking is even if we agree about the preferred learning style of students, including strengths and weaknesses, there is still a big challenge, which is what we should focus on in our teaching: strengths to make learning easier, or weaknesses to develop student skills.

2.4.5. Implications of Integrating Learning Style in the Education Process

Over the last five decades, many studies have been conducted in the field of education, and the results of these studies revealed that students have different needs and abilities. Therefore, the researchers think that the consideration of student learning styles is an influential factor in the success of the education process, and that integrating learning styles into the education process might play an important role in making the learning faster and easier for learners. Moreover, many researchers including (Felder, Silverman 1988, Radwan 2014) argue that the educational environment must be designed in a manner which supports the students who have pure preferences such as pure visual students, otherwise they might experience many difficulties in their learning.

In order to consider the preferred learning style of students in the teaching process, a number of procedures can be conducted; firstly, the preferred learning style of students should be investigated. Secondly, the students should be made aware of their preferred learning style, and their strengths and weaknesses should be explained clearly to them. This knowledge helps them to improve, monitor and manage their learning (Truong 2016, Coffield, Moseley et al. 2004).

A more intensive way of considering the learning styles in the education process is by matching the instructional environment with the preferred learning styles of students. This could be conducted through exposing the learners to educational activities and materials that correspond with their preferences and needs (Akasah, Alias 2010, Felder, Spurlin 2005, N. Fleming, Baume 2006, N. Othman, Amiruddin 2010, Truong 2016, Herod 2004, Alshammari 2016, Al-Jojo 2012).

2.4.6. Incorporating Learning Styles in the Education Process: Challenges and Criticism

Although the field of learning styles has seen a significant amount of pedagogical research, unfortunately, this field of research still has many open questions and controversial issues (Graf 2007). According to Truong more than seventy learning style theories and models were developed over the last thirty years. This large number of theories, models and instruments has led to criticisms and questions, especially that some of these models overlap with each other. Therefore, questions have been raised such as: which model is

most suitable? what instrument should be applied? what is the relationship between these models? (Truong 2016).

One point of criticism deals with the question of whether the preferred learning style of students is stable over time. The stability of learning style is a controversial issue. While some researchers think that learning styles do not change over time, and therefore they think that students should learn in matched approaches (Gregorc 2002), others see the learning style as a flexible indicator that can be changed over time, and therefore they think that students should also learn in mis-matched approaches, to improve their ability to adapt to other styles (Kolb 2014, Grasha 1984). However, more research is required regarding the stability of learning styles and teaching the students in mis-matching approaches.

Another criticism deals with the instruments that could be used to measure learning styles. Although most of the existing models provide an instrument where learners are requested to answer some questions about their preferences, these instruments attract much criticism (Graf 2007). One important issue is the reliability and validity of these instruments. According to Coffield, to ensure the validity and reliability of any pedagogical instrument four criteria at least have to be fulfilled (Coffield et al. 2004), and the criteria are: test-retest reliability, internal consistency reliability, predictive validity and construct validity. See more details about these criteria in Chapter 5, section 5.3.

Another point of concern deals with the huge number of different learning styles that might be taken into account, for example, according to Felder-Silverman model the same class might include up to 625 styles (Graf 2007). Consequently, teachers might not be able to tackle each and every learning style. However, ICT can provide some solutions for such problems even for a huge number of learning styles, for example; an Adaptive Education System is one of the ICT techniques that can manage the education process even for huge numbers of students with different learning styles. This leads us to provide a clear idea about the adaptive systems and how we can harness these systems for educational purposes.

2.5. Adaptive Hypermedia Systems (AHS) and Student Modelling

In 1998, Peter Brusilovsky explained the concept of adaptive hypermedia systems as: "*by adaptive hypermedia systems we mean all hypertext and hypermedia systems which reflect*

some features of the user in the user model and apply this model to adapt various visible aspects of the system to the user. In other words, the system should satisfy three criteria: it should be a hypertext or hypermedia system, it should have a user model, and it should be able to adapt the hypermedia using this model" (Brusilovsky 1998). Therefore, these systems are designed with the purpose of solving the problems of traditional systems that provide the same services and content to all users.

According to Brusilovsky, the adaptive hypermedia can be seen as an alternative to the traditional "one-size-fits-all" approaches (Brusilovsky 2001).

In order to get sound understanding regarding AHS, a number of key topics needed to be clarified. These topics are related to the concept of Hypermedia, Adaptation, Personalisation and User Modelling:

Hypermedia Definition

As mentioned before in Chapter 1, subsection 1.6.1, the hypermedia can be presented as a developed version of hypertext, because it extends the concept of hypertext by using not only text format but also the format of media such as graphics, pictures, audio and video (N. Stash 2007). In this context, Carrillo explained the concept of hypermedia using this equation (Hypermedia = "hypertext" plus "multimedia") (Peña de Carrillo, Clara Inés 2004). Therefore, the hypermedia can be seen as non-sequential chunks of different formats of text and media, which are connected by links.

Adaptation Concept

In computer science, the term adaptation refers to the ability of the system to change or adapt its content or behaviour to become more suitable for each individual user. Moreover, adaptation is usually conducted based on some user characteristics, but one important question remains: what are the features of the user that can be taken into account when conducting the adaptation process?

In 1998, Brusilovsky mentioned that the adaptation might be to (Brusilovsky 1998) :

- User knowledge;
- User preferences;

- User experience;
- User goals.

Personalization

The term personalization refers to the process of representing the knowledge in a manner suitable for each user to overcome the problems that might arise from the individual differences among the users.

User Modelling

In order to achieve the adaptation process, the adaptive systems need to collect some of the user features or information, which provide the fundamentals for the adaptive behaviour of the adaptive hypermedia systems. According to Kobsa, Koenemann and Pohl, there are three categories of user details, which can be used in student modelling (Kobsa, Koenemann et al. 2001):

- User data: refers to the personal details of the user;
- Usage data: refers to the way in which the user interacts with the system;
- Environment data: refers to the nature of the user environment.

The process of collecting and building up knowledge about the users and using it to represent the situation of the users is called user modelling.

2.5.1. Adaptive Educational Hypermedia Systems (AEHS)

Although students have different preferences, goals, experiences and knowledge, the traditional educational systems provide the same static content for all students (Brusilovsky 2001). Therefore, in considering the individual differences between students, adaptive systems have been harnessed in the education field. The educational generation of adaptive systems is called Adaptive Educational Hypermedia System (AEHS) or Adaptive Learning Environment (ALE). These systems have been defined as "*technological component of joint human–machine systems that can change their behavior to meet the changing needs of their users, often without explicit instructions from their users*" (Feigh, Dorneich et al. 2012). This generation of educational systems can provide the student with materials that are adapted especially to his / her preferences, goals, experiences or knowledge of the subject (Brusilovsky 2001, Brusilovsky 1998, N. Stash 2007).

2.5.2. Methods and Techniques of Adaptation

In order to achieve the adaptation process, several methods and techniques have been applied. These techniques have been operated on two different levels, which are content level (adaptive presentation) and links level (adaptive navigation). In 1996, Peter Brusilovsky developed a taxonomy explaining these adaptation ways. As a result of more recent research, this taxonomy was updated again in 2001 by Brusilovsky. See Figure 8.

Figure 8: Brusilovsky Adaptation Taxonomy.

Adaptive Presentation

Adaptive presentation aims to adapt the content to the user needs by presenting the content in a way which accommodates some of the user features such as preferences, goals, experience or knowledge. Therefore, the rules of adaptive presentation govern the process of selecting the most suitable chunks of information, and rebuilding it to be later presented. For example, based on the user preferences, the system might present a specific form of information (visual information) and ignore the other types of information (verbal information).

In 2001, Brusilovsky explained a number of techniques that might be operated on the content level to achieve adaptive presentation. He stated that there are five main techniques that could be applied to adapt the text, which are: Dimming fragments, Sorting fragments, Stretch text, altering fragments and Inserting / removing fragments (Brusilovsky 2001).

- **Inserting / removing fragments**

The content of any concept consists of a set of chunks or fragments. Each fragment corresponds to a specific style. Therefore, when the content of any concept needs to be presented, the system can find out the fragments that meet the conditions of the user model.

- **Sorting fragments**

The aim of this technique is to provide the user with a set of fragments that are presented in a clear sequence from the most relevant fragment to the least.

- **Stretch text**

Using this technique, the amount of presented information can be controlled whereby more details can be extended or shrunk based on the conditions of the student model.

- **Altering fragments**

One of the common strategies of adaptive systems is to store a set of alternatives of the same information and select the most suitable alternative to present based on the criteria of the user model.

- **Dimming fragments**

The idea behind this technique is to inform the user that the current fragments are not relevant by shading or dimming these fragments.

These techniques are useful for implementing the adaptation to the content, but not for the links; this situation lead us to discuss the second level of adaptation, which is adaptive navigation.

Adaptive Navigation

As mentioned earlier in subsection 2.5.2, there are two levels of adaptation, which are: adaptive presentation and adaptive navigation. While the idea of adaptive presentation depends on changing the presented content, the idea of adaptive navigation relies on changing the links that lead to this content. Therefore, the techniques of the adaptive navigation can be applied to the existing hyperlinks of the adaptive systems for the purpose of helping the users and supporting them to find out the relevant information and avoid them following the links that lead to irrelevant information. Based on Brusilovsky taxonomy, there are six different methods of adaptive navigation which are: direct guidance, adaptive link sorting, adaptive link annotation, adaptive link generation, map adaptation and adaptive link hiding.

Adaptive link hiding involves three different techniques that can be used to implement the navigation support, namely link hiding, link disabling and link removing.

2.6. Incorporating Learning Styles in Adaptive Educational Systems

Research into the use of information technology in computing based education has indicated that students have different abilities and needs. It is also indicated that, considering these differences increases the efficiency and effectiveness of educational activities. As mentioned earlier in subsection 1.6.1 and 2.5.1, the adaptive educational system aims to take into account the individual differences among the students by providing the materials, activities and teaching methods that accommodate student needs and abilities, but we also need to know what the features of students are that can be used for achieving the adaptation process "*adaptation to what*?" (Alshammari 2016).

In a recent study carried out by (Özyurt, Özyurt 2015) within the scope of adaptive educational systems, 69 studies published between 2005 and 2014 were analysed. This study demonstrates that learning style is one of the most common and most important parameters that could be used when designing adaptive learning environments to consider the individual differences among students. The results of this study reveal that, forty-eight studies out of sixty-nine (69.6 per cent) depend on learning style instruments to determine student learning styles in order to achieve the adaptation process, whilst the remainder (twenty-one studies, 30.4 %) used different techniques and methods such as artificial intelligence methods and classification algorithms. With reference to the learning styles models and instruments that have been employed in these studies, the results show that, the Felder-Silverman learning style model was the most preferred model. It was followed by the Kolb model.

More recently, Truong investigated integrating learning style in adaptive e-learning systems by reviewing 51 studies that were published from 2004 to 2014, and the results of this study show that, the Felder-Silverman learning style model was the most preferred model, and then the VARK model (Truong 2016).

2.7. Adaptive Education Systems: Previous Studies

This section describes a number of previous adaptive educational systems, which have attempted to harness the learning style models and learning style instruments to achieve the adaptation process.

2.7.1. CS383 System

This system seems to be the first adaptive educational system, which harnessed the Felder and Silverman learning style model and Index of Learning Style (ILS) instrument to detect the preferred learning style of students in terms of sensing-intuitive, visual-verbal and sequential-global dimensions (Al-Jojo 2012). The CS383 system also provides a comprehensive collection of educational materials including audio files, movies, slideshows, hypertext, lesson objectives, response system and digital library. These materials are rated on a percentage scale to determine to what extent each material corresponds a specific learning style. This ranking, in turn, was compared with the

preferred learning style of the student to find out the materials that achieve the best matching (Carver Jr, Howard et al. 1999). In order to evaluate the functionality of this system, the developer has depended on informal assessments collected from the learners during two years and the results were positive (Alghamdi 2010, Al-Jojo 2012).

2.7.2. INSPIRE System

The acronym INSPIRE stands for Intelligent System for Personalized Instruction in a Remote Environment, which is an adaptive hypermedia education system. This system was designed to be adaptive and adaptable at the same time. This was achieved by providing different levels of adaptation, levels which extend from entire system-control level to entire user-control level. The INSPIRE system allows the users to navigate and choose learning goals, and these goals in turn, are used to produce the curriculum, which correspond to student knowledge and learning style. The learning style is calculated by using the Honey and Mumford questionnaire in the first login on the system (Magoulas, Papanikolaou et al. 2003).

Although the system monitors the user actions and behaviours, the result of the monitoring process is not used for updating the preferred learning style of the user, which is stored in the student profile. Alternatively, the user has privileges to update his/her preferred learning style (Papanikolaou, Grigoriadou et al. 2003).

To evaluate this adaptive education system, an empirical study was conducted with 23 participants, and only half of them completed the learning style instrument.

Although the results of this study reported that most of the participants appreciated the adaptation functionality of this system (Al-Jojo 2012), Alghamdi mentioned that the INSPIRE system does not succeed in providing different versions of educational content for different types of learners. He also reported that this system was simply a different ordering of knowledge modules (Alghamdi 2010).

2.7.3. Arthur System

The Arthur system aims to provide many teachers for each student in a classroom. According to the developers, this aim can be achieved by collecting lessons and materials, which are related to the same subject and then taught by a set of teachers in different styles.

These lessons are specifically produced in four different styles, which are visual-interactive, auditory-text, auditory-lecture and text-only presentation. Therefore, in the first login of each student, Arthur assigns one lesson from the lessons repository to the student. And each lesson is followed by a multiple-choice quiz to evaluate student performance, and according to the functionality of this system, if the student scores 80 percent or more, they will be nominated to go forward onto the next lesson, which is typically presented in the same style and developed by the same teacher, because the system considers that the student gained good understanding about the concept of the first lesson. In contrast, if the student scores less than 80 percent, the systems will select another educational style because it assumes that the instructional method of the first lesson does not fit the student style.

The Arthur system observes the quiz results and stores it as cases, in order to use it later with the students who have a similar learning style (Gilbert, Han 2002). Although the results of two evaluation experiments reported that the Arthur system successfully achieved a significant difference in learning outcomes, some researchers criticised the accuracy of the functionality of assigning the first lesson initially, and the confirming or correcting of the instructional methods based on the quiz (Alghamdi 2010).

2.7.4. EDUEC System

EDUEC is an intelligent adaptive education system, which aims to enhance student performance through providing instructional materials that fit student characteristics. To achieve this aim, Gardner's Theory of Multiple Intelligence was used (Kelly, Tangney 2005) ; however, only 4 intelligences out of 8 were considered, which are respectively: logical/mathematical, verbal/linguistic, visual/spatial and musical/rhythmic intelligence. Moreover, the Multiple Intelligence Developmental Assessment Scales (MIDAS) inventory was used to detect learner preferences. For each learner, the system generates a static profile to save the results of completing the MIDAS inventory, and a dynamic profile to save learner details, including a history of navigation, learner feedback, and time spent on each lesson and results of interactive tests. These profiles are used for matching and mismatching with different, custom-designed styles of resources. The EDUEC system provides two different strategies of material presentation, which extend from presenting the most preferred materials to presenting the least preferred materials. Moreover, four

different instructional materials are available for each lesson, and these materials correspond to the four different intelligences mentioned above. Therefore, the presentation strategy and learner profile determine which curriculum is the best to present first (Kelly, Tangney 2004, Kelly, Tangney 2005).

In order to evaluate the EDUEC system, two empirical studies were conducted with (117 participants). In the two studies, the adaptation was conducted in four different ways, which are (the adaptation based on static profile), (the adaptation based on dynamic profile), (the adaptation with choice), and (no adaptation). Then, the results of the four adaptation approaches were compared. The findings revealed that the learners who have a low level of activity gain more knowledge from the resources that mismatch their preferences. The results also revealed that the level of control had no conclusive impact on knowledge gain; however, a number of researchers reported that, a possible limitation of this system was that the system automatically pre-selected mismatched or matched materials first and only thereafter students were given a choice of other materials (Alghamdi 2010, Al-Jojo 2012).

2.7.5. ILASH System

ILASH stands for “Incorporating Learning Strategies into Hypermedia”, it is an adaptive educational system aiming to incorporate learning strategies into hypermedia. The ILASH system used the Physics courseware, which targets students of GCSE-level. This courseware was adapted by Fullick in 2001 (Bajraktarevic, Hall et al. 2003a). Although the Felder- Silverman learning style model and index of learning style instrument were used to detect learner preferences, only one dimension out of four was considered, a global/sequential dimension. Based on the preferred learning style of the student, the system could present the instructional content (Bajraktarevic, Hall et al. 2003b).

In order to evaluate this system, an empirical study was conducted with 22 participants. In the first course, the participants have been taught by using a matched style and then, they have been taught by using a mismatched style in another course. Finally, statistical analysis has been conducted to find the impact of using this system on student performance. The results revealed that the students who were taught in the matched style achieved higher scores than others (Bajraktarevic et al. 2003b, Bajraktarevic et al. 2003a, Al-Jojo 2012).

2.7.6. 3DE System

3DE stands for Design, Development and Delivery - Electronic Environment for Educational Multimedia. It is an educational research project supported by the European Union and researchers from Italy, France, Spain and Finland participated (D. Corso, Ovcin et al. 2001, D. D. Corso, Ovcin et al. 2002).

While traditional classrooms provide one teacher for N students, the 3DE aims to provide N teacher for each student. According to Corso, this aim can be achieved through building a personalised learning environment, which enables each learner to choose the most suitable amongst several offered teachers and materials.

The 3DE system depends on the Honey and Mumford model to detect the learning preferences of students and classify them into four different groups, which are respectively: Activists, Reflectors, Theorists, and Pragmatists (D. Corso et al. 2001). Moreover, the learner has privileges to decide whether to follow his/her preferred learning style or try an alternative. Furthermore, some other characteristics such as previous knowledge, learning goals and competence skills were considered.

In order to evaluate the effectiveness of this system and the impact of matched and mismatched styles on the learning performance, a cross-cultural empirical study was conducted and forty participants from each country (Italy, France, Spain and Finland) participated. The results of this study revealed that the students who have learnt in a matching style scored significantly higher than the students who have learnt in a mismatched style (Alghamdi 2010).

Although the results of empirical evaluation of 3DE, support the teaching approaches that match the learning preferences, the 3DE allows the participant to switch the learning style, and this could affect the results of evaluation.

2.7.7. iWeaver System

iWeaver is a research project aiming to accommodate individual differences in an adaptive e-learning system to teach the java programming language (Wolf 2003). To achieve this goal, this system used the Dunn and Dunn learning style model. It also depends on different media experiences and a number of learning tools.

Firstly, the learner has to complete the Building Excellence Inventory to detect the learning preferences. These preferences, in turn, are used to build the student model, which is compared with the content model in each learning session. Subsequently, the best matching learning content and tools are recommended to the student.

Although each learner had to provide feedback about the system and content at the end of each learning session, this information is not used for updating learner profiles, but future versions of this system are planned to use this information to update the learner profiles. The iWeaver was evaluated by sixty-three learners in a 3 day workshop. However, this workshop did not succeed in providing any empirical evidence about the impact of the iWeaver on the performance of participants (Al-Jojo 2012).

2.7.8. AHA! System

AHA (Adaptive Hypermedia Architecture) is an adaptive education system (N. Stash, Cristea et al. 2005, N. V. Stash, Cristea et al. 2004, Zakaria 2004). AHA developers think that the authors should have privileges more than system developers in terms of determining which learning style model should be applied in adaptive systems. For that reason,
LAG-XLS generic adaptive language was developed, which allows three different styles of adaptive behaviour, namely selection of items, ordering information by type, and creating different navigation. This system also offers some pre-defined adaptation strategies for these dimensions: Active-Reflective, Verbalizer-Imager, Global-Analytic and Field Dependent-Field Independent. Moreover, the authors can reuse a pre-defined strategy or they can build their own strategy. This strategy, in turn, determines how the adaptation is conducted based on the three different styles of adaptive behaviour mentioned above. This system also allows the learner to show and change learning preferences that are detected by the system.

In order to evaluate this approach, thirty-four students from business information systems and computer science participated in an empirical study, and the participants were asked to use the system as learners and as authors. They were also asked to fill out the index of Learning Style questionnaire (ILS). Subsequently, the learner learning preferences were detected via the LAG-XLS generic adaptive language. The learning preferences of students detected via the index of learning style questionnaire were compared with learning

preferences of students that were detected via LAG-XLS generic adaptive language. The results showed a significant difference between the learning preferences detected using ILS and LAG-XLS. The findings also revealed that the participants understood the basics of learning styles; however, they faced many problems when they were asked to create their own instructional strategies as authors (Al-Jojo 2012, N. V. Stash et al. 2004, N. Stash, Cristea et al. 2006).

2.7.9. TANGOW System

TANGOW (Task-based Adaptive learNer Guidance On the Web) is an instructional web-based tool, which aims to adapt preferred learning styles in order to enhance learning and teaching process (Paredes, Rodriguez 2004, Zakaria 2004). The developers of this system think that the results of learning style instruments could be partly inadequate for many reasons related to the poor design and student Attention-Deficit. Therefore, they think that student preferences should be updated by considering the student actions, background, age, and language. This system firstly used the Index of Learning Style questionnaire (ILS) to collect explicit and implicit information about the student preferences in terms of two dimensions, which are sensing-intuitive and sequential-global. Later, other features of students such as age, background, language and user actions were considered to update student profiles. Accordingly, the system provides adaptive guidance for students. In terms of evaluation, this research does not provide any empirical evidence about the effectiveness and efficiencies of this adaptation mechanism (E. Brown 2007).

2.8. Summary of Similar Research Studies

Although many researchers, including (Özyurt, Özyurt 2015, Alshammari 2016, Al-Jojo 2012, Radwan 2014, Graf 2007) widely agree that the learning style is one of the most important methods that can be harnessed for modelling student learning, there is no clear agreement about the dimensions of learning style, which are worth adapting. Table 3 summarises a number of adaptive education systems that have been designed and developed based on the learning styles.

Table 3: Summary of Previous Adaptive Education Systems.

System	Learning style model	Learning style instrument	Preferences	Evaluation procedures
CS383	Felder and Silverman learning style model	Index of learning style instrument	Sensing-intuitive, visual-verbal and sequential-global dimension	No formal experimental research has been conducted to evaluate it (informal assessment)
INSPIRE	Honey and Mumford learning style model	Honey and Mumford questionnaire. (Student profile can be updated manually)	Reflector-activist	An empirical study with twenty-three participants was conducted
Arthur	Different learning styles	Determine by the system (No psychometric instrument)	Visual-interactive, auditory-text, auditory-lecture, text-only presentation	An empirical study with 89 participants was conducted
EDUEC	Gardner's Theory of Multiple Intelligence	MIDAS Multiple intelligence inventory	Logical/mathematical, verbal/linguistic, visual/spatial and musical/rhythmic	Two empirical studies with (117 participants) were conducted
ILASH	Felder- Silverman learning style model	Index of learning style questionnaire (ILS)	Global/sequential dimension	An empirical study with twenty-two participants was conducted
3DE	Honey and Mumford learning style model	Honey and Mumford questionnaire (students have privileges to decide whether follow his/her preferred learning style or try another alternative)	Activists, Reflectors	A cross-cultural empirical study was conducted and 40 participants from each country (Italy, France, Spain, Finland) have participated
iWeaver	Dunn and Dunn learning style model	Building Excellence Inventory	Global, analytical, impulsive, reflective, visual, auditory, kinaesthetic	A workshop with sixty-three learners was conducted
AHA!	Determined by the instructor	LAG-XLS generic adaptive language. Students update change his/her profile using special forms.	Providing pre-defined strategies for (Active-Reflective, Verbalizer-Imager, Global-Analytic and Field Dependent-Field Independent), authors can build their own strategy	An empirical study with thirty-four participants was conducted
TANGOW	Felder- Silverman learning style model	Index of learning style questionnaire (ILS) and updating the student profiles using student actions, background, age and language.	Sensing-intuitive and sequential-global	No formal experimental research has been conducted to evaluate this system

2.9. Arab Studies in Adaptive Educational Systems

Although the adaptive educational systems in many developed countries have seen a significant amount of pedagogic research in technical subject areas, unfortunately in the Arab countries this work is still in its infancy. In light of this, the literature reveals that there are very few studies that have been conducted in Arab region in this field. Moreover, the literature also revealed that no learning style instrument has been written in the Arabic language to be applied for Arab culture. In a recent study, carried out by (Özyurt, Özyurt 2015) within the scope of adaptive educational systems based on learning styles, 69 studies published from 2005 to 2014 were explored, and the results of this study revealed that, only two (2.9 per cent) out of sixty-nine articles were about the Arab region. This reveals that the amount of research on adaptive educational systems conducted in Arab countries is not sufficient, and that there is a lack of research in this field in this region.

Despite this lack of research, the few conducted studies revealed positive results, for example, in 2011, Essaid El Bachari conducted his study at University of Cadi Ayyad in Morocco. This study used the Myers-Briggs Type Indicator (MBTI) tool to design and develop a new adaptive education system, for the purpose of matching teaching strategies with needs of students. The study, which involved forty-eight Computer Information Systems students, concludes that the educational systems that considered the student learning styles are significantly better than traditional educational systems in terms of student performance (Essaid El Bachari, El Hassan Abelwahed, El Adnani 2011). More recently, in 2014 Radwan, investigated the importance of considering the learning styles in the education process. This study was conducted at Sadat Academy for Management Science in Egypt and involved 108 undergraduate students from different disciplines. In this study, a new adaptive e-learning system was developed using a Learning Activity Management System (LAMS) for the purpose of providing materials that fit to different learning styles. The study, which used the Myers-Briggs learning style model, concluded that the students with different learning styles showed significantly different preferences in the adaptive system, and also that the courses should be provided in a manner that fit the different learning styles (Radwan 2014).

In terms of learning style instruments, in 2012, Al-Jojo focused on translating the English version of Felder-Soloman Index of Learning Styles (ILS) into Arabic, and the Arabic version of ILS has been used in an adaptive education system (Al-Jojo 2012). The study, which was conducted at the King Abdul-Aziz University in Saudi Arabia, involved 1204

students from Arts and Humanities Faculty and the Economics and Administration Faculty. This study concludes that using adaptive educational systems based on learning styles has a positive impact on student achievement and engagement.

In conclusion, it is noteworthy that the literature review has revealed that there are few studies in this area conducted in the Arab region. Where only three related studies were found, this confirms that there was a significant lack of resaerch into this field in the Arab region.

2.10. Research Gaps Investigated by this Research

The suitability of learning style instruments is one of the major gaps in the knowledge addressed in this research. Since the existing learning style instruments have typically been constructed using only textual information, which is more accessible to verbal learners than others, there are no visual forms of information in the instruments. Thus, there may be differences in how students interact with the items of the instruments, resulting in threats to the suitability, validity, and reliability of measurement. This research bridges the gap by investigating the effect of using visual and active forms of information in the instrument construction, and then developing a new valid and reliable learning style instrument.

This research also addresses another gap in knowledge, which is the suitability of learning style instruments for the learners in an Arab community and culture. In this context, the existing learning style instruments were typically written in English and designed for a western culture (Shaw 2012), and the literal translation of instrument items may affect the meaning and lead to linguistic differences, resulting in threats to the suitability, validity, and reliability of measurement. This research bridges the gap by developing the first valid and reliable Arabic learning style instrument. In addition, this new instrument was used to develop an adaptive education system in order to investigate the effect of using such systems on the performance of the learners in the Arabic-speaking communities.

2.11. Summary

This chapter provided an overview of the Libyan Higher Education System (LHES) and its challenges in terms of using technology and pedagogy in the teaching process. This chapter discussed the most popular pedagogical frameworks including TPACK and TIM

Framework, a covered the most well-known learning style models including VARK, Felder–Silverman, Kolb, Gregorc and Dunn-Dunn model. It also provided a clear idea about the adaptive education systems, the methods, and techniques that could be harnessed to achieve the adaptation process. Finally, the chapter has touched on the reviews of related work and similar research studies.

In the following chapter, the issues of research methods and methodology will be provided in detail.

3. Chapter Three: Methodology

3.1. Introduction

The previous chapter addressed the literature related to the subject area including learning style models and instruments, and the impact of an adaptive education system on the education outcomes.

This chapter highlights the methodology used in this research and organised under the following topics:

- System development methodology;
- Research approaches;
- Research worldview;
- Research design;
- Research environment;
- Designing a new learning style instrument and an adaptive education system;
- Data collection and analysis methods;
- Validity and reliability procedures;
- Ethical review.

The research methodology was adopted based on the nature of the research questions and research environment, in order to acquire quality-assured results.

This chapter also provides an introduction to the tools that were used to collect the data from the participants, including the main research instrument, which to the author's knowledge, is the first reported Arabic learning style instrument. This instrument was used to investigate student preferences and was also integrated into the proposed educational system to achieve the adaptation process.

3.2. The Evolution of Research Enquiries

In order to achieve a quality-assured outcome, research should concentrate on tackling specific issues. Therefore, as a first step, the research problem should be identified precisely in order to establish whether it is possible to investigate a certain topic and how we can explore it (Brew 2001).

As discussed in the previous chapter sections 2.9 and 2.10, the conclusions reached following the literature review revealed that all of the existing learning style instruments have been built using a single type of information, textual information, and that may imply these instruments are ineffectual because the textual form of information is more accessible to verbal learners than those with other learning styles.

A key reason for undertaking this study is that the researcher did not find any learning style instrument built using more than one type of information. A second reason is that at present there is no learning style instrument designed for Arab learners and culture.

Therefore, this research aims to improve the efficiency and effectiveness of learning style instruments by exploring the effect of using visual and active forms of information to build learning style instruments. This research also aims to develop the first Arabic learning style instrument and integrate it into a new adaptive education system to improve the outcomes of the educational process in terms of computer education in the Libyan Higher Education System.

3.3. Research Approaches

The research approach is the procedures that should be undertaken to conduct the research. Selecting the most appropriate approach is a critical and important decision. This decision depends on many considerations including the nature of the research environment, which is governed by specific constraints. These constraints are different from one research to another (Cohen, Manion et al. 2013). The research question and the nature of data involved in the research topic are important issues that need to be considered when selecting the research approach. According to Creswell, there are three research approaches, which are respectively: a qualitative approach, a quantitative approach and a mixed methods approach (Creswell 2013). However, Creswell (2013) further suggests that the researcher should not treat these research approaches and research types as an either/or option because these approaches are not dichotomies. Further explanation and justifications are provided in the next sections.

3.4. Worldview (Research Paradigm)

The term worldview, is defined by Creswell as a "*general philosophical orientation about the world and the nature of research that a researcher brings to a study*" (Creswell 2013). The term "*worldview*" has been mentioned in other resources, as paradigms, ontologies and epistemologies, to mean the general model, which provides guidelines to the researcher regarding the basic tasks of research, including the research problem, data collection, and result interpretation (Lincoln, Lynham et al. 2011). One important element to consider is how the basic set of philosophical concepts or beliefs that shape the worldview might be affected by a number of factors, such as researcher experience and expert advice. According to Creswell, there are four types of worldview, including post-positivism, constructivism, transformative and pragmatism (Creswell 2013). In this research, we will highlight two types, namely post-positivism and constructivism because they represent the core of research in Social Science (Kisanga 2015).

3.4.1. Constructivism

Constructivism, or the social constructivist worldview, aims to acquire new knowledge through investigating the beliefs of individuals who live in a particular situation. The developer of this worldview thinks that people tend to build their views and meanings based on the surrounding environment where they live, study, work and play; this overflow of beliefs and views represent rich resources that help the researchers to extract new knowledge. In this type of worldview, the researcher usually meets the people, discusses issues with them and observes how they interact. This mechanism makes the constructivist approach more qualitative than quantitative (Creswell 2013). Some of the key concepts of this worldview are listed below:

- Individuals construct their visions under the effects of the surrounding environment where they engage;
- Theories can be built based on investigating the understanding of people extensively;
- Knowledge can be gained through analysing the beliefs of individuals;
- To generate a theory, a researcher needs to begin with specific details and then move into the general concepts.

To account for this view, the participants of this study have their own beliefs, views and perceptions, which they have built through their previous experience and their interaction with others. These beliefs, views and perceptions about using technology in education were extracted using interviews and open-ended questions (G. Brown, Edmunds 2011). However, Rickert states that the constructivist worldview has some limitations: "… *it terminates in the relativization of Truth to perspectival truths. There can be no true facts in this system, only pragmatic facts*" (Rickert 2009). This leads to exploring the second worldview, which is post-positivism.

3.4.2. Post-Positivism

The post-positivist worldview aims to verify specific theory through exploring and observing individual behaviour. Therefore, in this type of worldview the researcher starts with a specific theory, and then collects and analyses data to gain empirical evidence, which either not accept or not reject the hypothesis of the theory. This mechanism makes the post-positivist worldview more quantitative than qualitative. Some others might call this worldview an empirical science, science research or positivism (Creswell 2013). Some of the key concepts of this worldview are listed below:

- There is no absolute truth;
- Researchers must not be positive about the alleged knowledge;
- Empirical evidence is required to not reject any theory;
- Knowledge can be gained through analysing the empirical data;
- To verify any theory, the researcher needs to begin with general concepts and then move into specific details.

In this research, the researcher used a questionnaire to explore teacher attitudes towards using technology in education, and a learning style instrument to measure the preferred learning styles of students. Then, correlation, differences and factor analysis tests were used to investigate the research hypotheses.

Like any other paradigm, post-positivism has some issues. According to Kisanga, one of the main problems with this worldview is giving less consideration to understanding any particular knowledge of an individual in a detailed way (Kisanga 2015).

Finally, both worldviews, post-positivism and constructivism, are extensively used in Social Science research, and have strengths and weaknesses, both of which should be considered. Both are harnessed in this research, in order to obtain a detailed understanding of learning style theory from individuals, as well as to determine the most important factors that can affect teacher and student attitudes towards using Information Technology (IT) in education, and investigating the impact of using different forms of information in constructing learning style instruments.

3.5. Non-Empirical Research

The previous knowledge and related work, which corresponds to the research topic, are important considerations for any research, as these considerations in turn might represent the main resources for conducting non-empirical research; for example, sometimes researchers completely rely upon investigating the literature and comparing the related work in order to conduct their research. This kind of research does not involve primary data collection activities because it depends on the previous person's experience (Al-Jojo 2012, Jack. R Fraenkel, Wallen 2006). However, non-empirical research alone sometimes is not sufficient to achieve the task and answer the research question, and this is a good reason to explore another type of research, which is empirical research.

3.6. Empirical Research

Empirical research provides empirical evidence through collecting and analysing primary data. This is considered a key requirement to perform this kind of research, which can be verified based on experience and observation (Cohen et al. 2013). This process might be conducted in a qualitative, quantitative or mixed way. In order to set the pace for the discussion, brief explanations are provided in the following subsections.

3.6.1. Quantitative Research

According to Creswell, "*quantitative research is an approach for testing objective theories by examining the relationship among variables*" (Creswell 2013). He also mentioned that the data corresponding to these variables is typically collected using instruments, and then statistically analysed in a deductive way to obtain empirical evidence to support not

accepting or not rejecting the hypothesis. Therefore, the usual protocol of quantitative research is as follows (G. Brown, Edmunds 2011):

- Determine the purposes of research;
- Formulate the hypotheses of research;
- Select the appropriate methods of data collection;
- Select the appropriate statistical tests to investigate the hypotheses.

Quantitative research could be applied in the pedagogy to investigate different aspects such as:

- Performance of student;
- Dealing unfamiliar equipment;
- Teamwork;
- Leadership;
- Teaching;
- Problem-based learning;
- Developing training protocols;
- Individual differences.

However, the problem with this type of research is that the statistical techniques usually require a large number of participants (Newby 2010). Furthermore, some researchers argue that a phenomenon cannot be completely investigated by quantitative research alone (Cagiltay, Bichelmeyer 2000), which leads to the need to explore the second method of empirical research, which is qualitative research.

3.6.2. Qualitative Research

As mentioned in the preceding section, some researchers think that a phenomenon cannot be completely investigated by only quantitative research, because it is difficult to be investigated using only statistical techniques. Therefore, a qualitative research approach is used also as it is concerned with the meaning of words, whilst quantitative research is focused on the significance of evidence and statistical data.

A qualitative approach is concerned with exploring cultural and social phenomena through investigating the understanding and beliefs of individuals and groups. These beliefs, in

turn, can be gathered by different techniques such as interviews, focus groups, open-ended questions and observations. The researcher typically interprets the data to extract the knowledge and hidden meanings in an inductive way (Creswell 2013, Al-Jojo 2012, Jack. R Fraenkel, Wallen 2006).

According to Newby, qualitative research is a powerful and flexible research approach with potential to extract the evidence even with a small sample size (Newby 2010). However, the nature of research sometimes requires using both approaches of quantitative and qualitative to achieve the aim of the research. This leads us to describe the mixed method approach.

3.6.3. Mixed Method Approach

Based on the nature of research questions, data and research environment, sometimes qualitative or quantitative methods cannot alone explore the research problem. Therefore, the mixed methods approach aims to provide a comprehensive and deep understanding of a research problem by combining the methods of both quantitative and qualitative approaches. According to Fraenkel, there are styles of mixed approach such as: exploratory style, explanatory style, and triangulation style (Jack. R Fraenkel, Wallen 2006). In the exploratory style, the researcher begins with qualitative methods and then moves to quantitative to verify or expand the results of the qualitative study, while in the explanatory style, the researcher starts with quantitative and then moves to qualitative to enhance the results of the quantitative study. The third style is the triangulation style, and in this style, both methods of qualitative and quantitative have the same importance and both of them are used to conduct the research. See subsection 3.8.1 for more detail.

Table 4 shows the principles of qualitative and quantitative research approaches.

Table 4: Qualitative and Quantitative Research Approaches.

	Quantitative approach	Qualitative approach
Concerned with	Numbers, statistics	Beliefs, understanding, perspective
Focusing on	Significance of numbers	Meaning of words
Aims to	Test theory	Build theory
Key Strategies	experiments	Case studies
Data usually collected by	Instruments	Observation, interview
Nature of questions	Closed-ended	Open-ended
Preference for	Deductive studies	Inductive studies

3.7. Justification of the Selected Approach

This research uses the methods of a post-positivist worldview to conduct the research, partly because one important aim of this research is to investigate the effect of using learning style theory to enhance education outcomes. Also, this research is post-positivist because it provides empirical evidence based on primary data, which is collected by questionnaires (as examples, the learning style instrument to find the preferred learning style of students, a questionnaire to investigate the current situation of the LHES). This research also harnesses the strategies of a constructivist worldview because it explores student beliefs about the concept of learning styles, and impact of using visual forms of information to build new learning style instruments.

This research also considers the methods of both empirical and non-empirical research, as non-empirical research was conducted to explore the previous related work to acquire a detailed knowledge about the subject area. The empirical research methods were used to provide empirical evidence based on new primary data.

In order to conduct this research, the methods of both approaches, quantitative and qualitative, were used.

All of the methodologies mentioned in this section are well-known and well-accepted in social science research as well as being extensively used specifically in educational research.(Creswell 2013, Al-Jojo 2012, Jack. R Fraenkel, Wallen 2006).

Table 5: Justification of Research Methodology.

Justification of methodology					
Post-positivist	Constructivist	Non-empirical	Empirical	Quantitative	Qualitative
This research investigated the influence of using learning style theory in education	Beliefs of students and teachers in LHES were investigated	Previous related work was reviewed and investigated	Primary data was collected and analysed to obtain empirical evidence	This research involves survey and experiments	The beliefs and feedback were collected from individuals using interview and open-ended questions

3.8. Validity and Reliability

Reliability and validity are important issues for effective research. Therefore, if any part of research is not valid, that means the research will be worthless (Cohen et al. 2013) (Ary, Jacobs et al. 2006).

In order to ensure that this research will be conducted in an effective way and the collected data will be valid and trustworthy, the researcher considered a number of best-known criteria including data triangulation, content validity and reliability tests.

3.8.1. Data and Triangulation

The term triangulation has been explained by Denscombe as "*the practice of viewing things from more than one perspective*" and he thinks that could be reached through "*the use of different methods, different sources of data or even different researchers within the study*" (Denscombe 2010). The triangulation is also considered "*a powerful way of demonstrating concurrent validity*" (Cohen et al. 2013), because "*seeing things from a different perspective and the opportunity to corroborate findings can enhance the validity of the data*" (Denscombe 2003). Therefore, triangulation is highly recommended in social science research (Creswell 2013, Gorard, Taylor 2004, Robson 2011).

In order to maximize the trustworthiness and realize data triangulation, this study used multiple methods of data collection (questionnaires, interviews, learning style instruments)

to collect the data from different resources (teachers, students, pedagogical experts). This helps the researcher to gain a deeper understanding of the phenomenon.

3.8.2. Content Validity

A new learning style instrument was developed by the researcher and evaluated by experts in the subject area to explore the validity of its content before it was employed for this research study. The items of the instrument were evaluated in terms of their clarity, adequacy and relevance to the research area. The Content Validity Index (CVI) method was used, and this method provides evidence of content validity based on content experts. For more details see section 5.3.

3.8.3. Reliability Test

Reliability refers to consistency and repeatability. Normally, test-retest methods are used to test the stability of an instrument over time. This method assumes that, if the same instrument is used with the same or similar sample of participants, then the results should not be different (M. S. Zywno 2003a, Tuckman, Harper 2012, Aljojo, Adams et al. 2015). In this research, test-retest analysis test was conducted twice to investigate the reliability of the new instrument (ALSI), and the Cronbach coefficient alpha was calculated to investigate the internal consistency reliability of these instruments (Litzinger, Lee et al. 2005). See section 5.3 for more details.

3.8.4. Ethical Issues

In addition to reliability and validity issues, social science research faces a number of ethical issues. In this context, Bryman states that "*the ethical issues cannot be ignored, as they relate directly to the integrity of a piece of research and of the disciplines that are involved*" (Bryman 2015). He further states that the ethical issues are generally related to particular transgression, and can be divided into four main areas:

- Harm of participants;
- Lack of information;
- Invasion of privacy;
- Involvement of deception.

All of the ethical concerns, which are mentioned above, including privacy and anonymity, were considered during this research, which followed clear ethical procedures set out by the Research Ethics Committee at Nottingham Trent University. Misurata University also gave ethical permission to carry out the research.

In this research, the following actions were also undertaken:

- All participants were provided with a clear idea about the research, including the aims of the study, how they were going to participate and the manner in which the data would be collected, analysed and used;
- The researcher also pledged to respect the rights of participants to stop or withdraw at any time throughout the research;
- They were also informed that the information they would give would be confidential.

3.9. Research Design

The main aim of this study was to improve the outcomes of LHES. The importance and appropriate timing of this research were supported by the ambitions of Misurata University to make developments to its education systems. To ensure that this study will be conducted in an effective way, a primary version of the new pedagogical technological framework was created, based on the existing literature and results of investigating the current situation of the LHES.

In order to explain the overall mechanism of this research and the work that needed to be done, the following blueprint presents the basic phases of this study.

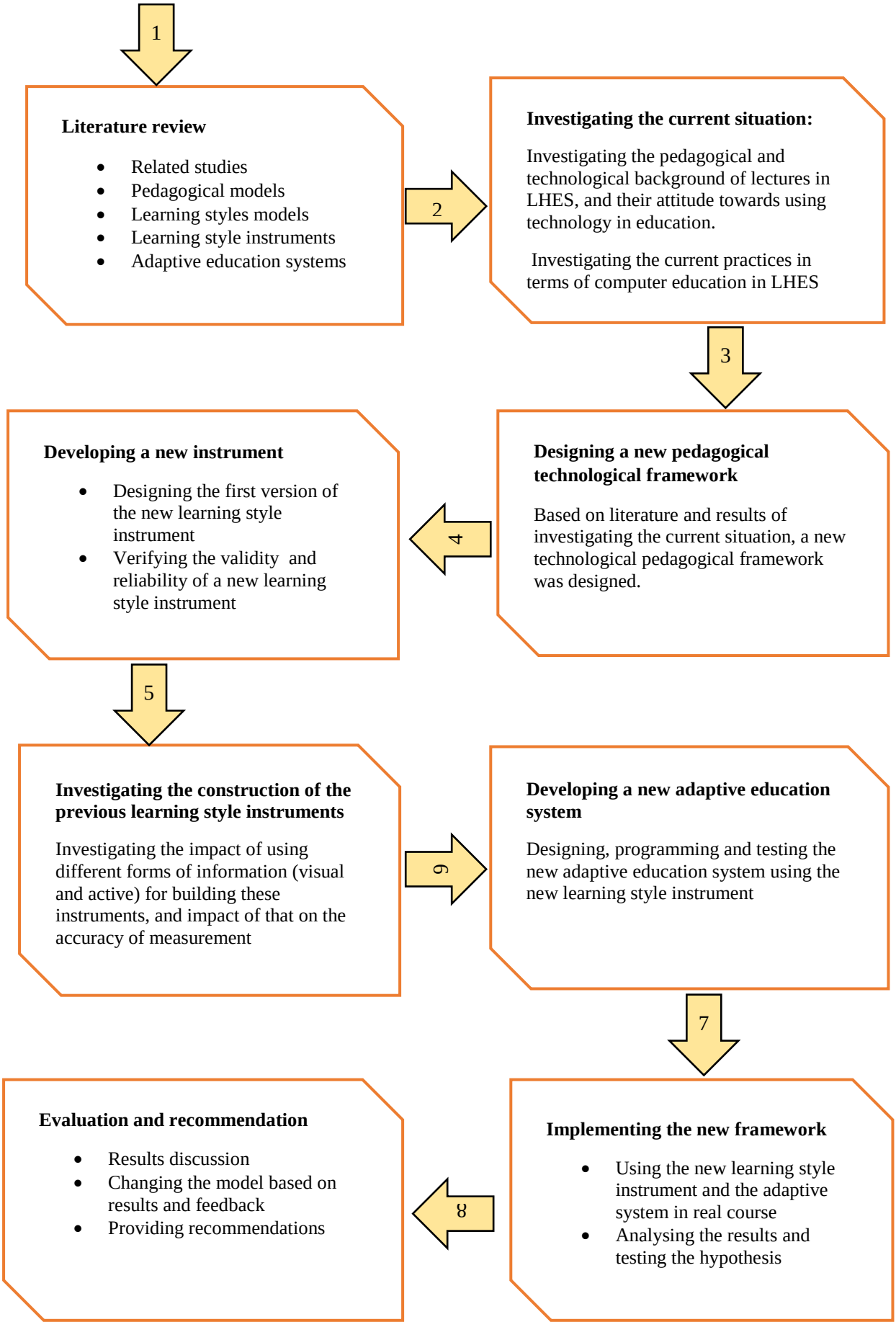

Figure 9: Research Design.

3.9.1. Literature Review Stage

In this stage, the researcher explored the previous related work including achievements and challenges of LHES, technological pedagogical frameworks, learning style models and instruments as well as adaptive education systems, as illustrated in Figure 10. This assists the researcher in collecting and analysing the secondary data, which provides a clear insight and comprehensive knowledge of the research field. This knowledge, in turn, is harnessed to identify the problems, which might be faced in this research and provide guidelines for the right selection of the most appropriate research methods, tools and instruments. Finally, a good understanding was obtained through investigating the related works, and this promotes the move to the next stage, which is investigating the current situation of LHES.

For more details see Chapter 2.

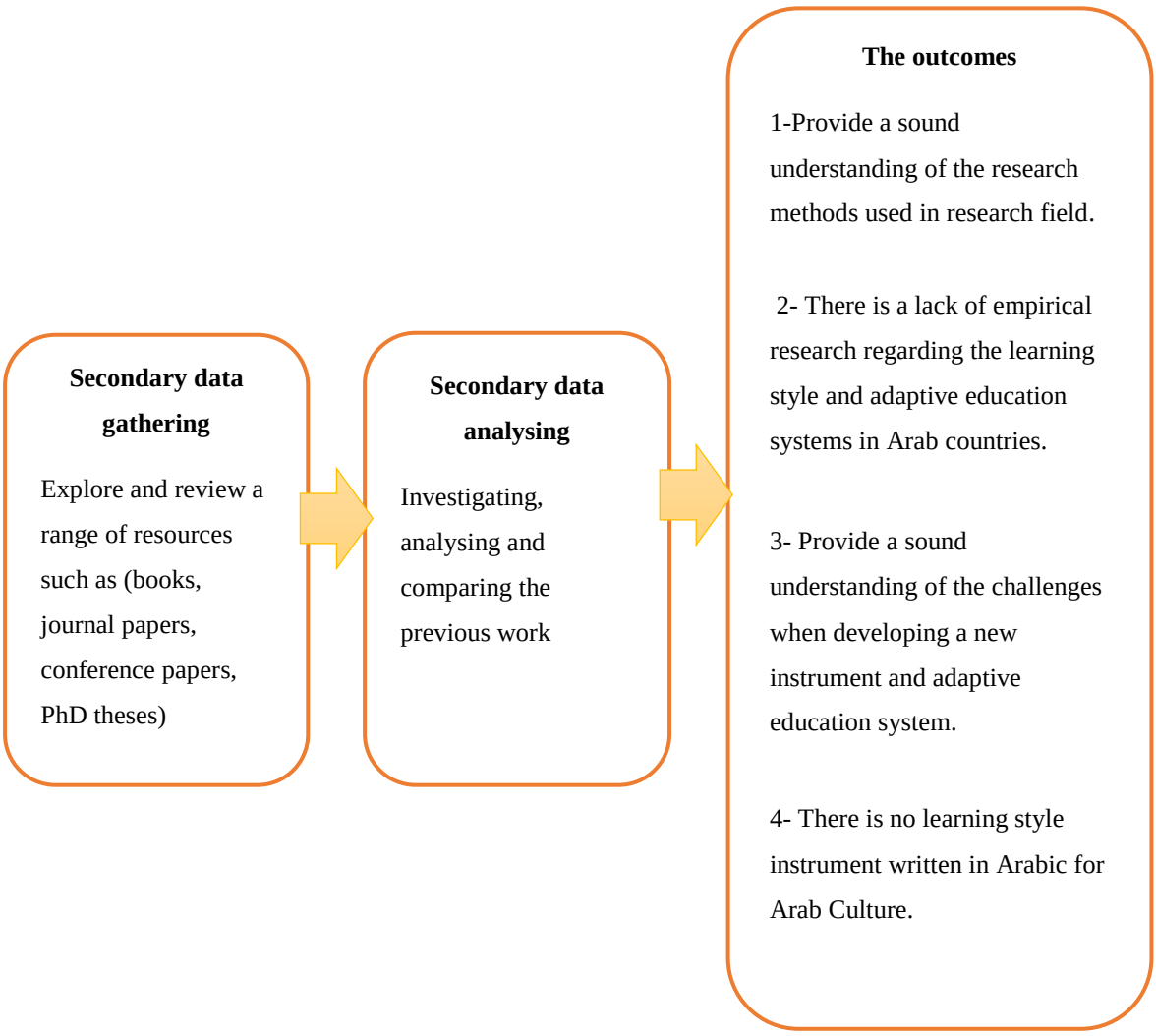

Figure 10: Literature Review Stages.

3.9.2. Stage of Investigating the Current Situation of LHES

In order to obtain a clear insight into the rules, constraints and properties, which governed the research environment, the researcher investigated the current situation and the current practices of computing education in LHES. As a result of this study, the researcher gained a comprehensive knowledge of the following:

- The pedagogical and technological background of teachers;
- Teacher attitudes towards using technology to develop education processes;
- Teacher needs regarding using technology in education processes;
- The most important factors that might influence the use of technology to develop education processes;
- Considering the individual differences of students in the teaching process;
- Employing different teaching strategies to enhance learning outcomes;
- The dominant teaching approaches used in computer education.

Finally, the results of this stage provide a deep understanding of the research problem and the properties of the surrounding environment, and this understanding allows the researcher to provide a precise perception for treating the research problem. The results of investigating the current situation will be provided in detail in Chapter 5, section 5.2.

3.9.3. Stage of Designing a New Technological Pedagogical Framework

Based on the literature and results of investigating the current situation, a sound understanding was obtained regarding previous technological pedagogical frameworks, which aim to develop the education outcomes through integrating technology in the education process. This understanding, in turn, was harnessed by the researcher for developing a new technological pedagogical framework. This framework provides a precise description of how the technology might be integrated into the education process to enhance the learning outcomes. More details will be provided in detail in Chapter 4, section 4.2.

3.9.4. Stage of Developing a New Learning Style Instrument

Based on the literature, the researcher noticed that there is no learning style instrument written in the Arabic language to be applied for Arab culture; for that reason, the

researcher developed a new learning style instrument. This instrument was designed from good research practice and tailored for delivery in Arab cultures and communities. The development of this instrument followed the steps listed below:

- The items of the new instrument were designed based on the results of the literature review;
- Testing the first draft of the new instrument on a small focus group and discussing the structure and items of the instrument;
- Adapting the new instrument based on the previous step;
- Testing the validity and reliability of the new instrument;
- Applying the new instrument to a full sample (Misurata University - Libya);
- Translating the new instrument into English and translating back into Arabic [back translation is a well-known technique, which used to check the accuracy of translation] (Dimitriou, Ducette 2018, Aydin, Pasinlioglu 2018).
- Testing the validity and reliability of the new instrument (English Version);
- Applying the new instrument in a different environment (Nottingham Trent University - UK).

Finally, this stage introduced the first reported Arabic learning style instrument in the literature, which will be integrated into the adaptive education system to measure the preferred learning styles of students for the purpose of matching teaching styles with preferred learning styles of students. For more information see Chapter Four, section 4.4.

3.9.5. Investigating the Impact of Using Different Formats of Information to Construct the Instruments of Learning Styles

Learning style instruments were built assuming that there is no one teaching method and curriculum fit for all students (Franzoni-Velázquez et al. 2012) because they have different preferences and abilities. Therefore, each type of student tends to get more knowledge from the materials that fit his/her style, for example, visual learners tend to benefit more from visual forms of information such as charts, graphs and figures. Based on the literature, the researcher noticed that none of the current learning style instruments present information in different formats, and, the content that was used to build these instruments depends only on the textual form of information, and this might be leading to a bias in the measurement of learning style, as the textual form of information is more accessible to

verbal learners. This encouraged the researcher to investigate the effect of using visual and active content in instrument construction, and how this affects the accuracy of instruments, because the items of instruments should be presented in different forms of information to correspond to the different styles of students. The process of investigating the effect of using visual and active content in instrument construction is described below:

- Investigating the previous learning style models and instruments;
- Developing a new learning style instrument by using some visual and active content;
- Investigating the validity and reliability of the new instrument;
- Measuring the preferred learning style of 50 students by using the new instrument once and VARK instrument once again;
- Comparing the results of the two instruments;
- Interviewing some of the participants for more investigation.

As a result, a new learning style instrument was produced, and this instrument used visual and active content. For more details see Chapter Five, section 5.5, and (Alzain et al. 2016).

3.9.6. Stage of Developing a New Adaptive Education System

The adaptive educational system aims to adapt the educational content to match the preferences of individuals. For example, the needs of each user will be considered by providing the resources, which are the most suitable for him/ her (Brusilovsky 2001). Based on the literature, a number of adaptive systems have been built based on learning style instruments, to achieve the personalisation process. Therefore, the new learning style instrument was used in this system. The overall process of developing the new system included the following steps:

- Reviewing the previous related work including design, programming and testing the adaptive education system;
- Investigating the methodologies and strategies of personalisation;
- Investigating the methods and techniques of adaptation;
- Selecting the most appropriate strategy for achieving the personalisation and adaptation;
- Exploring the tools and techniques of programming the adaptive education systems;

- Selecting the most appropriate tools for programming the system;
- Using the selected methods and tools to develop the system;
- Evaluating the system on a number of computer teachers and students.

After carrying out the literature review, investigating the current situation and developing a new learning style instrument, the next phase was to develop the adaptive system. The methodology used to develop this system was a method presented by Royce (Isaias, Issa 2015, Balaji, Murugaiyan 2012). Figure 11 illustrates the methodology followed. For more details see Chapter Four, section 4.5.

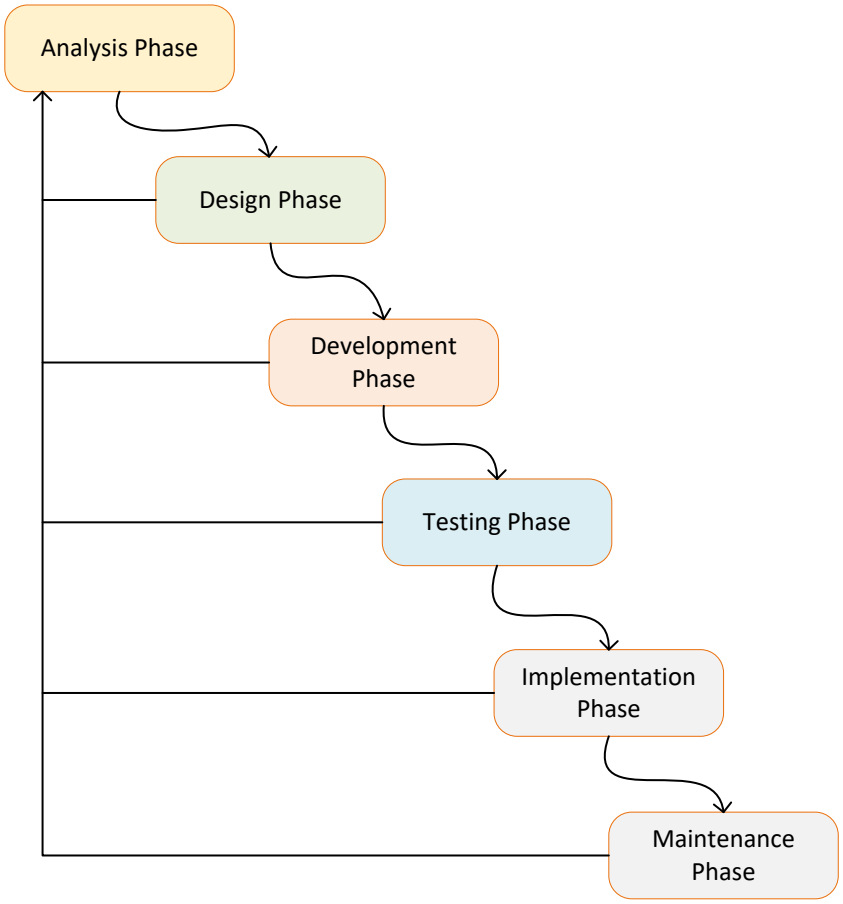

Figure 11: The Methodology of Developing the Adaptive System.

3.9.7. Stage of Implementing the Pedagogical Framework Using the Adaptive Education System

The new technological pedagogical framework that results from stage three has been applied in this stage by using the new adaptive education system, which was used as an

assisting educational tool to support teachers in considering learner differences among students. The process of implementing the new framework consisted of:

- Explaining to the students the concepts of learning styles and adaptive education systems;
- Giving the students guidance on how to use the new system;
- Teaching the students without using the system and testing the learning outcomes (pre-test and post-test);
- Teaching the students using the new system and testing the learning outcomes (post-test and post-test);
- Statistically comparing the outcomes of two sessions (with and without the system) to investigate the research hypotheses;
- Conducting four interviews with four experts in the subject area (officials in LHES);
- Collecting the feedback from the experts and analysing the results.

For more details see Chapter Five, section 5.6.

3.9.8. Evaluation and Recommendation Stage

In this stage, the new pedagogical framework, implemented using the adaptive system, is adapted based on the emerging results and from this, the researcher will also provide some recommendations. The overall process includes the following:

- Discussing the results
- Adapting the framework based on results and feedback
- Providing some recommendations.

3.10. Experiment Design

3.10.1. Sample Size

In quantitative research methods, it is known that a large sample size increases the accuracy and reliability of the finding. In the present research, although the sample size was slightly small, however, it was the best that could be done, because of two main reasons. The first reason is the current unstable situation in Libya. The second reason is that, these are the only courses that I have got access to. And to avoid the problems that might arise from the small sample size, some qualitative research was conducted to investigate and support the quantitative results. Moreover, based on research limitations', recommendations for future work were suggested, Section 6.5.

ALSI Validity and Reliability

As mentioned above, Because of the unstable situation in Libya, the population was not a certain number, the population of the target group was estimated to be 1000 students who were enrolled in computer departments at MU.

In this study, the confidence level that was selected is 90 % (Teigen, JØrgensen 2005) , and Equation (1) was used to calculate the Margin of Error (MOE) of the sample size 111 students (LeBlanc 2004, Antonius 2003)

$$MOE = Z\sqrt{\frac{p(1-p)}{n} * \frac{(N-n)}{N-1}} \qquad \text{Equation (1)}$$

Where:

Z _ the confidence interval constant

p _ population proportion

n _ sample size

N _ The population size

for confidence level 90%, the standard confidence interval (Z = 1.645), and maximum probability of (p) is 0.5 (Singh 2015)

$$MOE = 1.645 \sqrt{\frac{0.5(1-0.5)}{111} * \frac{(1000-111)}{1000-1}}$$

$$MOE = 0.074$$

The Margin of Error (MOE) = 7.4%. This seems like a reasonable value (Conroy 2006).

Current situation of LHES

In this study, the population of the target group was 75 teaching staff member in Faculty of education and faculty of infromation technoloy at Misurata University.

the Margin of Error (MOE) was clculated using Equation (1) based on a 90% confidence level.

$$MOE = 1.645 \sqrt{\frac{0.5(1-0.5)}{46} * \frac{(75-46)}{75-1}}$$

$$MOE = 0.076$$

The Margin of Error (MOE) = 7.6 %.

Implementing the New Framework

In order to implement the (Five-arrow framework), I have got access to three different courses (in Misurata University). The first course is, (Formal Languages and Automata Theory) module, which is offered by the Faculty of Information Technology. In this course, 10 students were enrolled, all of them have participated in this study. The second course that I have got access to is, (Computer Basics) module, which is offered by the Faculty of Education. In this course, 18 students were enrolled, and 16 students have participated in this study. The third course is (Programming Languages) module, which is also offered by the Faculty of Education. In this course, the number of enrolled students is 14, and all of them have participated in this study.

3.10.2. Investigating the Libyan Higher Education System

The main purpose of this part of the study is to investigate the technical and vocational higher education and training system in Libya, in order to ascertain some insights into the problems faced in the teaching process and the challenges for the future. A questionnaire methodology is utilized to obtain the teacher views on these challenges, including the use of technology and pedagogy in the teaching process. The investigation took place at Misurata University in Libya, and data was collected from 46 computing teaching staff members.

Before starting the investigation, the researcher provided the participants with a brief idea about the research and discussed with them some related issues such as:

- The importance of using technology and pedagogy in education;
- Where and how to find more information about using technology and pedagogy in education.

After that, the participants were required to fill out the questionnaire, and the results were analysed using Statistical Package for the Social Sciences (SPSS). The results of this investigation are mainly covered in Chapter Five, section 5.2, and (Alzain et al. 2014).

3.10.3. Investigating the Validity and Reliability of the New Instrument

The main purpose of this part of the study is to investigate the reliability and validity of the Arabic version of the new learning style instrument before harnessing it in this research, and before integrating it into the new adaptive education system. This investigation was conducted in the Faculty of Education and the Faculty of Information Technology at Misurata University, and the data was collected from 111 undergraduate students. Before starting the investigation, the researcher provided the participants with a brief idea about the research and discussed with them some related issues such as:

- The concept of learning style;
- Some previous learning style models and instruments;
- The importance of using learning styles in the education process;
- Where and how to find more information about learning style models and learning style instruments.

After that, the participants were required to fill out the instrument, and the results were analysed using SPSS Version 22. The internal consistency reliability, classical item analysis, test-retest reliability and factor analysis techniques were used to explore the validity and reliability of this instrument. Furthermore, to investigate the content validity of this instrument, 6 experts in the subject area were asked to rate the items of this instrument, and the content validity index was computed. This investigation is mainly covered in Chapter Five, subsection 5.3.1, and (Alzain et al. 2016).

The same procedure was followed to investigate the reliability and validity of the English version of the new learning style instrument. This investigation was conducted in the School of Science and Technology at Nottingham Trent University in United Kingdom, and the data was collected from 50 undergraduate students. The results of this investigation are mainly covered in Chapter Five, section 5.3.2.

3.10.4. Investigating the Effect of Instrument Content on the Measuring of Learning Styles

The purpose of this part of the research is to investigate the effect of using different forms of information (visual and active) on constructing the instruments for assessing learning style, and how this will affect the efficiency and effectiveness of these instruments. This investigation was conducted in the SST at Nottingham Trent University, and the data was collected from 50 students. Before starting the experiment, the researcher provided the participants with a brief idea about the research and discussed with them some related issues such as:

- The concept and theory of learning styles;
- Dimensions of learning styles;
- The previous learning style models and instruments.

The preferred learning style of participants was measured twice using the newly developed instrument and a VARK instrument.

In order to avoid the bias caused by using one of the instruments first, the preferred learning style of some participants was measured initially using the ALSI instrument and subsequently, using a VARK instrument. While the rest of the participants used the VARK instrument first and then the ALSI instrument.

The results of both were compared and data was analysed using SPSS Version 22. A paired t-test was conducted to determine if there were any significant differences between student learning styles. Furthermore, to view the situation from more than one perspective (data triangulation), semi-structured interviews were conducted with 6 participants. The results of this investigation are mainly covered in Chapter Five, section 5.5, and partially in (Alzain et al. 2016).

3.10.5. Implementation of the New Framework Using the Adaptive System

The purpose of this part of the research is to investigate the results of applying the new technological pedagogical framework, which will be implemented using the new adaptive education system, and the impact of that on the performance of students. Three different experiments were conducted in the Faculty of Education and the Faculty of Information Technology at Misurata University, and 40 undergraduate students participated. Each experiment was carried out in three sessions, each lasting for about 120 minutes (for each session). The researcher explained to the participants some of the key issues including concept of learning style, learning style instruments, how learners can measure their preferred learning styles, how they can use it to manage their learning, adaptive education system and how it works. The researcher also explained to the participants the procedure and aim of the experiment. The participants were first taught without using LAES system, and they were asked to complete a pre-test and a post-test to know the learning outcomes. The learning outcomes were also tested in the next experimental session, in which the participants were taught using the adaptive system, and the learning outcomes of two experimental sessions were compared. The results of this part are mainly covered in Chapter 5, section 5.6. Furthermore, to view the situation from more than one perspective (data triangulation), semi-structured interviews were conducted with 4 experts in the subject area (officials in LHES). The results of this investigation are mainly covered in Chapter 5, subsection 5.6.7.

3.11. Summary

This chapter provided a description of the research approaches, which can be employed to achieve the research aims. It also provided a justification for the adopted methodology in this research. This methodology was selected based on the research problem as well as the properties and constraints of the research environment. Finally, this chapter explained the main stages of the research and the main activities of each stage, as well as the main experiments that were conducted.

In the following chapter, the issues of design and development of the new technological pedagogical framework, the learning style model and the learning style instrument will be presented, together with an overview of the structure, design and development of the adaptive education system.

4. Chapter Four: Initial Development

4.1. Introduction

The previous chapter gave a comprehensive understanding regarding several key concepts related to the research method and methodology that have been harnessed in this research as well as in similar works.

This chapter describes the process of initial development of a new technological pedagogical framework called Five-arrows framework. This chapter also describes the initial development of the learning style model and first Arabic Learning Style Instrument (ALSI). The chapter also focuses on the design and development of a Libyan Adaptive Education System (LAES), specifically, the adaptation process of the system, content model, student model and pedagogical model.

4.2. A New Technological Pedagogical Framework

Based on the learning outcomes and learning styles of students, the Five-arrows framework shows how to consider the individual differences between the learners, and how to determine the most suitable content, teaching methods and most suitable technological tools that could be used in the teaching process.

Firstly, students preferred learning styles and learning outcomes needed to be determined, and both would be used to specify appropriate teaching styles. Secondly, the most suitable content, from that available, will be determined. Finally, the most suitable technology, from those available, could be determined based on the preferred learning styles of students, teaching styles and selected content. See Figure 12.

The Five-arrows framework also recommends a number of factors that could effectively support the success of the educational process. These factors are listed below:

- Professional training courses;
- Technical support;
- Performance evaluation;
- Resource updating.

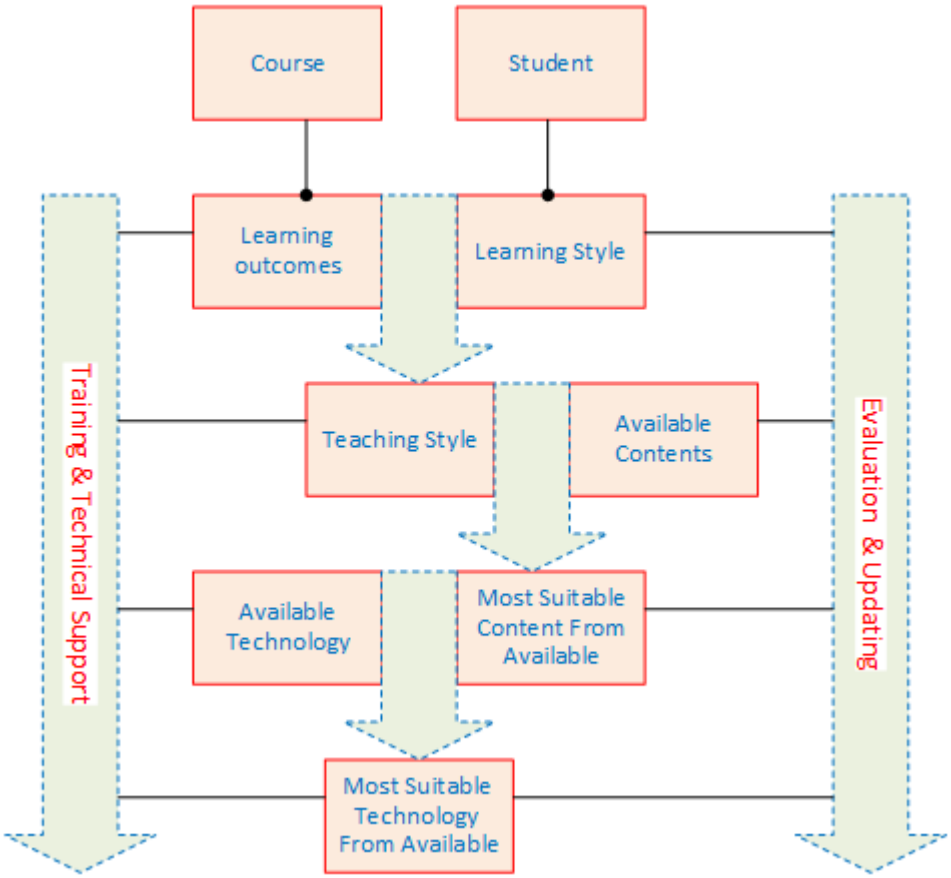

Figure 12: Five-Arrows Framework.

4.3. Developing the New Learning Style Model

As discussed in literature review subsection 2.4.1, the existing learning style models are different in terms of the characteristics that should be included under the umbrella of Learning Styles. However, one question that needs to be asked is, whether every factor that has an effect on learners should be included or not. A reasonable approach to tackling this issue could be linking the learning style with the concept of the learning process, thereby, designing the learning style model. The learning can be defined as a process of knowledge acquisition through receiving new information and interacting with it. This encompasses two main steps, which are receiving information and interacting with it (Alshammari 2016, Jonassen 1991, Felder, Silverman 1988). Consequently, the proposed learning style model (Alzain Model) contains two dimensions. Figure 13 illustrates the Alzain

Learning/Teaching Model, which is designed based on the definition of the learning process as well as the literature review. See Chapter 2 section 2.4.

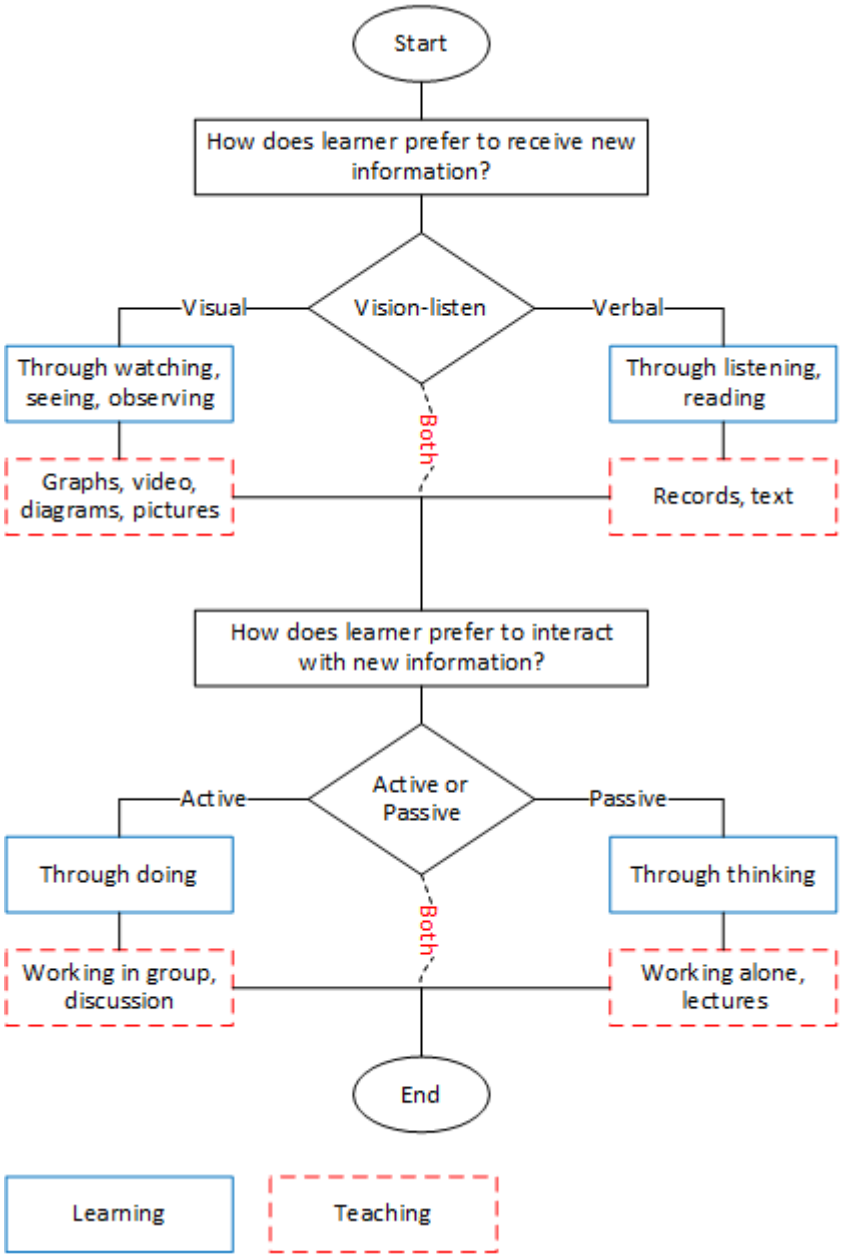

Figure 13: Alzain Learning Style Model.

According to the Alzain model, there are four different types of preferences and the learners could be classified as follows:

- Visual: visual people prefer visual style in teaching material to receive the new knowledge. Therefore, they get more from visual forms of information such as pictures, figures, charts... etc;
- Verbal: verbal people prefer the reading and listening as entry channels for receiving the new knowledge. Therefore, they get more from textual forms of information and audio;
- Active: active people tend to remember what they have done. Therefore, they prefer more practical activities;
- Passive: passive people tend to remember what they have thought about. Therefore, they learn better when they have time to think about things before doing it. See Figure 13 and Table 6.

Table 6: Dimensions of Alzain Learning Style Model.

Description	Dimension Channel of knowledge entry		Description
Get more from what they have seen and observed	Visual (V)	Verbal (E)	Get more from what they have heard, read and said
Description	Dimension Ways of processing the new knowledge		Description
Get more from what they have done	Active (A)	Passive (P)	Get more from what they have thought about

4.4. Developing the First Arabic Learning Style Instrument (ALSI)

Research into the use of information technology in computing based education has indicated that students have different abilities and needs. In other words, they tend to learn in different ways: these ways are called learning styles. Although learning styles in many developed countries has seen a significant amount of pedagogic research in technical subject areas (Özyurt, Özyurt 2015, Truong 2016), unfortunately in the Arab region this work is still in its early stages (Abdelsalam 2013, Al-Jojo 2012, Essaid El Bachari, El

Hassan Abelwahed, El Adnani 2011). This encouraged the researcher to develop the first Arabic learning style instrument.

4.4.1. Suggested Plan to Design the New Instrument

In light of the literature review, it is clear that developing learning style instruments requires a number of rigorous procedures to ensure the scales validity and reliability (Polit, Beck 2006, Alzain et al. 2016). Therefore, this plan was suggested to develop the new instrument and increase its validity and reliability.

- Investigating the previous learning style models, instruments and related work;
- Designing the first draft of an original instrument, which is the first Arabic learning style instrument;
- Testing it on a small focus group of (5) experts in this field;
- Discussing the structure and items of the instrument;
- According to this discussion, the items of the instrument might be slightly changed;
- Testing the validity and reliability; applying the instrument in a full sample to calculate Cronbach's alpha, PCA, T-Test and CVI to evaluate the validity;
- According to the results of validity and reliability, the items of the instrument might be slightly changed;
- Applying the instrument in a different environment (NTU - UK):
    - The original instrument translated into English by a professional translator and translated back into Arabic;
    - Test it on a small focus group (5) and discuss the structure and items of the instrument;
    - Testing the validity and reliability; applying the translated instrument (English version) in a full sample;
    - Comparing the results with the results of the first experiment.

4.4.2. The Developed Instrument (ALSI)

After investigating the literature, the new instrument was developed based on the Alzain learning style model (see section 4.3). The instrument consists of sixteen items, each of which has four choices, which correspond to the four learning modes. Respondents needs

to select the answer(s) that best fits their preference by determining the priority levels from 1 (least important) to 3 (most important), for the respective choices. The respondents are also allowed to give the same priority level for different choices at the same time. The highest score possible is 48, and each preference is divided into three equal categories, including mild preference (from 1 to 16), moderate (from 17 to 32) and pure (from 33 to 48).

Why the Developed Instrument Is Different

As mentioned earlier, students have different learning styles (Franzoni-Velázquez et al. 2012, Alzain et al. 2014). In other words, they respond to the materials in different ways; for example, visual students respond strongly to the visual forms of information, which are more suitable and motivating for them. Therefore, motivation is an important issue that should be taken into consideration when designing the instruments of learning styles (Alshammari 2016). Based on this, the question that needs to be asked is, why the items of existing learning style instruments are not provided in a visual and active way to correspond to the different types of learners. This is for the purpose of attracting and motivating all types of students equally. Therefore, one key issue that will be investigated in this research is the impact of using different forms of information (visual and active) in constructing the instruments for assessing learning style, and how this will affect the efficiency and effectiveness of these instruments as well as accuracy of measurement. The following points illustrate the differences between the developed instrument and the existing by highlighting the advantages of the developed instrument (ALSI):

- Content of developed instrument: the content is presented in a different manner to correspond to the different types of learners. For example, visual resources like figures, graphs and charts are used to build some of the items, which measure the visual preferences. Appendix A illustrates some of this visual content;
- The methodology of questions: respondents choose priority levels from 1 (least important) to 3 (most important) in the dashed boxes for the respective choices (see Appendix A). The respondents are also allowed to give the same priority level for different choices at the same time. This mechanism is to ensure that the learning preferences will not be treated as dichotomies (either/or options). See subsection 2.4.2 and 2.4.3.

4.5. A New Adaptive Education System Design

The proposed system is a Web-based adaptive educational system. This system tackles the problems arising from individual differences by presenting the most suitable content and educational activities for students.

This system has been constructed with ASP.NET, MSSQL on a windows environment as a general adaptive education system for different disciplines. The main purpose of this system is to assist the teachers and students by providing the most suitable learning materials and interesting learning activities to the students based on their learning preferences. Figure 14 shows the system architecture, which includes four main domains:

- Content Model: contains the chunks of learning materials and any relevant details;
- Student Model: includes details of students and their learning preferences;
- Teaching Strategies Model: includes details of different teaching strategies and relevant activities;
- Pedagogical Model: this model involves three components which are respectively:
  - Preferences Detection Component: contains learning style instrument to detect the preferred learning style of student;
  - Adaptation Component: consists of a set of rules, which organise the relationship between the student model, content model and teaching strategies model. These rules determine which content and teaching strategy are appropriate for a specific learning style;
  - Revision Component: the learning preferences that are obtained as a result of completing the instrument of learning style. These preferences can be fine-tuned during the course if the students and teacher believe that the initial preferences need to be revised.

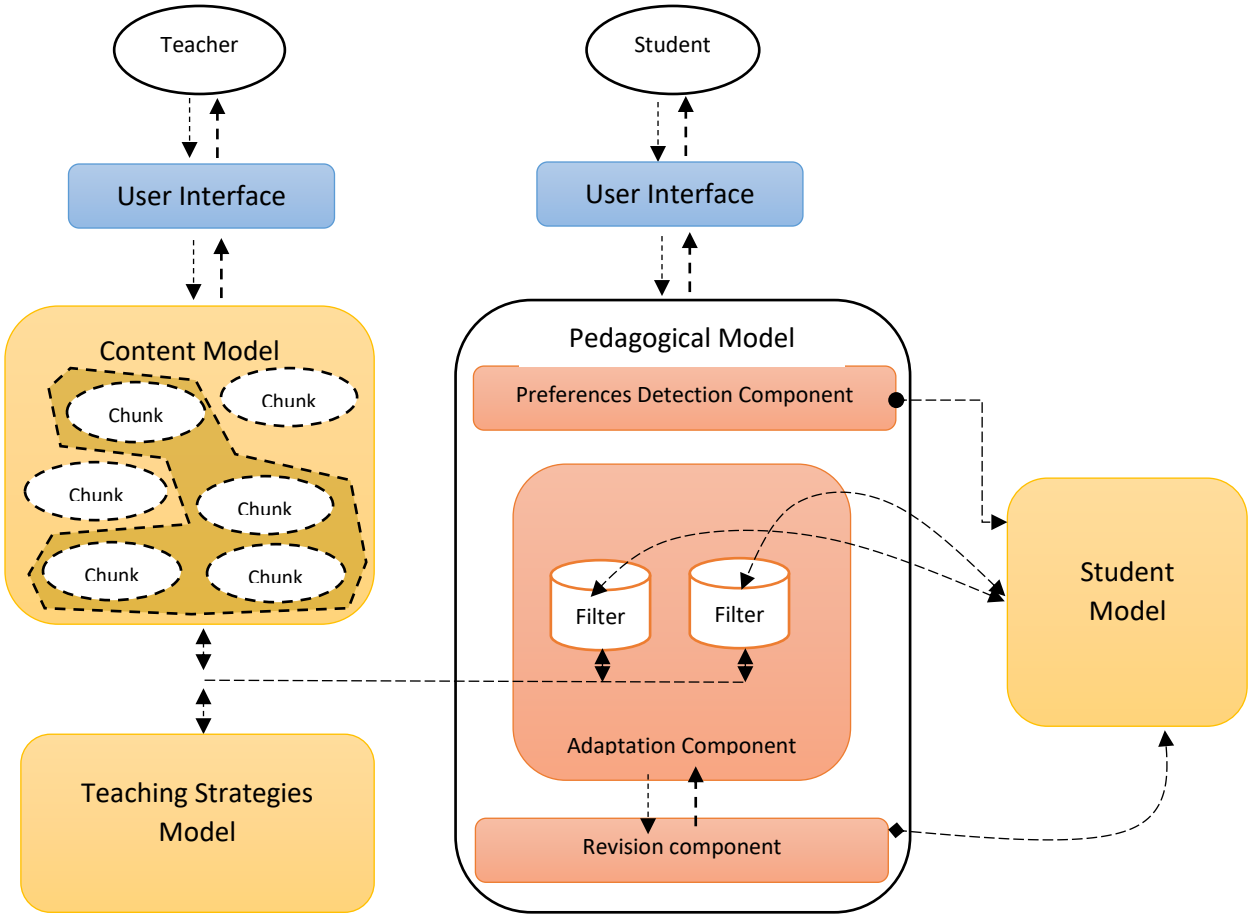

Figure 14: LAES System Architecture.

4.5.1. Content Model (CM)

This model includes the curriculum or educational content. Typically, each course can be depicted as a tree of educational units, which are called chunks (see Figure 15). Each unit starts with outlines and then presents the content and concludes with the summary.

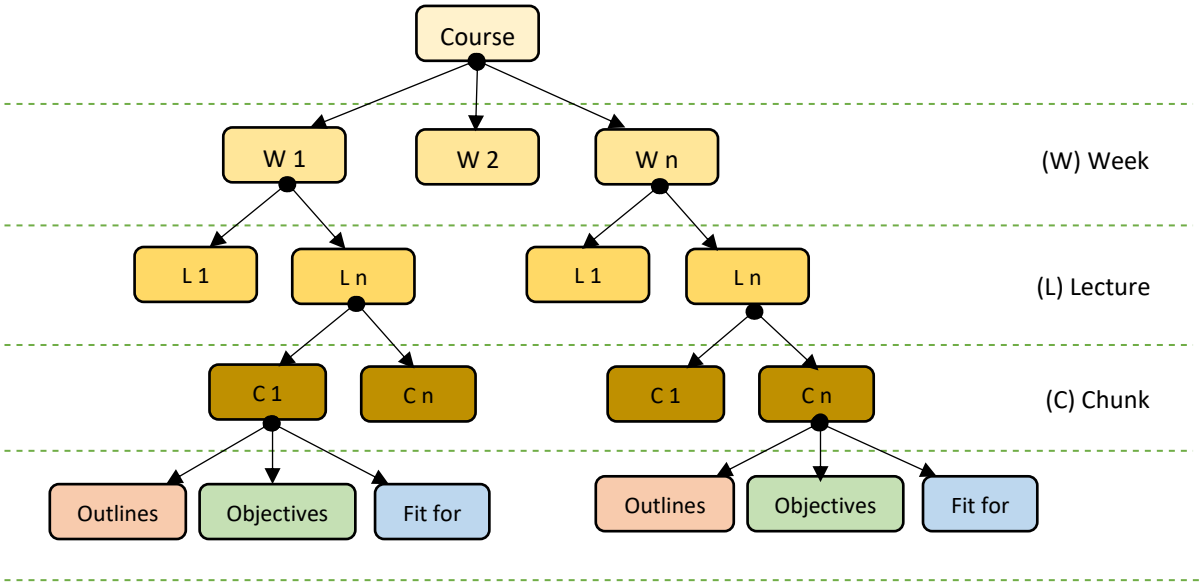

Figure 15: Content Model - LAES System

The materials of the content model were designed based on the ideas of two well-known educational theories, namely Component Display Theory (CDT) and Elaboration Theory (Al-Jojo 2012, Aljojo, Adams 2009). These theories provide guidelines for designing, developing and constructing the educational content. In order to set the pace for the discussion, brief explanations of these two theories are provided in the following subsections.

Component Display Theory (CDT)

According to the Component Display Theory (CDT), education can be presented as a two-dimensional matrix, where the first dimension refers the type of content, and the second dimension represents the level of performance. See Figure 16.

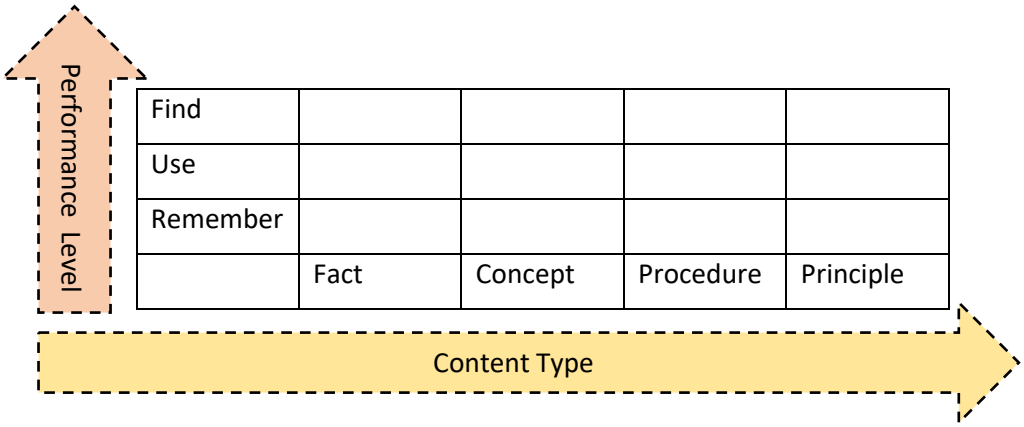

Figure 16: Component Display Theory (CDT).

This theory also indicates that, the ideal instruction should involve various forms of curriculum presentation. In addition, this theory identified four forms for primary presentation, which are: Generality, referring to "general concepts"; Instance, referring to "specific examples"; Expository, referring to "talking"; and, Inquisitory, referring to "asking". Moreover, this theory identified five forms of secondary presentation, which are prerequisite details, contextual details, mnemonics, attention concentrating and alternative representation. According to the CDT, instructional material will be more effective and efficient if all of the primary and secondary presentation forms have been considered (Merrill 1983).

Elaboration Theory (ET)

According to this theory, to reach the optimal education, the instruction should be designed and presented in increasing levels of complexity. Accordingly, instructional sessions should start with the simplest scenarios and then move to the more complex, linking these educational sessions by reminding the learners what they have learned so far.

In line with component display theory and elaboration theory, in this research, the educational content of each session has the following features:

- Designed for specific learning objectives;
- Designed for specific learning outcomes;
- Provided in a different way of presentation;
- Remind the students about what they have learned in the last session;

- Presented in increasing order of complexity.

4.5.2. Student Model (SM)

A student model holds the student details, characteristics and learning preferences. Accordingly, based on these details, the learning materials and teaching strategies can be adapted to fit the preferred learning style of the students. In other words, this model represents a student profile, which stores all user-relevant details. These details can be divided into two main parts. While the first part summarises the preferred learning style of students, as detected by the ALSI instrument, the second part contains the personal details of students including student name, number, age, email, etc. Figure 17 explains the structure of the student domain.

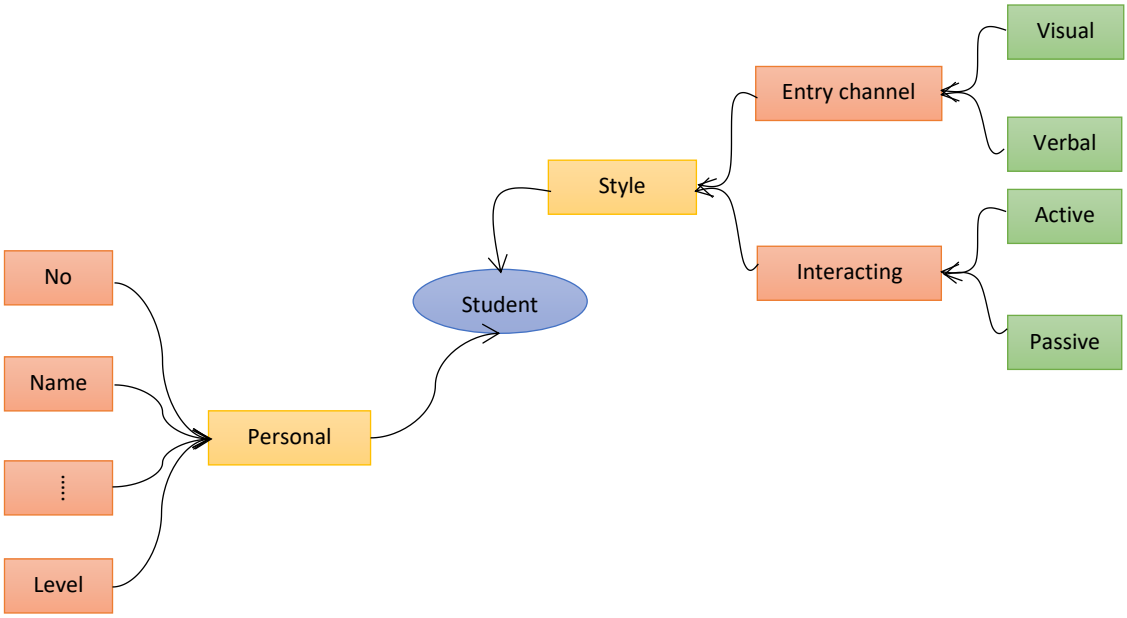

Figure 17: Student Model (SD) - LAES System.

4.5.3. Teaching Strategies Model (TSM)

Teaching strategy defined as “a particular set of steps to evoke from learners a specific set of desired behaviors” (Silver, Hanson et al. 1982).

A teaching strategies model contains a description of various teaching strategies that can be used to teach the different types of students. Typically, each teaching strategy involves a set of teaching activities. In this sense, each teaching strategy can be presented as a tree of teaching activities (see Figure 18).

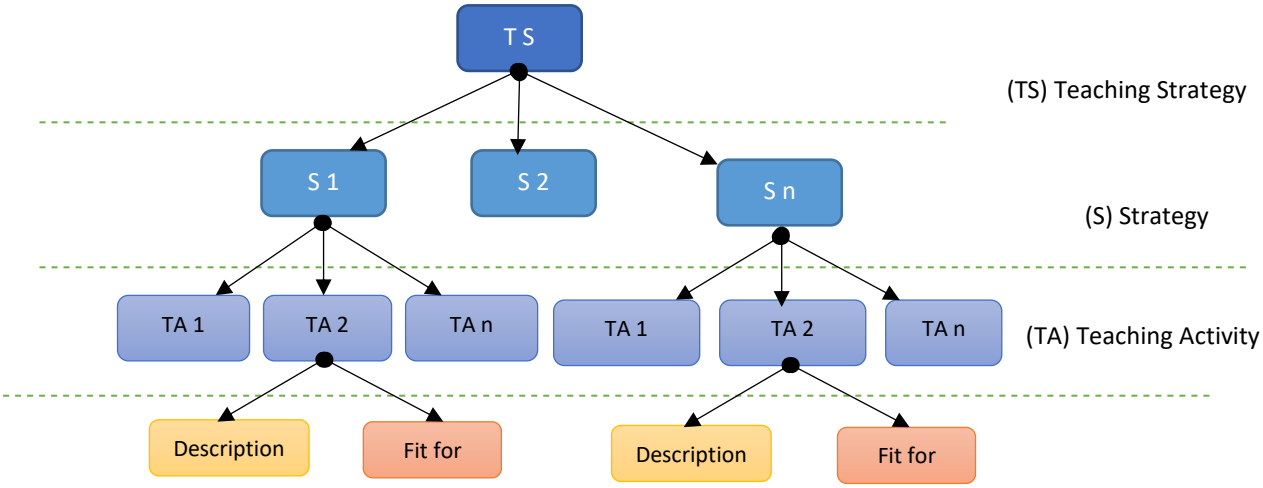

Figure 18: Teaching Strategies Model (TSM) - LAES System.

4.5.4. Pedagogical Model

The main objective of this model is to provide interesting content and teaching activities for each individual student. To this end, if the student is a new user, the system will direct them to fill out the learning style instrument (ALSI) that consists of sixteen questions to detect the student learning style, which will be stored in a student profile. The learning session starts when the student is logged in. Accordingly, the system recommends the most

suitable content and teaching activities based on the preferred learning style of the student who is logged in (see Figure 19).

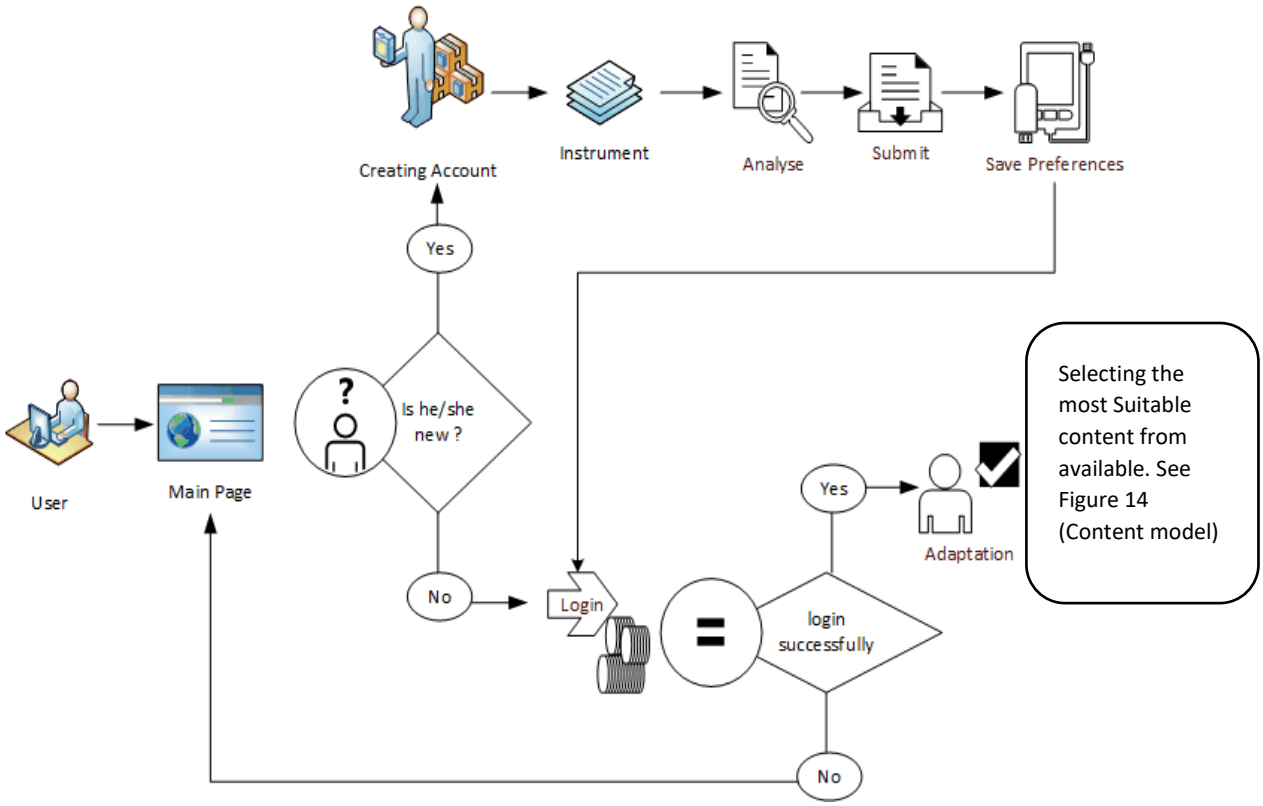

Figure 19: Pedagogical Model (PM) - LAES System .

The preferred learning style of the student plays an important role in the adaptation process because the content and teaching activities will be selected based on them (see Figure 20).

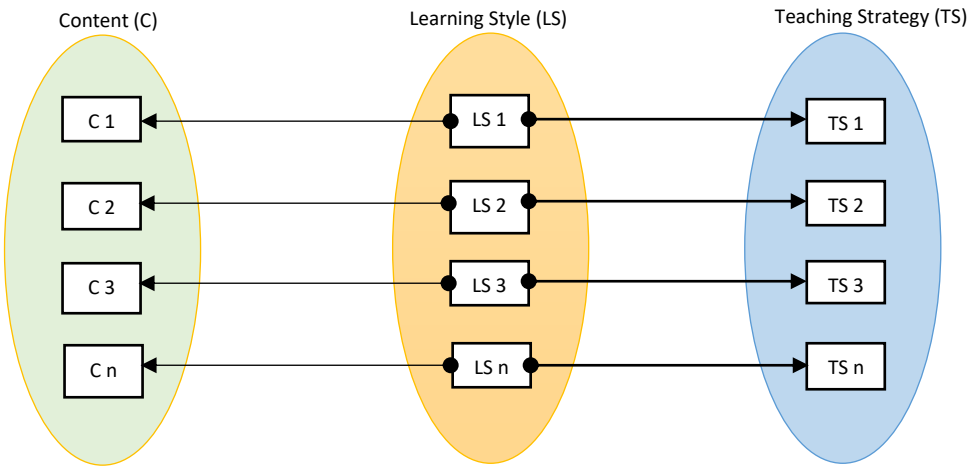

Figure 20: Learning Style, Teaching Style and Content Relationship - LAES System.

In order to clarify the concept of learning style at the beginning of course. It is also important to explain the different types of educational content and activities, and which content is the most appropriate for a specific learning style. This explanation will provide clear insights for students and help them to make the most favourable decision.

4.5.5. Classification of Students and Adaptation Rules

Based on the Alzain Learning Style Model, there are 4 types of combination of leaning styles (see Table 7).

Table 7: Combination of Learning Styles Based on Alzain Learning Style Model.

Combination of learning styles	
1	Visual / Active
2	Visual / Passive
3	Verbal / Active
4	Verbal / Passive

These different types of learning styles are considered by the use of the following four elements, and the rules of each type are described below (Kinshuk, Lin 2004):

- Visual: get more from visual forms of information
  - ✓ More figures, graphs, charts and pictures;
  - ✓ Highlighting and colouring the important concepts;
  - ✓ Multimedia and animated demonstrations.
- Verbal: get more from verbal forms of information
  - ✓ Heavy textual content;
  - ✓ Audio records and files.
- Active: doing very well in groups
  - ✓ Providing discussion area;
  - ✓ More exercises;
  - ✓ Fewer examples.
- Passive: thinking before doing
  - ✓ Less detailed content (summarised);

- ✓ Giving time to think periodically;
- ✓ More examples;
- ✓ Fewer exercises.

4.5.6. The Adaptation Process of the System

This system depends on the following procedure to achieve the adaptation process: firstly, the new student needs to create a new account and then the system will direct them to fill out the ALSI instrument; the obtained score represents the student preferences in terms of visual, verbal, active and passive styles, and these preferences as well as the personal details are used to construct the student profile. Finally, the data stored in the student profile are used to apply the adaptation rules and generate the most suitable content and learning activities. See Figure 21.

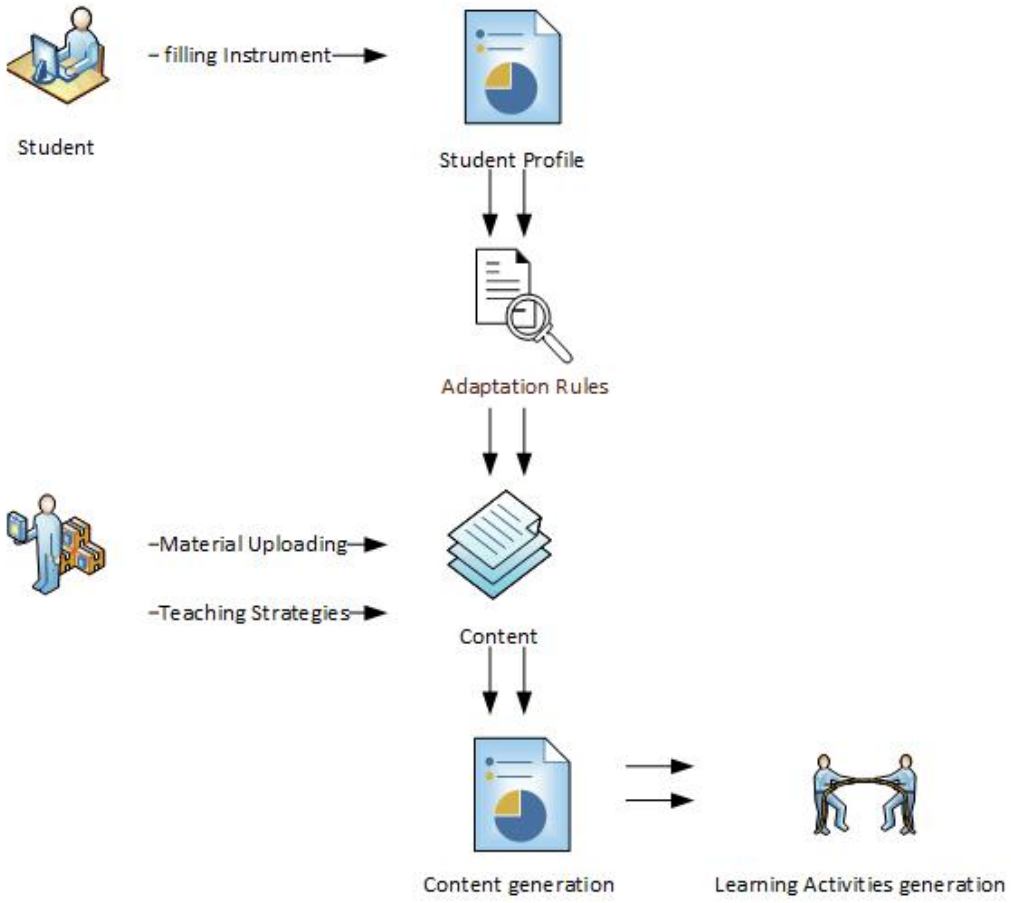

Figure 21: Adaptation Process - LAES System.

4.5.7. Determine the Student Preferences

To determine the preferred learning style of students, the procedure is as follows:

- The instrument consists of 16 questions;
- Each question has 4 choices;
- Participants need to give a priority level from 1 (least important) to 3 (most important) for each choice;
- Each choice corresponds to one preference;
- The highest score possible is 48 for each preference;
- Visual Preferences (VP) = $\sum_{Q=1}^{16} V$;
- Verbal Preferences (EP) = $\sum_{Q=1}^{16} E$;
- Active Preferences (AP) = $\sum_{Q=1}^{16} A$;
- Reflective Preferences (RP) = $\sum_{Q=1}^{16} R$;
- Preferred Style of Receiving new information (PSR) = VP – EP;
    - ✓ If PSR > 0 then student has Visual preference;
    - ✓ If PSR < 0 then student has Verbal preference;
- Preferred Style of Interacting new information (PSI)= AP-RP;
    - ✓ If PSI > 0 then student has Active preference;
    - ✓ If PSI < 0 then student has Reflective preference;

The preferred learning style of each student will be stored in his/her profile in order to use it as criteria to achieve the adaptation process. The next subsection presents the different methods of presentation.

4.5.8. Methods of Presentation in LAES System

The preferred learning style of the student is the main criteria, which governs the adaptation process and determines whether content and teaching activities are relevant or not. In this context, three different ways of presentation were designed in order to provide additional support to the teachers and students where needed.

- **Matching method**

In this approach, the user will be provided with the content and teaching activities that match his/her preferred learning style. For example, if the preferred learning style of the student is (visual/active) the system will provide him/ her with the visual and active content as well as the teaching activities that fit this style.

- **Mismatching method**

In this case, the user will be provided with the content and teaching activities that do not match their preferred learning style. For example, if the preferred learning style of the student is (visual/active) the system will provide them with the content and teaching activities that fit (verbal and passive) learning style.

- **Balanced method**

This approach is in between the two previous ways (matching and mismatching). Therefore, it is more suitable for the students who have equivalent or convergent preferences. For example, if the preferred learning style of the student in terms of the dimension of receiving new information (visual-verbal) was equivalent or convergent, that means the student mostly tends to benefit equally from the visual and verbal forms of information. Accordingly, the system will provide them with the content and teaching activities that consider both styles (visual and verbal).

In order to determine criteria for this approach, five experts in the subject area were interviewed and they suggested that, if the difference between the scores of the two scales is less than or equal to 10 percent we can consider that the preferences are equivalent. Accordingly, 10 percent of 48 (The highest score possible) ≈ 5. The equations can be found in subsection 4.5.7.

- ✓ If PSR (Preferred Style of Receiving new information) = {5,4,3,2,1,0,-1,-2,-3,-4,-5} then the student has an equivalent preference in terms of the preferred style of receiving new information;
- ✓ If PSI (Preferred Style of Interacting new information) = {5,4,3,2,1,0,-1,-2,-3,-4,-5} then the student has an equivalent preference in terms of the preferred style of interacting with the new information.

4.5.9. Adaptation of Teaching Strategies and Electronic Content

In this research, we have used the Alzain learning style model as the basis of our classification. As shown in Table 8, the Alzain learning style model takes into account two dimensions, which are channel of knowledge entry (visual-verbal) and ways of processing the new knowledge (active-passive). More details in subsection 4.3.

Table 8: Alzain Learning Style Model Dimensions.

Description	Dimension		Description
	Receiving new information		
Get more from what they have seen and observed	Visual	Verbal	Get more from what they have heard, read and said
Description	Dimension		Description
	Ways of processing the new knowledge		
Get more from what they have done	Active	Passive	Get more from what they have thought about

In 2008, Franzoni defined teaching strategies as "*the elements given to the students by the teachers to facilitate a deeper understanding of the information*" (Franzoni et al. 2008) . She also explained that the adaptive educational systems should consider not only learning style but also teaching strategies, and the reason behind that is that the teaching quality will be affected by the applied teaching strategies. Therefore, the teachers must select the teaching strategies carefully and apply them in a manner that supports the students and encourages them to acquire knowledge, solve problems and look for solutions by themselves. Table 9 presents some teaching strategies that fit the different learning styles (Franzoni et al. 2008).

Table 9: Teaching Strategies and Learning Styles.

		Learning Styles			
		Visual	Verbal	Active	Passive
Teaching Strategies	Presentation	✓			✓
	Brainstorming		✓	✓	
	Discussion panel		✓	✓	
	Games	✓		✓	
	Learning based on problem solving			✓	
	Role playing			✓	
	Case study				✓
	Question and answer		✓		✓
	Project			✓	

4.6. Summary

This chapter describes the process of development of a novel technological and pedagogical framework (the Five-arrows framework). It also discussed the development of the Alzain Learning Style Model and the ALSI instrument. Finally, this chapter discussed the design and development of LAES system, specifically system architecture, content model, student model and pedagogical model.

The following chapter will present in detail the results of investigating the current situation of Libyan Higher Education System in terms of using technology and pedagogy in the education process, as well as the results of investigating the reliability and validity of the first Arabic Learning Style Instrument (ALSI). The chapter will also cover the results of investigating the impact of using visual and active information in constructing the instruments of learning styles and the impacts of that on the efficiency and accuracy of these instruments. Finally, the chapter will present in detail the results of implementing the Five-arrows framework using the LAES system and the impact of that on the performance of students.

5. Chapter Five: Results and Discussion

5.1. Introduction

The preceding chapter discussed the development of the Five-arrows framework, the Alzain Learning Style Model and the ALSI instrument. It also covered the details of the design and development of the LAES system.

This chapter presents in detail the results in accordance with the research objectives and research questions as outlined in Chapter 1. It firstly presents the results of investigating the current situation of LHES in terms of using technology and pedagogy in the education process, as well as teacher attitudes and needs regarding using technology to develop the education process. Secondly, the chapter presents the results of investigating the reliability and validity of the ALSI Instrument, specifically focusing on its internal consistency reliability, test-retest reliability and content validity index. This chapter also presents the findings of investigating the preferred learning style of computing students in Misurata University in Libya, compared with the preferred learning styles of students across a number of related studies around the world. Moreover, the chapter presents the results of investigating the impact of using visual and active information for constructing the instruments of learning styles, and the impact of that on the efficiency and accuracy of these instruments. Finally, this chapter presents in detail the results of applying the Five-arrows framework using the LAES system and the impacts of that on the performance of students.

5.2. Investigating the Current Situation of the Libyan Higher Education System (LHES)

5.2.1. Introduction

This part of the research, investigates the technical and vocational education and training system in Libya, in order to gain some insights into the problems faced in the teaching process and the challenges for the future.

A questionnaire methodology has been utilised to collect data. The data was collected from 46 teaching staff members across 3 faculties and 2 higher institutes (polytechnics). An exploratory statistical analysis of this data is presented in the following subsections.

5.2.2. Data Collection

A five-level Likert scale questionnaire was designed, and distributed to achieve the study objectives. The questionnaire contained 40 questions covering the three basic domains of the study: Content, Pedagogy and Technology, and 37 were close-ended questions to encourage the participants to select their response.

Although 55 questionnaires were distributed, the actual number of respondents was 46, which represents a response rate of 83 percent. The format of the questionnaire used in this study allowed participants to select one of the following alternatives: “1” ‘strongly disagree’ , “2” ‘disagree’, “3” ‘neutral’ , “4” ‘agree’ , “5” ‘strongly agree’ , to indicate to what extent they are satisfied with each statement.

For testing the reliability of the entire questionnaire and evaluating internal consistency Cronbach’s Alpha was conducted. The calculated value of Cronbach’s Alpha was (0.82) and that was considered an adequate value for testing questionnaire reliability because it is more than 0.7 (Tuckman, Harper 2012).

Table 10 presents the characteristics of teaching staff members who participated in the study.

Table 10: Demographic Description of the Participants - Experiment of Investigating the Current Situation in LHES.

		Number	Percentage
Working at	University	31	67.40 %
	Institute	15	32.60 %
Age	22 - 30	15	32.60 %
	31 - 39	17	37.00 %
	40 – 50	12	26.10 %
	50 +	2	4.30 %
Experience	1 – 5	29	63.04 %
	6 – 10	8	17.40 %
	11 – 15	6	13.04 %
	16 +	3	6.52 %
Gender	Male	31	67.40 %
	Female	15	32.60 %

5.2.3. Perceptions of Staff Members

As shown in Figure 22, teaching staff members were asked whether they felt they needed to be involved in professional training courses in instructional content design and presentation. Figure 22 shows that half of them (50 %) strongly agree, while (37 %) agree. On the other hand, (13 %) of them have a neutral opinion. These statistics underline the participants need for professional training courses of content design and presentation.

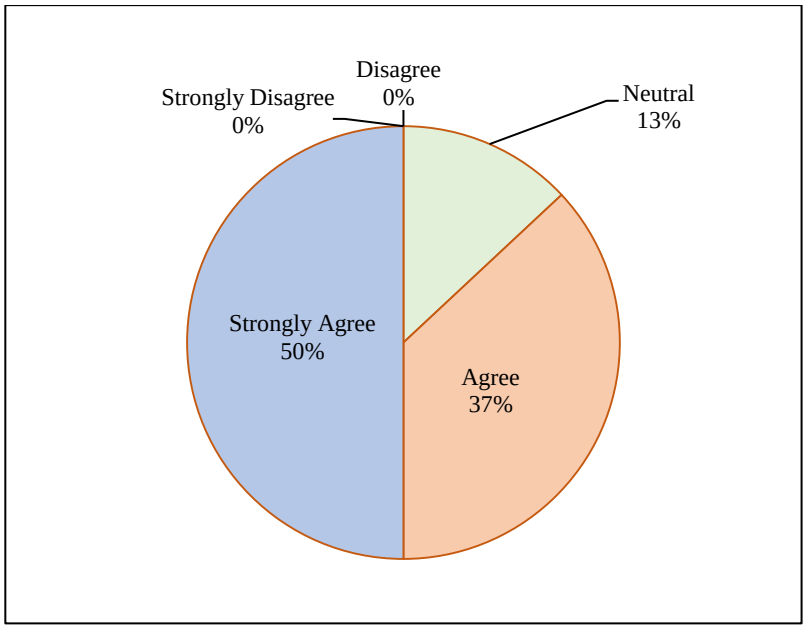

Figure 22: Percentage of Participants who Needed to be Involved in Professional Training Courses of Content Design and Presentation.

Participants were also asked whether they would like to be involved in professional training courses in terms of technological practices in education. As illustrated in Figure 23, all participants (100 %) strongly agree or agree. This pattern of responses might demonstrate the clear desire of sample members to engage in these courses.

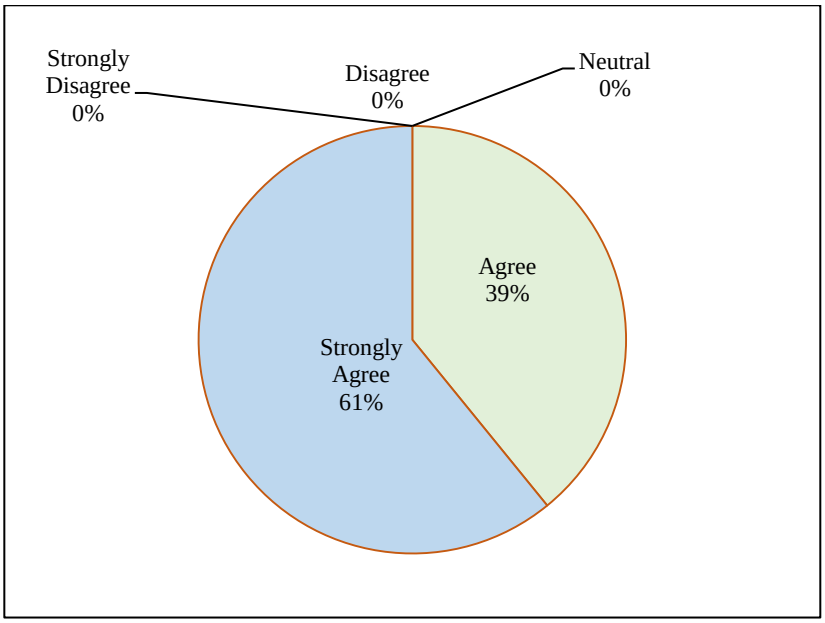

Figure 23: Percentage of Participants who Needed to be Involved in Professional Training Courses in Technological Practices in Education.

With regard to pedagogical training courses, the participants were asked whether they felt they needed to be involved in professional training courses regarding pedagogical practices in education. The results (Figure 24) show that the majority of them (87 % of the sample) strongly agree or agree, whereas (13 %) of them are neutral or disagree. These statistics clearly indicate that the majority of participants think that they need to improve their skills in terms of pedagogical practices in education.

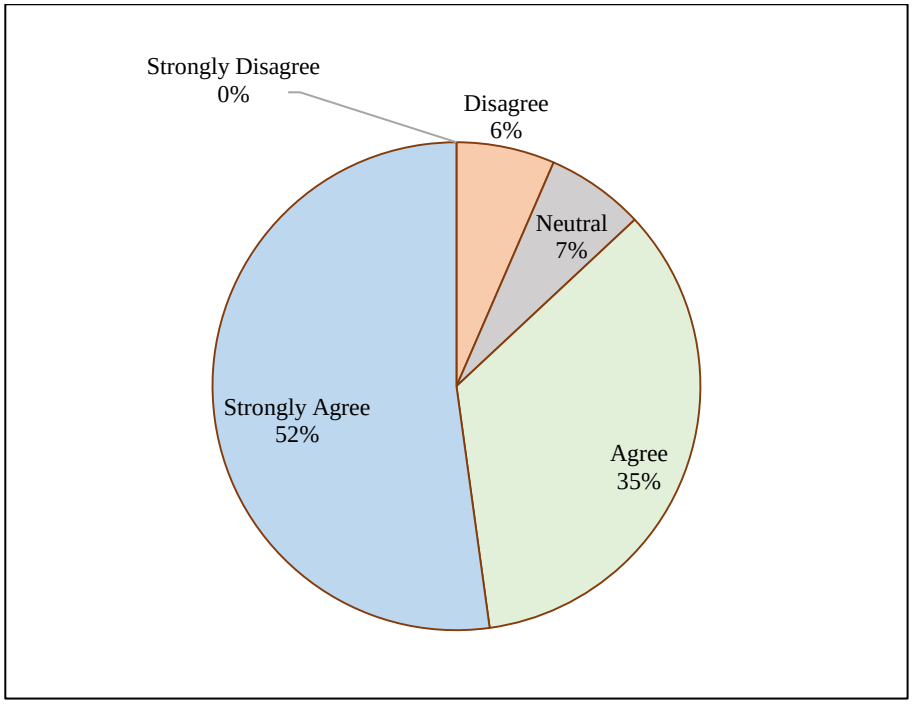

Figure 24: Percentage of Participants who Needed to be Involved in Professional Training Courses in Pedagogical Practices in Education.

Overall, it can be stated that most teaching staff members wish to engage in more professional training courses about content, technology and pedagogy.

5.2.4. Teacher Beliefs Regarding Using ICT in the Education Process

With regard to harnessing technology in education, the participants were asked whether they think that using technology in education often has a positive impact on student performance. The results show that (65 %) of participants agreed; in contrast, 35 % of participants think that the technology sometimes is not useful (see Figure 25) because they believe:

(Participant 2) “Sometimes the technology like the internet makes the students and teachers more passive because it provides a huge amount of resources and services, and this makes them over-reliant on technology.”

(Participant 19) “Technology should be used elaborately.”

(Participant 34) “That depends on teacher experience about using technology.”

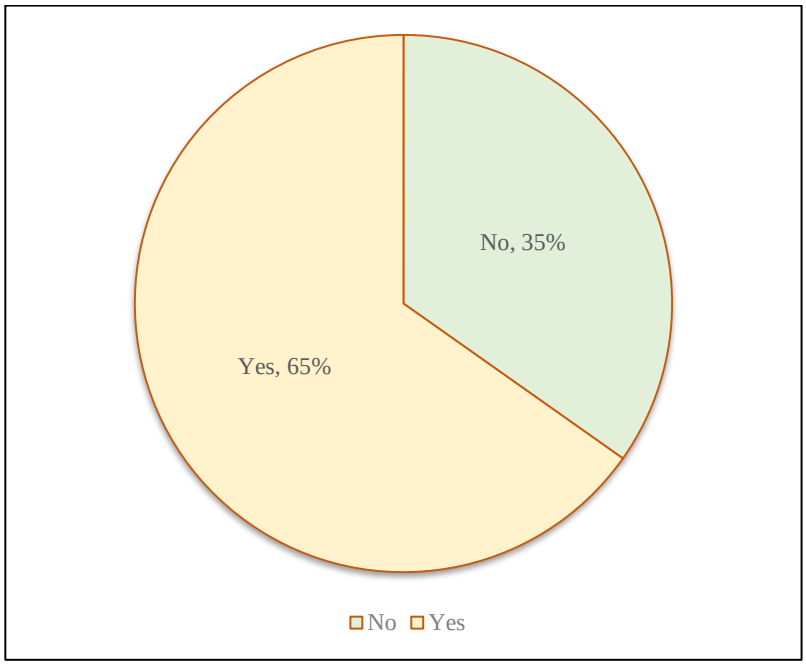

Figure 25: Percentage of Participants who Think that Using Technology in Education has Positive Impact on Performance of Students.

5.2.5. Teaching Approaches

The participants were also asked whether they think a student-centred teaching approach is more effective than a teacher-centred teaching approach. Although more than (75 %) of participants think that the student-centred teaching approach is better than the teacher-centred approach, only (41 %) of participants indicated that they are using student-centred teaching approaches in their teaching. For more details, see Table 11.

Table 11:Percentage of participants who think that student-centred teaching approach is better than the teacher-centred approach, and participants who depend on student-centred teaching approach in their teaching

	Percentage of participants who think that student-centred teaching approach is better than the teacher-centred approach	Percentage of participants who depend on student-centred teaching approach in their teaching
Strongly disagree	0 %	2 %
Disagree	4 %	26 %
Neutral	20 %	31 %
Agree	33 %	39 %
Strongly agree	43 %	2 %

5.2.6. Graduates and Job Market Needs

As illustrated in Figure 26, the participants were asked about the suitability of LHES graduates for job market needs. The analysis showed that only (16 %) of participants agreed that the outcomes of the teaching process are suitable to meet job market needs. In contrast, 84 % think that the outcomes of the teaching process do not fit job market demands. They reported that:

> "The education system is much more theoretical than practical" (Participants 2, 8).
>
> (Participants 7, 18, 22, 28, 32): "Lack of coordination and connection between education system and the other sectors."
>
> (Participants 15, 17, 27, 38, 39): "Lack of planning, managing and developing the curriculum."
>
> (Participants 31, 36): "Lack of investigating the real needs of job market."
>
> (Participants 26, 33, 37): "Lack of student steering especially in early stages."

This pattern of responses might demonstrate the urgent need for more research in this field.

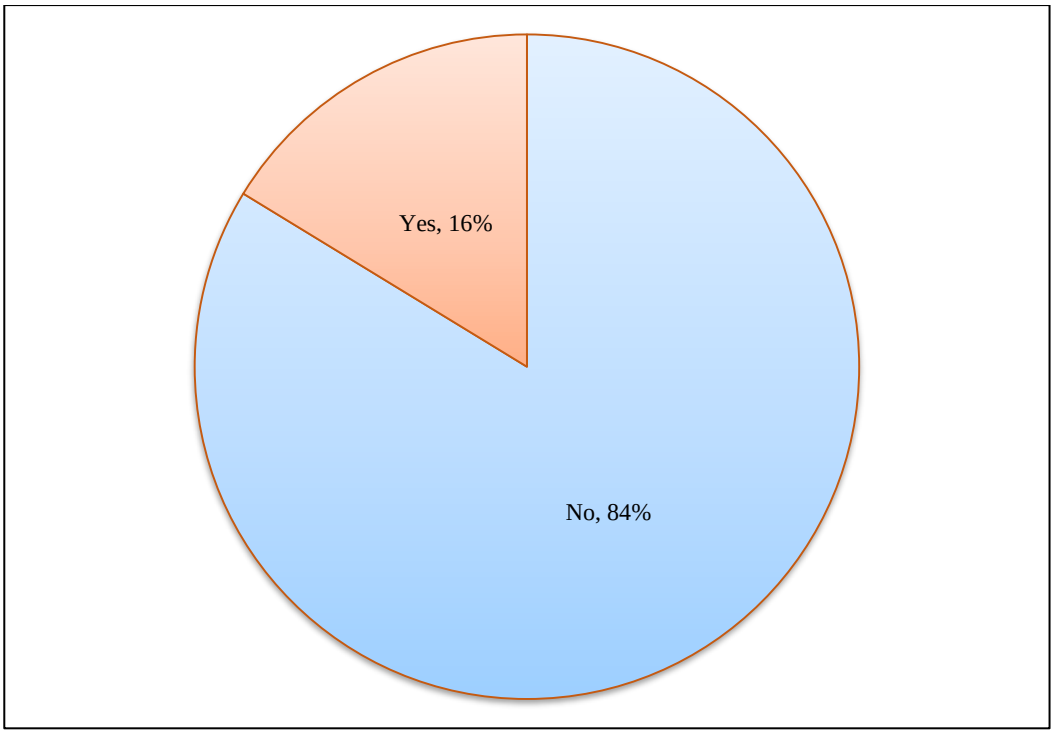

Figure 26: Participants' Opinion about the Suitability of LHES Graduates to Job Market Needs.

5.2.7. Correlation Measuring

As shown in Table 12, Spearman's correlation coefficient test was conducted to measure the strength of the association among the participant age and experience on the one hand, and using technology and pedagogy in teaching and teaching style on the other hand.

Table 12: Correlation Coefficient between the participant age, experience and using technology and pedagogy in teaching.

		N	Using technology in teaching process	Using pedagogy in teaching process	Using student-centred approach	Using teacher-centred approach
Age	Correlation Coefficient	46	0.154	- 0.275	0.024	0.119
	Sig. (2-tailed)	46	0.307	0.557	0.519	0.454
Experience	Correlation Coefficient	46	0.270	- 0.098	0.100	- 0.060
	Sig. (2-tailed)	46	0.062	0.569	0.423	0.988

The results showed the absence of any significant correlation between these variables.

5.2.8. Discussion and Conclusion of Investigating the Current Situation of LHES

Information and Communications Technology (ICT) has been extensively used in education to improve the quality of outcomes. In this context, Abod-her stated that: *"ICT is used strategically to enhance learning and teaching which may enhance teaching possibilities. It also helps to improve the quality of education (with the introduction of advanced teaching approaches), to improve learning outcomes and to allow for reform or the better organisation of education systems particularly university education systems"* (Abod-her 2013) .

With reference to the Libyan context, in 2012 Kenan investigated the Impact of ICT on collaborative learning processes in LHES, and this study concluded that: *"Libyan universities could benefit from the active learning notion, and develop it as E-learning, where students are not only listeners in the class but interact with the teacher and discuss together the knowledge offered by the subject*" (Kenan, Pislaru et al. 2012). This was also supported by Rhema, 2012, who stated that, "*using ICT as an instructional medium will likely change many of the traditional strategies employed by both Libyan students and instructors in the learning process*" (Rhema, Miliszewska 2012)**.**

Although the Libyan government has given more attention to developing the higher education system and given the top priority to ICT, it is clear that the higher education system still encounters many challenges, and Libyan officials have had problems with establishing a satisfactory education system. These results reflect the opinion of (Abod-her 2013) who think that *"most developing countries including Libya have not so far succeeded in effectively utilizing ICT for economic development. Additionally, ICT services are not yet a reality in most institutions in these countries."* In this sense, Rhema also thinks that the harness of technology in education is still in its quite early stages in Libya (Rhema, Miliszewska 2012).

In this work, after investigating the literature, it was important to explore the current practices and situation of LHES to get a sound understanding regarding teacher perceptions, needs and attitudes towards using technology in education.

This approach is highly recommended for the studies that are concerned with using technology in education because, *"positive attitude towards ICTs is widely recognized as a necessary condition for the effective implementation"* (Sife, Lwoga et al. 2007, Woodrow 1990), and *"Understanding the user's attitudes in the direction of E-learning facilities is*

important for the creation of appropriate E-learning environments for teaching and learning" (Kenan et al. 2012). However, the researcher noticed that the earlier studies concerned with learning styles and adaptive education systems, with minor exceptions, have been implemented without investigating the surrounding environment including teacher attitudes towards using technology in education.

In line with a number of studies, the results of this study revealed that the teachers generally have a positive attitude towards using technology in education, and they think that technology has a positive impact on student performance.

In 2013, Othman investigated the attitudes and awareness of a group of Libyan students studying abroad with regards to use of IT in education, and the results showed that, "*The majority of students in this research were comfortable and confident concerning usage of computers as well as the online environment in general*" (A. Othman et al. 2013a). This was also supported by Abod-her who reported that *"All academic staff displayed a positive attitude to the use of ICT in their teaching and learning practice. Participating teachers seemingly realised the value of ICT as a tool to reinvigorate their teaching practice, and acknowledged that ICT could open new opportunities to enhance learning"* (Abod-her 2013).

Despite this positive attitude, some teachers think that sometimes technology is not useful, and this might lead to resistance in adopting technology in education, due to insufficient awareness of using technology in education. In this sense, El Zoghbi stated, "*In Libya, the awareness of educational technology and basic computer skills are generally low which leads to resistance in adopting ICT for teaching"* (El Zoghbi, Kumar et al. 2010). This lack of skills and awareness might be the main reason behind the significant wish of the participants in this study to be involved in professional technological training courses, whereby all of the participants (46 teachers) explicitly declared that they would like to be involved in professional training courses in terms of technological practices in education. As a result, the researcher recommends the institutions launch professional training courses in order to allow teachers to enhance their awareness, knowledge and skills. These recommendations are consistent with results of a number of related studies, which investigated the barriers that might be holding back adoption of technology in LHES. These studies revealed that the lack of professional training courses is one of these barriers (A. E. Elzawi 2015, Abod-her 2013).

In this context, the researcher thinks that the success of harnessing of technology in education depends on a number of factors, such as the positive attitude towards using

technology in education, well-developed infrastructure, technical support, and most importantly, qualified academic staff who know when and how to use the technology, and how to choose the most suitable technological tool for the instructional situation and learners needs.

Another important issue investigated in this study was the suitability of LHES graduates in relation to job market needs. The results showed that most of the participants (84 %) think that the outcomes of LHES do not fit the job market demands. This is an important result, because if the outcomes do not meet what the job market needs that means more and more work and research are required to investigate and develop the teaching approaches and curriculum.

The findings of this research revealed that one of the main reasons behind this is a lack of connection, cooperation and coordination between the sector of higher education and the other sectors such as the industrial and healthcare sectors. In this sense, in 2011, Tamtam mentioned that, *"Universities and their administration have failed to establish a relationship with the labour market making learners to be without favour from the job market. Through linking undergraduate and graduate programs with the labour market, the education system can greatly shape the future of the students and the industry as well"* (Tamtam et al. 2011). That was supported later by Kenan in 2012: *"Current education does not provide a "job-ready" workforce because the education system is disconnected from the demands of the job market"* (Kenan, Pislaru 2012).

In order to increase the level of cooperation between the higher education system and the other sectors, this study recommends establishing a joint research group to organise and conduct the workshops and research that can enhance the mutual cooperation between these sectors. Another solution was proposed by Triki, who investigated the perceptions of students regarding Technical and Vocational Education and Training programmes in Libya. The results of this research revealed that most of the participants (71.2 %) wish to spend time on training in relevant industry. Therefore, this study recommends that, *"Higher education programmes should prepare students and train mature workers according to the manufacturing industry demands and technological evolution"* (Triki 2013). This research also indicated that there is an urgent need to develop the educational content and teaching strategies to be more relevant to the ICT. In this sense, El Zoghbi reported that "*Because e-learning is different from traditional learning, the curriculum and pedagogical methods need to be modified and developed*" (El Zoghbi et al. 2010).

In conclusion, it is clear that the results of this part of the research supplied the researcher with a sound understanding of the current state of LHES and its challenges, boosting the possibility of effective implementation and increasing the value of the results of this research. Finally, although the Libyan government has given more attention to developing the education system in general, and the higher education system in particular, it is clear that the higher education system still encounters many challenges and much more work is required to develop the outcomes of LHES.

5.3. The Reliability and Validity of ALSI Instrument

Data collection instruments can significantly affect the research outcomes (Polit, Beck 2006, Alzain et al. 2016). Therefore, the instruments that are used to collect the data must be both valid and reliable. In order to validate the ALSI instrument, a number of rigorous procedures were conducted. The following few subsections provide a brief description of these procedures.

Internal Consistency Reliability Test

When a new instrument emerges, the first and most important issue considered by the developers is its reliability. Reliability is about the repeatability and internal consistency. While repeatability can be tested by test-retest reliability, the internal consistency of the instruments can be estimated by computing Cronbach's Alpha (M. S. Zywno 2003a, Cohen et al. 2013, Tuckman, Harper 2012).

Test-Retest Reliability Test

As mentioned earlier, reliability refers to the consistency and repeatability. Normally, test-retest method is used to test the stability of the instrument over time. This method assumes that if the same instrument is used with the same or similar sample of participants, the results should not be different (M. S. Zywno 2003a, Al-Jojo 2012, Tuckman, Harper 2012).

Content Validity Index Test

Researchers often investigate the content validity of new instruments by computing the Content Validity Index (CVI). The CVI method provides evidence of content validity based on experts rating. To calculate CVI, the relevance of each item to the underlying construct should be evaluated by a number of experts (from 3 to 10) (Polit, Beck 2006). In this part of the study, to avoid the neutral opinion, a four-point ordinal scale was used to evaluate the relevance of ALSI items (1= not relevant, 2= somewhere relevant, 3= quite relevant, 4= highly relevant). This scale was recommended by (Davis 1992).

The Item Content Validity Index (I-CVI) was also computed for each item. In 2006, Polit and Beck reported that I-CVI = the number of experts giving a rating of (quite relevant) or

(highly relevant) divided by the total number of experts (Polit, Beck 2006). Consequently, the average of the overall scale (S-CVI/Ave) is computed by the average of I-CVI_S or averages of the proportion of items, which are rated as relevant across the experts.

Factor Analysis Test

Factor analysis is a statistical test used for testing the relationships within a set of observed variables, consequently minimising the number of variables to a small number of components (Beavers, Lounsbury et al. 2013).

According to Zywno, there are two approaches to estimate the number of extracted factors using the factor analysis test. The first approach is the Kaiser-Gutman approach, which ignores the factors that have Eigenvalues less than (1.0). Another approach is a "scree plot". This approach focuses on the area of the scree plot, where the eigenvalues are smoothly decreased to the right, and it ignores the factors beyond this area (M. S. Zywno 2003a). While the first approach (the Kaiser-Gutman) sometimes extracts too many factors, the number of extracted factors by the second approach (the scree plot) are sometimes too few. For this reason, some researchers suggest that the important criterion that we have to consider is the percentage of total variance that is explained by the extracted factors; therefore, the researchers in the education field reported that (50 %) of total variance is adequate (Beavers et al. 2013).

5.3.1. A Study of the Reliability and Validity of the Arabic Version of the ALSI

Sample Description

This experiment was conducted with 111 undergraduate students from Misurata University, 30 males (27 %) and 81 females (73 %). The mean participant age was 22 (SD = 3.10), the minimum age was 17 and the maximum age was 34. The mean participant experience (years of computer use) was 6.92 (SD = 2.74), the minimum experience was 1 and the maximum experience was 18. Table 13 and Table 14 present the characteristics of the participants.

Table 13: Sample Description of Participants in the Experiment of Validating the Arabic Version of the ALSI Instrument.

GENDER			
		Frequency	Percent
Valid	Female	81	73 %
	Male	30	27 %
	Total	111	100 %

Table 14: Descriptive Statistics of Participants in the Experiment of Validating the Arabic Version of the ALSI Instrument.

Statistics							
		Age	Experience	Active Scale	Passive Scale	Visual Scale	Verbal Scale
N	Valid	111	111	111	111	111	111
	Missing	0	0	0	0	0	0
Mean		22.00	6.92	31.44	22.91	32.14	22.29
Std. Deviation		3.10	2.74	6.28	6.42	7.05	6.33
Minimum		17.00	1.00	11.00	6.00	15.00	9.00
Maximum		34.00	18.00	43.00	38.00	46.00	36.00

The results of exploring the preferred learning styles of the participants are listed below in Table 15. The columns of Table 15 are labelled active, passive, visual, verbal and equivalent preference. These columns show the percentage of students who have these learning preferences.

The results indicate that (85 %) of students are more active in comparison with (11 %) who are passive and only (4 %) of students who have equivalent preferences. On the other hand, most of the students, (85 %) have visual preferences in comparison with only (10 %) with verbal preferences and (5 %) of students with equivalent preferences. See Table 15.

Table 15: Participants Classification – the Experiment of Validating the Arabic Version of the ALSI Instrument.

Misurata University (N = 111)					
Active - Passive Dimension			Visual - Verbal Dimension		
Active	Passive	Equivalent Preference	Visual	Verbal	Equivalent Preference
85 %	11 %	4 %	85 %	10 %	5 %

Figure 27 shows the distribution of participants based on each scale.

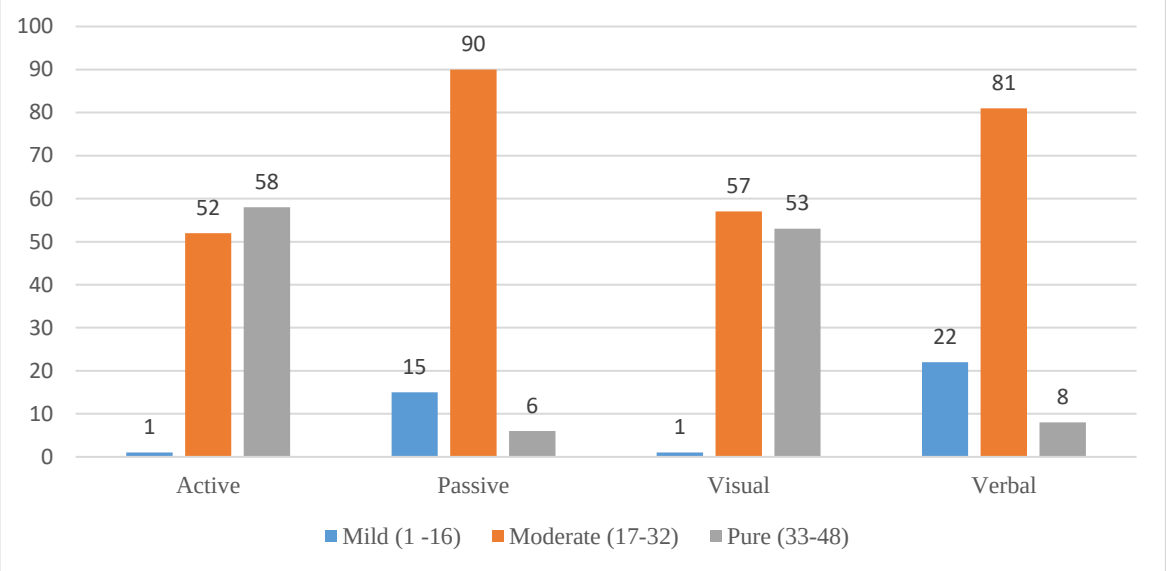

Figure 27: Participant Distribution Based on Scales - the Experiment of Validating the Arabic Version of the ALSI Instrument.

Internal Consistency Reliability: the Arabic Version of the ALSI Instrument

To check the internal consistency reliability of scales, Cronbach's alpha coefficient was computed for each scale. Table 16 shows the values of Cronbach's alpha coefficient, which are obtained based on a sample of 111 students. The calculated values meet the criterion of

Tuckman, who considered that alpha of (0.50) or greater is adequate for the instruments that measure attitude or preference such as learning style (Tuckman, Harper 2012).

Table 16: ALSI Instrument (Arabic Version) – Cronbach's Alpha Coefficient.

Scale	Alpha value 16 items	Mean	Std. Deviation	N
Active	0.678	31.44	6.28	111
Passive	0.591	22.91	6.42	111
Visual	0.711	32.14	7.05	111
Verbal	0.577	22.29	6.33	111

To investigate whether the reliability of the instrument was negatively affected by any item, a classical item analysis was conducted. The results of this test show the weakest item in each scale and the largest increase in the value of Cronbach's alpha coefficient if this item is deleted; these items are written in red bold format in Table 17.

Table 17: ALSI Instrument (Arabic Version) - Output of Classical Item Analysis Test.

Active Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	Passive Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1 ACT	0.373	0.311	0.654	Q1 PAS	0.324	0.159	0.556
Q2 ACT	0.238	0.288	0.669	Q2 PAS	0.012	0.131	0.605
Q3 ACT	0.266	0.215	0.665	Q3 PAS	0.204	0.209	0.577
Q4 ACT	0.252	0.242	0.667	Q4 PAS	0.299	0.246	0.561
Q5 ACT	0.179	0.162	0.678	**Q5 PAS**	**0.210**	**0.364**	**0.644**
Q6 ACT	0.140	0.204	0.682	Q6 PAS	0.335	0.270	0.553
Q7 ACT	0.300	0.223	0.661	Q7 PAS	0.140	0.138	0.588
Q8 ACT	0.316	0.327	0.659	Q8 PAS	0.098	0.173	0.595
Q9 ACT	**0.075**	**0.187**	**0.690**	Q9 PAS	0.200	0.271	0.578
Q10 ACT	0.114	0.253	0.685	Q10 PAS	0.349	0.309	0.554
Q11 ACT	0.433	0.374	0.652	Q11 PAS	0.377	0.266	0.549
Q12 ACT	0.390	0.416	0.650	Q12 PAS	0.297	0.256	0.562
Q13 AC	0.353	0.321	0.654	Q13 PAS	0.421	0.395	0.537
Q14 ACT	0.473	0.333	0.641	Q14 PAS	0.277	0.262	0.566
Q15 ACT	0.235	0.237	0.671	Q15 PAS	0.151	0.227	0.587
Q16 ACT	0.491	0.397	0.639	Q16 PAS	0.287	0.331	0.564
Visual Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	Verbal Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1 VIS	0.406	0.397	0.688	Q1 VER	0.233	0.255	0.557
Q2 VIS	0.296	0.165	0.699	Q2 VER	0.232	0.266	0.557
Q3 VIS	0.474	0.488	0.676	Q3 VER	0.151	0.206	0.572
Q4 VIS	0.367	0.196	0.691	Q4 VER	0.201	0.262	0.563
Q5 VIS	0.348	0.297	0.693	Q5 VER	0.316	0.228	0.542
Q6 VIS	0.190	0.237	0.709	Q6 VER	0.242	0.270	0.555
Q7 VIS	0.269	0.195	0.702	Q7 VER	0.148	0.390	0.573
Q8 VIS	0.170	0.186	0.711	Q8 VER	0.157	0.134	0.570
Q9 VIS	0.457	0.307	0.680	Q9 VER	0.267	0.286	0.551
Q10 VIS	0.400	0.338	0.691	Q10 VER	0.106	0.166	0.577
Q11 VIS	0.397	0.279	0.691	Q11 VER	0.386	0.237	0.533
Q12 VIS	0.234	0.241	0.705	Q12 VER	0.363	0.390	0.533
Q13 VIS	0.313	0.331	0.696	Q13 VER	0.175	0.221	0.567
Q14 VIS	0.270	0.323	0.702	Q14 VER	0.389	0.372	0.529
Q15 VIS	0.355	0.170	0.691	**Q15 VER**	**0.003**	**0.159**	**0.596**
Q16 VIS	**0.054**	**0.175**	**0.724**	Q16 VER	0.055	0.371	0.589

Q= Question, ACT= Active, VIS= Visual, VER= Verbal, PAS= Passive.

The effect of the weakest items on the value of Cronbach's alpha coefficient of the ALSI instrument was highlighted in Table 18. The greatest increase was in the passive scale, from 0.591 to 0.644 followed by the verbal scale from 0.577 to 0.596.

Table 18: Cronbach's Alpha of Arabic Version of the ALSI Instrument if the Weakest Item in each Scale is Deleted.

Scale	Alpha Value 16 items	Alpha Value 15 items
Active	0.678	0.690
Passive	0.591	0.644
Visual	0.711	0.724
Verbal	0.577	0.596

The positive note that we should mention is that no item fell below the level of 0.10 in the Squared Multiple Correlation (see Table 17). That means the items in each scale are strongly related: "*The Squared Multiple Correlation is essentially the degree to which variance of the item score is accounted for by the scores for the other items in the scale*" (Litzinger et al. 2005).

Results of Cronbach's alpha coefficient and the classical item analysis provide evidence of internal consistency of the Arabic version of the ALSI instrument, and that leads us to the second part of the reliability test, which is concerned with repeatability.

Test-Retest Reliability: the Arabic Version of the ALSI Instrument

In this experiment, test-retest analysis test was conducted and the time lapse between the measurements was about three weeks. Table 19 shows the results of a *t*-test. As can be noted, the results revealed that there are no significant differences between the means of scores on the four scales of measurements (*p*. value > 0.05). Consequently, the results of the *t*-test provide evidence of repeatability for the Arabic version of the ALSI instrument.

Table 19: Results of Reliability Test - the Arabic Version of the ALSI Instrument.

Style	N	Mean	Std. Deviation	*t*	Sig (*p*. Value)
Active	60	31.91	6.17	0.86	0.45
	51	30.88	6.40		
Passive	60	22.95	7.11	0.07	0.09
	51	22.86	5.55		
Visual	60	32.68	6.97	0.87	0.64
	51	31.50	7.16		
Verbal	60	21.81	6.10	0.85	0.46
	51	22.84	6.61		

Content Validity Index: the Arabic Version of the ALSI Instrument

In order to investigate the content validity of the ALSI instrument, its items were evaluated by six experts in the subject area. Table 20 illustrates the ratings of experts for the ALSI instrument.

Table 20: ALSI Instrument (Arabic Version) - Rating on a 16 - Items Scale by Six Experts.

Item Number	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Number of Agreements	Item CVI
1	4	3	4	4	4	4	6	1.00
2	4	4	4	3	4	4	6	1.00
3	3	1	4	4	3	4	5	0.83
4	3	4	4	4	4	4	6	1.00
5	3	4	4	4	4	4	6	1.00
6	4	4	4	4	4	4	6	1.00
7	4	4	4	3	4	4	6	1.00
8	4	4	3	4	4	4	6	1.00
9	4	4	4	4	4	4	6	1.00
10	4	4	3	4	4	4	6	1.00
11	4	4	3	4	4	4	6	1.00
12	3	2	4	4	3	4	5	0.83
13	3	2	4	4	3	4	5	0.83
14	4	4	4	3	4	4	6	1.00
15	3	1	4	4	3	4	5	0.83
16	3	2	3	4	3	4	5	0.83
							Mean items I-CVIs	0.95
Proportion Relevant	1.00	0.69	1.00	1.00	1.00	1.00	Mean expert Proportion	0.95
							S-CVI/UA (Universal Agreement)	0.69

Based on Table 20, all six experts rated 11 items out of the 16 as (quite relevant) or (highly relevant). That means 69 percent of items were rated as relevant. However, for the rest of the items (3, 12, 13, 15 and 16) only one expert out of six rated these items as somewhere relevant or not relevant.

According to Polit, Lyann (1986) mentioned that, the value of I-CVI$_S$ should be in the vicinity of 0.8 when there are more than 5 experts (Lynn 1986, Polit, Beck 2006). As noted from Table 20, all of the items meet this criterion.

Factor Analysis: the Arabic Version of the ALSI Instrument

For more investigation, a factor analysis test was performed. The corresponding scree plot is shown in Figure 28.

According to the Kaiser-Gutman standard (Eigenvalues > 1.0), the number of extracted factors was equal to 22, accounting for 74.86 percent of the total variance. And the number of extracted factors using scree plot approach was 10, accounting for 49.11 percent of the total variance.

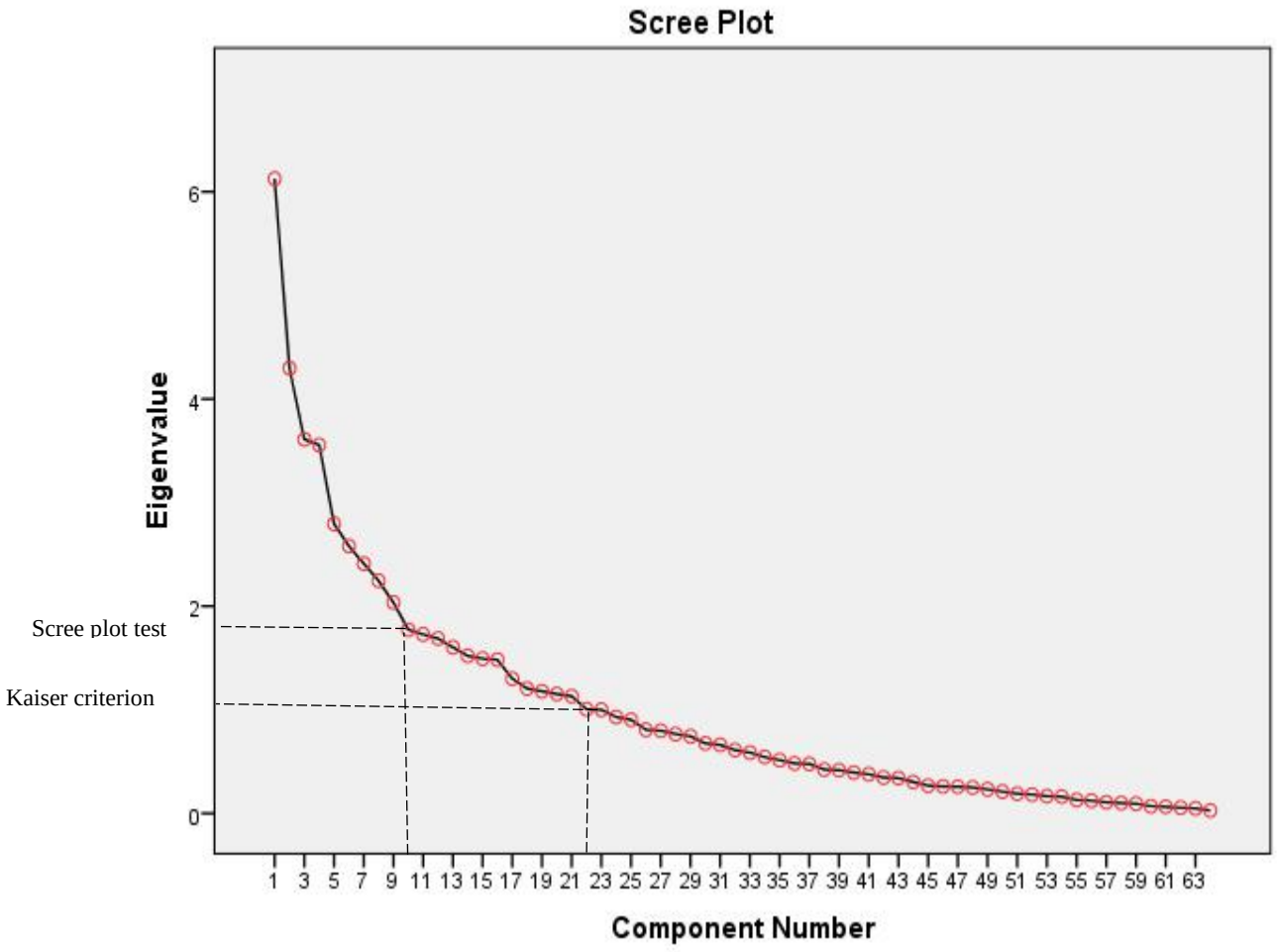

Figure 28: Scree Plot - Factor Analysis Test - the Arabic Version of the ALSI Instrument.

The results reveal that the visual scale maintained a stable structure, with all of the visual scale items consistently loading on two factors. The results also reveal that the other scales were related to more than two factors. Table 21 shows the results of ten-factor solution.

Table 21 : the ALSI Instrument (Arabic Version) - Factors in the Ten Factor Solution.

Scale	Number of factors	Factor	Items	Number of items in each factor
Visual	2	3	1, 2, 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15	13
		9	4,6,16	3
Active	3	1	11, 12, 13, 14, 15, 16	6
		4	1, 5, 7, 8, 9, 10	6
		5	2, 3, 4, 6	4
Verbal	3	2	2, 3, 4, 5, 6, 9, 10, 11, 12, 13, 14, 15	12
		10	1, 7, 8	3
		4	16	1
Passive	4	6	2, 3, 4, 7, 8, 10, 15	7
		4	5, 9, 13, 14	4
		8	1, 12, 16	3
		10	6, 11	2

5.3.2. A Study of the Reliability and Validity of the English Version of the ALSI Instrument

Sample Description

The experiment was conducted with 50 undergraduate students from Nottingham Trent University (NTU), 40 males (80 %) and 10 females (20 %). The mean participant age was 19.65 (SD = 2.01), the minimum age was 18 and the maximum age was 26. The mean participant experience (years of computer use) was 8.72 (SD = 2.83), the minimum experience was 3 and the maximum experience was 18. Table 22 and Table 23 present the characteristics of participants.

Table 22 : Sample Description - the Experiment of Validating the English Version of the ALSI Instrument.

GENDER			
		Frequency	Percent
Valid	Female	10	20 %
	Male	40	80 %
	Total	50	100 %

Table 23 : Descriptive Statistics of Participants in the Experiment of Validating the English Version of the ALSI Instrument.

Statistics							
		Age	Experience	Active Scale	Passive Scale	Visual Scale	Verbal Scale
N	Valid	50	50	50	50	50	50
	Missing	0	0	0	0	0	0
Mean		19.65	8.72	32.12	21.85	31.44	21.42
Std. Deviation		2.01	2.83	6.56	6.97	6.23	7.42
Minimum		18.00	3.00	18.00	10.00	12.00	6.00
Maximum		26.00	18.00	44.00	41.00	41.00	37.00

The results of exploring the preferred learning styles of students in NTU University are listed in Table 24. The columns of Table 24 are labelled active, passive, visual, verbal and

equivalent preference. The columns show the percentage of students who are active, passive, visual or verbal learners, and the students who have equivalent preferences.

The results indicate that (89 %) of students are more active in comparison with (9 %) who are passive and only (2 %) of students who have equivalent preferences. On the other hand, most of the students (87 %), have visual preferences in comparison with (11 %) who have verbal preferences and only (2 %) have equivalent preferences. See Table 24.

Table 24: Participant Classification - Experiment of Validating the English Version of the ALSI Instrument.

Nottingham Trent University (N= 50)					
Active-Passive dimension			Visual-Verbal dimension		
Active	Passive	Equivalent Preference	Visual	Verbal	Equivalent Preference
89 %	9 %	2 %	87 %	11 %	2 %

Figure 29 shows the distribution of participants based on each scale.

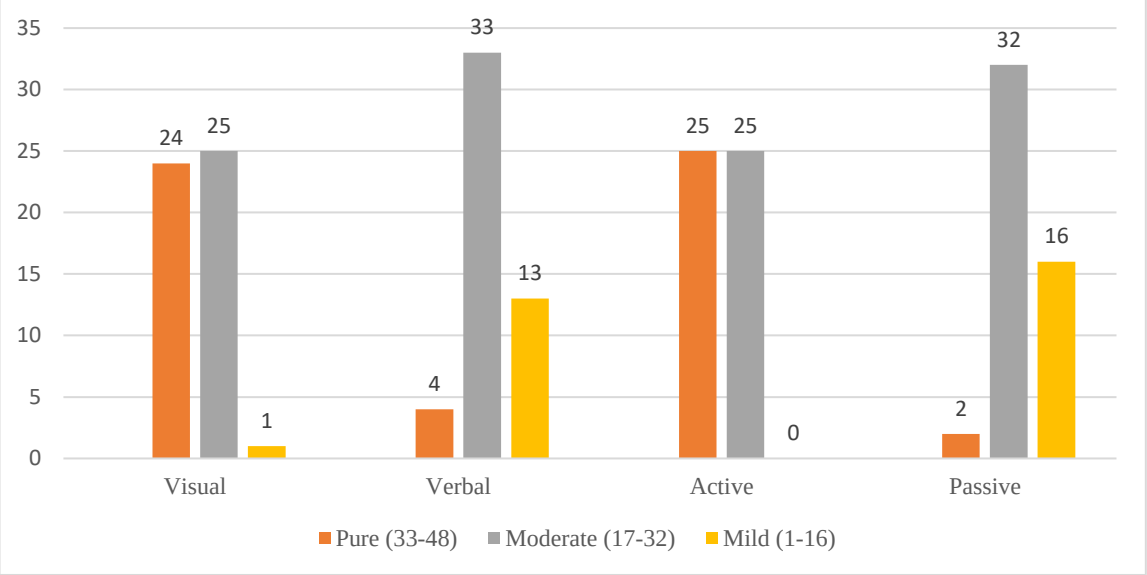

Figure 29: Participant Distribution Based on Scales - the Experiment of Validating the English Version of the ALSI Instrument.

Internal Consistency Reliability: the English Version of the ALSI Instrument

In order to check the internal consistency reliability of the scales of the English version of ALSI instrument, Cronbach's alpha coefficient was computed for each scale. Table 25 shows the values of Cronbach's alpha, which are obtained based on a sample of 50 students. All of these values meet the criterion of Tuckman and Harper, who considered that alpha of (0.50) or greater is adequate for the instruments that measure attitudes or preferences like the learning style (Tuckman, Harper 2012).

Table 25: the ALSI Instrument (English Version) – Cronbach's Alpha Coefficient.

Scale	Alpha value 16 items	Mean	Std. Deviation	N
Active	0.704	32.12	6.56	50
Passive	0.738	21.85	6.97	50
Visual	0.667	31.44	6.23	50
Verbal	0.782	21.42	7.42	50

A classical item analysis was also conducted to explore the weak items that might negatively affect the reliability of each scale. Table 26 shows the weakest item in each scale and the largest increase in reliability if this item is deleted; those items are written in red bold format.

Table 26: the ALSI Instrument (English Version) - Output of Classical Item Analysis Test.

Active Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	Passive Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1 ACT	0.355	0.453	0.684	Q1 PAS	0.386	0.448	0.719
Q2 ACT	0.342	0.429	0.686	Q2 PAS	0.184	0.466	0.737
Q3 ACT	0.343	0.439	0.685	Q3 PAS	0.382	0.578	0.720
Q4 ACT	0.517	0.604	0.660	Q4 PAS	0.314	0.598	0.726
Q5 ACT	0.133	0.377	0.709	Q5 PAS	0.488	0.565	0.710
Q6 ACT	0.399	0.436	0.678	**Q6 PAS**	**0.049**	**0.265**	**0.751**
Q7 ACT	0.246	0.295	0.696	Q7 PAS	0.219	0.424	0.735
Q8 ACT	0.438	0.495	0.672	Q8 PAS	0.473	0.546	0.710
Q9 ACT	0.247	0.273	0.696	Q9 PAS	0.238	0.558	0.733
Q10 ACT	0.360	0.385	0.682	Q10 PAS	0.519	0.720	0.708
Q11 ACT	0.449	0.378	0.676	Q11 PAS	0.444	0.737	0.713
Q12 ACT	**0.084**	**0.470**	**0.716**	Q12 PAS	0.051	0.288	0.751
Q13 ACT	0.270	0.465	0.694	Q13 PAS	0.487	0.537	0.709
Q14 ACT	0.073	0.231	0.712	Q14 PAS	0.243	0.346	0.734
Q15 ACT	0.151	0.506	0.707	Q15 PAS	0.499	0.469	0.706
Q16 ACT	0.420	0.467	0.675	Q16 PAS	0.327	0.469	0.725
Visual Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted	Verbal Scale	Corrected Item- Total Correlation	Squared Multiple Correlation	Cronbach's Alpha if Item Deleted
Q1 VIS	0.272	0.483	0.653	Q1 VER	0.505	0.507	0.761
Q2 VIS	0.366	0.401	0.644	Q2 VER	0.535	0.522	0.758
Q3 VIS	0.375	0.407	0.639	Q3 VER	0.470	0.560	0.763
Q4 VIS	0.073	0.457	0.674	Q4 VER	0.349	0.350	0.773
Q5 VIS	0.088	0.178	0.675	Q5 VER	0.391	0.392	0.770
Q6 VIS	0.573	0.499	0.611	Q6 VER	0.492	0.487	0.762
Q7 VIS	0.292	0.329	0.650	Q7 VER	0.379	0.559	0.771
Q8 VIS	0.160	0.280	0.668	Q8 VER	0.230	0.257	0.782
Q9 VIS	0.503	0.743	0.617	Q9 VER	0.503	0.475	0.760
Q10 VIS	0.144	0.477	0.665	Q10 VER	0.549	0.550	0.760
Q11 VIS	0.364	0.307	0.640	Q11 VER	0.286	0.184	0.778
Q12 VIS	0.157	0.403	0.669	Q12 VER	0.239	0.303	0.781
Q13 VIS	0.500	0.613	0.623	**Q13 VER**	**0.098**	**0.272**	**0.792**
Q14 VIS	**-0.052**	**0.542**	**0.700**	Q14 VER	0.336	0.472	0.774
Q15 VIS	0.279	0.457	0.652	Q15 VER	0.167	0.216	0.787
Q16 VIS	0.317	0.491	0.646	Q16 VER	0.551	0.511	0.756

Q= Question, ACT= Active, VIS= Visual, PAS= Passive, VER= Verbal.

The effect of the weakest items on the reliability was highlighted in Table 27, and the greatest increase was in visual scale, from 0.667 to 0.700.

Table 27: Cronbach's Alpha of English Version of the ALSI Instrument if the Weakest Item in Each Scale is Deleted

Scale	Alpha Value 16 items	Alpha Value 15 items
Active	0.704	0.716
Passive	0.738	0.751
Visual	0.667	0.700
Verbal	0.782	0.792

Moreover, the items in each scale are strongly related, because (Squared Multiple Correlation > 0.1) for each item in the scale. See Table 26. (Litzinger et al. 2005).

These results provide evidence of internal consistency of the English version of the ALSI instrument, and that leads us to the second part of the reliability test, which is concerned with the repeatability.

Test-Retest Reliability: the English Version of the ALSI Instrument

In this part of the research, the test-retest analysis was conducted, and the time lapse between the measurements was about three weeks. Table 28 shows the results of a *t*-test. As can be noted, the results reveal that there were no significant differences between the means of scores on the four scales of measurements (*p*. value > 0.05). Consequently, the results of the *t*-test provide evidence of repeatability for the English version of the ALSI instrument.

Table 28: the Results of Reliability Test - English Version of the ALSI.

Style	N	Mean	Std. Deviation	*t*	Sig (*p*. Value)
Active	25	33.52	6.65	1.57	0.84
	25	30.54	6.23		
Passive	25	22.60	8.03	0.78	0.13
	25	21.00	5.61		
Visual	25	32.08	5.21	0.73	0.14
	25	30.72	7.29		
Verbal	25	20.80	7.68	-0.61	0.95
	25	22.13	7.22		

Content Validity Index: the English Version of the ALSI Instrument

In order to investigate the content validity of the English version of the ALSI instrument, the items of this instrument were evaluated by six experts in the subject area. Table 29 illustrates the ratings of 6 experts.

Table 29: the ALSI English Version - Rating on a 16-Items Scale by Six Experts.

Item Number	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Number of Agreements	Item CVI
1	4	3	3	3	3	3	6	1.00
2	2	3	4	4	3	3	5	0.83
3	3	3	2	4	3	4	5	0.83
4	4	4	4	4	2	3	5	0.83
5	3	4	4	3	3	3	6	1.00
6	3	3	4	4	4	4	6	1.00
7	4	4	3	4	3	4	6	1.00
8	3	3	3	3	3	3	6	1.00
9	3	3	4	3	4	2	5	0.83
10	4	3	4	3	4	4	6	1.00
11	4	3	4	4	4	4	6	1.00
12	3	3	3	4	3	3	6	1.00
13	4	4	4	4	4	3	6	1.00
14	4	3	3	3	3	3	6	1.00
15	4	4	4	4	4	3	6	1.00
16	3	3	3	3	4	3	6	1.00
							Mean items I-CVIs	0.96
Proportion Relevant	0.94	1.00	0.94	1.00	0.94	0.94	Mean expert Proportion	0.96
							S-CVI/UA (Universal Agreement)	0.75

Based on Table 29, all six experts rated 12 items out of the 16 as quite or highly relevant, meaning 75 percent of the items were rated as relevant. However, for the rest of the items (2, 3, 4 and 9) each one of them was rated as somewhere relevant by only one expert out of six.

According to Polit, Lyann mentioned that, the value of I-CVI$_S$ should be in the vicinity of 0.8 when there are more than five experts (Lynn 1986, Polit, Beck 2006). As noted from Table 29, all of the items meet this criterion.

Factor Analysis: the English Version of the ALSI Instrument

For more investigation, a factor analysis test was performed. The corresponding scree plot is shown in Figure 30.

According to the Kaiser-Gutman standard (Eigenvalues > 1.0), the number of extracted factors was equal to 20, which account for 84.78 percent of the total variance. And the number of extracted factors using the scree plot approach was 10, accounting for 59.98 percent of the total variance.

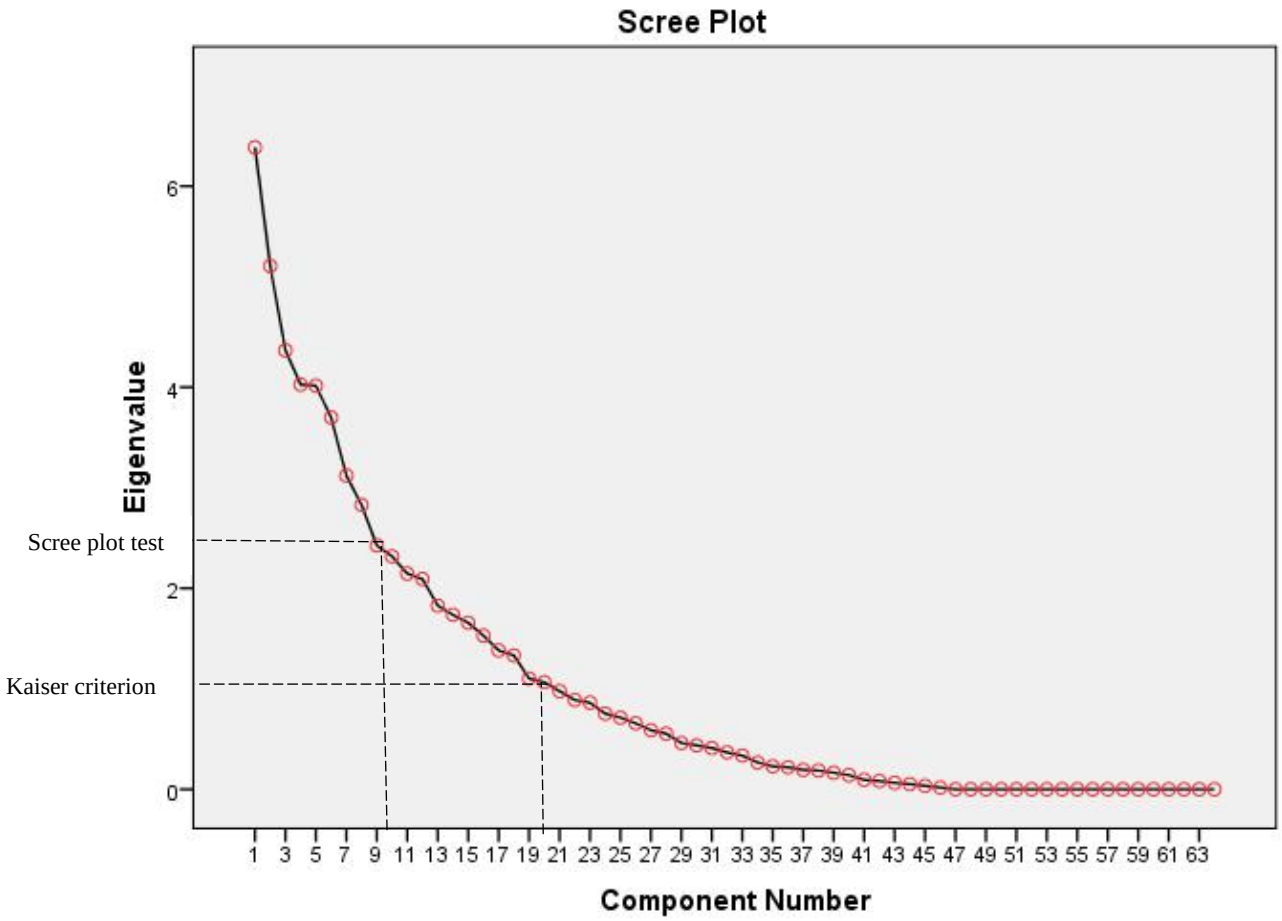

Figure 30: Scree Plot - Factor Analysis Test of the English Version of the ALSI Instrument.

The results reveal that the verbal and active scale maintained a stable structure, with most of the verbal and active scale items consistently loading on two factors. The results also reveal that the other scales were related to more than two factors. Table 30 shows the results of a ten-factor solution.

Table 30: the ALSI English Version - Factors in the Ten Factor Solution.

Scale	Number of factors	Factor	items	Number of items in each factor
Visual	3	4	2, 7, 9, 11, 13, 16	6
		5	1, 3, 6, 12, 14, 15	6
		7	4, 5, 8, 10	4
Active	3	3	1, 6, 7, 8, 9, 10, 11, 12	8
		6	2, 3, 4, 5, 13, 15, 16	7
		8	14	1
Verbal	3	1	1, 2, 3, 4, 5, 6, 9, 10, 11, 16	10
		6	13	1
		10	7, 8, 12, 14, 15	5
Passive	3	2	4, 8, 10, 11, 12, 15	6
		8	9, 13, 14, 16	4
		9	1, 2, 3, 5, 6, 7	6

5.3.3. Validating the ALSI Instrument: Discussion of Results

When a new instrument is developed, the first and most important issue considered by the developers is its reliability and validity because the reliability and validity of the instrument can significantly affect the research outcomes (Abdelsalam 2013, Alzain et al. 2016). Therefore, the instruments that are used to collect the data must be both valid and reliable.

Regarding the instruments of learning style, the literature review revealed that the existing learning style instruments were typically written in English and designed for a Western culture. The literature review also revealed that there is no learning style instrument that has been written in the Arabic language to be applied for Arab culture. Moreover, there are very few studies that have been conducted in the Arab region in terms of learning style models and instruments. This was discussed in Chapter 2, section 2.9 and 2.10.

In recent research conducted by (Al-Jojo 2012), the researcher translated the Felder-Soloman Index of Learning Styles (ILS) into the Arabic language. The same instrument (ILS) was later translated into Arabic by (Abdelsalam 2013), who investigated the personal characteristics of university lecturers in Libyan universities. Although both researchers undertook good procedures to translate and produce the Arabic version of ILS, the researcher noticed that there are some differences between both translated versions, and these differences might have resulted from the translation. This situation encouraged the researcher to design and develop the first Arabic learning style instrument.

In light of the literature review, it is clear that developing learning style instruments requires a number of rigorous procedures to ensure the scales validity and reliability. Therefore, the researcher created a plan to develop the new instrument and ensure its validity and reliability. Section 4.4.1 explains this plan. Moreover, the developed instrument (ALSI) was constructed in a new way to improve the accuracy of measurements, whereby the instrument was built using different forms of information. Section 4.4.2 discusses why the developed instrument is different.

In order to investigate the internal consistency of the ALSI instrument, Cronbach's alpha coefficient was calculated for each scale. For the Arabic version of ALSI, the values of Cronbach's alpha were obtained based on a sample of 111 students, with values ranging from 0.577 to 0.711. These values meet the criterion (> 0.50) (Tuckman, Harper 2012). This criterion was also met by the values of Cronbach's alpha coefficient of the English

version of ALSI, which was obtained based on a sample of 50 students, where the values ranged from 0.667 to 0.782. Compared with other related studies, these values are good (Al-Jojo 2012, Abdelsalam 2013). Moreover, a classical item analysis revealed that the reliability of scales of the ALSI Instrument can be improved by deleting the weakest item in each scale, and the results of classical item analysis (both versions) revealed that the items in each scale are strongly related, because the value Squared Multiple Correlation for each item did not fall below the level of 0.10. This was discussed in subsections 5.3.1 and 5.3.2.

The results of the present research also provide evidence of the stability of the ALSI instrument over time, where a test-retest analysis test was conducted and the time lapse between the measurements was about three weeks. The results of a *t*-test revealed that there are no significant differences between the means of scores on the four scales of measurements (*p*. value > 0.05). See subsections 5.3.1 and 5.3.2.

Regarding the content validity, the items of ALSI instruments were judged by a panel of six experts. While, the Arabic version of ALSI scored (I-CVIs = 0.95 and S-CVI/UA = 0.69), the English version of ALSI scored (I-CVIs = 0.96 and S-CVI/UA = 0.75). The results show the high level of experts' endorsement, which not disprove the content validity of ALSI instrument (See Table 20 and Table 29).

To investigate the construct validity, factor analysis was conducted. Results of factor analysis provide evidence of construct validity for the ALSI instrument. The strongest evidence is for the visual scale, for which all items load on a two factor and the Cronbach alpha is high (0.711). Although the items of verbal, active and passive scales were loaded on more than two factors, the values of the Cronbach alphas for these scales were adequate (greater than 0.5) (See Table 18).

Finally, it is clear that the results of this section contribute to current research on learning style models and instruments by providing the first learning style instrument, which is designed for the Arab communities and environment (See section 2.9 and 2.10).

Importantly, it examines carefully the validity and reliability issues of the instrument by conducting a number of rigorous procedures including Cronbach's alpha, test-retest, content validity index and factor analysis.

5.4. Exploring the Preferred Learning Styles of Computing Students in Misurata University - Libya

5.4.1. Comparison of Learning Style Scores between Misurata University and Nottingham Trent University

The results of exploring the preferred learning styles of students in Misurata University are listed in Table 31, along with the results of exploring the preferred learning styles of students in Nottingham Trent University. The columns of the table are labelled Active, Passive, Visual, Verbal and Equivalent preference. These columns show the percentage of students who are active, passive, visual, verbal learners and the students who have equivalent preferences.

Based on the results, the students in both universities are more active and visual than passive and verbal. Therefore, the dominant learning style is active / visual in Misurata University as well as Nottingham Trent University. See Table 31 and Figure 31.

The results also indicate that the students in both universities have approximately the same preferences where nearly (86 %) of students are active and visual learners in comparison with only nearly (10 %) passive and verbal.

Table 31: Comparison of Learning Style Scores - Misurata University and Nottingham Trent University.

University	Receiving of information			Interacting with information			N
	Visual	Verbal	Equivalent Preference	Active	Passive	Equivalent Preference	
Misurata University	85 %	10 %	5 %	85 %	11 %	4 %	111
Nottingham Trent University	87 %	11 %	2 %	89 %	9 %	2 %	50

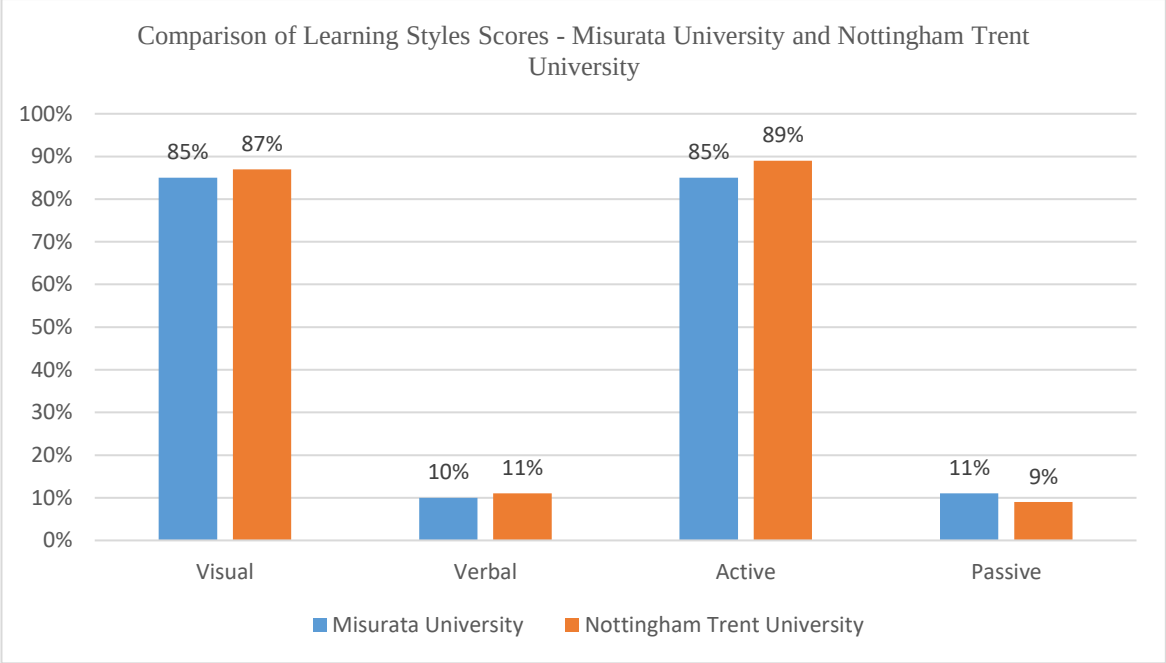

Figure 31: Comparison of Learning Styles Scores - Misurata University and Nottingham Trent University.

For more investigation, an independent sample *t*-test was conducted. Table 32 shows the mean and mean differences for both samples. For all dimensions, *p* values are greater than 0.05. This reveals that the mean learning style scores of students in both universities was not significantly different.

Table 32: Differences of Learning Style Scores - Misurata University and Nottingham Trent University.

Dimension	Mean Score (Misurata UNI)	Mean Score NTU	Mean Differences	*t*	*p* Value
Visual score	32.14	31.44	0.70	0.71	0.47
Verbal score	22.29	21.42	0.87	0.82	0.41
Active score	31.44	32.12	- 0.68	0.49	0.62
Passive score	22.91	21.85	1.06	1.12	0.26

5.4.2. Comparison of Learning Styles Scores between Misurata University and Arab Universities

The results of exploring the preferred learning styles of students in Misurata University are listed in Table 33 along with the results of two studies that were conducted in the Arab region. The columns of the table labelled active, passive, visual and verbal show the percentage of students who are active, passive, visual and verbal learners.

Based on the results, the students in the three universities (Misurata University, King Abdul-Aziz University and American University of Sharjah) are more active and visual than passive and verbal. The results also indicate that the students in Misurata university are more active than the students in the other two universities, where 85% of students in Misurata University were active in comparison with 65 % in King Abdul-Aziz University and only 51% in American University of Sharjah. On the other hand, the students of King Abdul-Aziz University were more visual than the students in Misurata University and the American University of Sharjah where the percentage of visual students in the three universities are 87%, 85%, and 79% respectively. See Figure 32.

Table 33: Comparison of Learning Styles Scores - Misurata University and some Arab Universities.

University	Active	Passive	Visual	Verbal
Misurata University	85 %	11 %	85 %	10 %
King Abdul-Aziz University	65 %	35 %	87 %	13 %
American University of Sharjah	51 %	49 %	79 %	21 %

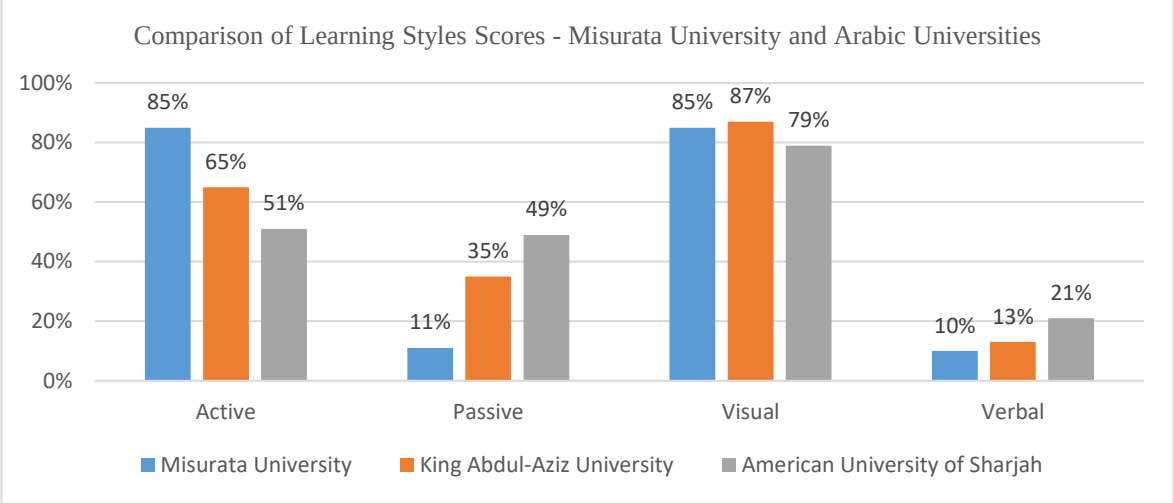

Figure 32: Comparison of Learning Styles Scores - Misurata University and some Arab Universities.

5.4.3. Relevant Studies and Dominant Learning Styles

The results of exploring the preferred learning styles of students in Misurata University are listed in Table 34 along with the results of a number of relevant studies. The columns of the table labelled active, passive, visual, verbal and equivalent preference show the percentage of students who are active, passive, visual, verbal learners.

Table 34 explain a percentage of preferences in each study, as well as the dominant learning style across a number of related studies around the world.

Table 34: Learning Style Preferences around the World.

Country	University	Affiliation	Sample	Active	Passive	Visual	Verbal	Reference
U S	Iowa State	Materials Eng.	129	63 %	37 %	85 %	15 %	(Constant 1997)
U S	Michigan Technological	Environmental Eng.	83	56 %	44 %	74 %	26 %	(Paterson 1999)
U K	Oxford Brookes	Business School	63	64 %	36 %	74 %	26 %	(Vita 2001)
		International students	42	52 %	48 %	76 %	24 %	
		British students	21	85 %	15 %	52 %	48 %	
Canada	Ryerson university	Electrical Engineering (2000)	87	53 %	47 %	86 %	14 %	(M. Zywno, Waalen 2001)
		Electrical Engineering (2001)	119	60 %	40 %	89 %	11 %	(M. S. Zywno 2002)
		Electrical Engineering (2002)	132	63 %	37 %	89 %	11 %	(M. S. Zywno 2003b)
U S	Tulane University	School of Science and Engineering – first year students	192	56 %	44 %	83 %	17 %	(Dee, Livesay et al. 2003)
		School of Science and Engineering – second year students	245	62 %	38 %	88 %	12 %	(Livesay, Dee et al. 2002)
Brazil	Universities in Belo Horizonte	School of Science	214	65 %	35 %	79 %	21 %	(Felder, Spurlin 2005)
		School of Humanities	235	52 %	48 %	39 %	61 %	
Ireland	University of Limerick	Manufacturing Engineering	167	70 %	30 %	91 %	9 %	(Seery, Gaughran et al. 2003)
U S	Universities of Michigan	Chemical Engineering	143	67 %	33 %	69 %	31 %	(Montgomery 1995)
Puerto Rico	Universities of Puerto Rico-Mayaguez	Biology - semester 1	39	65 %	35 %	74 %	26 %	(R. J. Buxeda, Moore 1999)
		Biology - semester 2	37	51 %	49 %	66 %	34 %	
		Biology - semester 3	32	56 %	44 %	77 %	23 %	
		Electrical and Computer Engineering	?	47 %	53 %	82 %	28 %	(R. Buxeda, Jimenez et al. 2001)
Brazil	University of São Paulo	School of Engineering	351	60 %	40 %	79 %	21 %	(Kuri, Truzzi 2002)
		Civil Engineering	110	69 %	31 %	76 %	24 %	
		Electrical Engineering	91	57 %	43 %	80 %	20 %	
		Mechanical Engineering	94	53 %	37 %	84 %	26 %	
		Industrial Engineering	56	66 %	34 %	73 %	27 %	
Jamaica	University of Technology	University of Technology	?	55 %	45 %	70 %	30 %	(Smith, Bridge et al. 2002)
Canada	Western Ontario University	Western University - Faculty of Engineering	858	69 %	31 %	80 %	20 %	(P. Rosati 1999)
		Faculty of Engineering – First year students	499	66 %	34 %	78 %	22 %	(P. A. Rosati 1996)
		Faculty of Engineering – Second year students	359	72 %	28 %	81 %	19 %	
		Faculty of Engineering	53	51 %	49 %	94 %	6 %	
U A E	American University of Sharjah	American University of Sharjah	?	51 %	49 %	79 %	21 %	(Al-Jojo 2012)
U A E	UMD University	UMD University	?	46 %	54 %	90 %	10 %	(Al-Jojo 2012)
Saudi Arabia	King Abdul-Aziz University	Arts and Humanities Faculty	532	65 %	35 %	87 %	13 %	(Al-Jojo 2012)
		Economics and Business Administration Faculty	492	61 %	39 %	89 %	11 %	
		King Abdul-Aziz University	1024	63 %	33 %	87 %	13 %	
Libya	Misurata University	Misurata University	111	85 %	11 %	85 %	10 %	(Alzain et al. 2016)
U K	Nottingham Trent University	School of Science and Technology	50	89 %	9 %	87 %	11 %	This research

By comparing the percentages in Table 34, it is clear that both university MU and NTU scored the highest level in terms of active preference. This result may be interpreted by the fact that the instrument that used in this study (ALSI) was constructed using different forms of information including active content to present the items that fit this type of learners. On the other hand, the rest of the studies were conducted using some of the existing instruments, which are completely depended on only textual information to present all of its items.

The results also indicate that the dominant learning style seems to be more visual and active than verbal and passive.

This study is one of the few studies that explores the preferred learning styles of students in the Arab region. See section 2.9 (Abdelsalam 2013, Al-Jojo 2012). Therefore, the experiment provides a clear idea about the preferred learning preferences of computer students in LHES. This experiment also compared the results with the results of similar studies around the world to explore the dominant learning style around the world.

5.5. Learning Style Instruments: Implications of Content

5.5.1. Introduction

Over the last few decades, a number of learning styles and instruments have emerged (Hawk, Shah 2007). Initially, the choice of instrument to be used does not seem as important as understanding how learners like to learn (N. Fleming, Baume 2006). However, the instruments of measuring learning style are often criticised (Alshammari 2016). The researchers claim that selecting a specific instrument to measure the preferred learning style is an important issue because it is critical to build our teaching strategies and systems (such as adaptive education systems) in light of the consequences of instruments. The content of all existing learning style instruments have not been presented in a manner which corresponds to the different types of learning because it is based on heavy-textual content. Moreover, there is a lack of research into the effect of the content of the instruments. According to Leite and Shi, "*learning style instruments tend to be constructed in isolation from one another without much attempt to validate their underlying constructs, but because the concept of style appeals so strongly to educators and learners alike, there is often a rush to implementation without adequate analysis of the properties of an instrument*" (Leite et al. 2010). More recently, in 2016 Truong carefully reviewed aspects of learning styles theories and instruments, and reported that *"Nevertheless, even though there are several predictors that have been taken into account, none of the papers found in this review manages to compare the power of different attributes in predicting learning styles. The finding of such comparisons can play an important role in improving the performance and efficiency of different prediction and classification models"* (Truong 2016). Therefore, in this research, we will investigate the effect of inserting new visual and active features into the instruments and consequently, the impact of that on the efficiency of the instrument as well as accuracy of measuring student preferences.

This part of the study seeks to investigate the following hypotheses:

- Hypotheses 5:
    - **(H_0)**: constructing the instruments of learning style using the visual and active content will not impact the measuring of learning preferences;
    - **(H_1)**: constructing the instruments of learning style using the visual and active content will impact the measuring of learning preferences;

- Hypotheses 6:
    - **(H_0):** there is no significant differences in terms of learning style between males and females;
    - **(H_1):** there is significant differences in terms of learning style between males and females;
- Hypotheses 7:
    - **(H_0):** there is no significant correlation between learning styles and years of computer use;
    - **(H_1):** there is a significant correlation between learning styles and years of computer use;
- Hypotheses 8:
    - **(H_0):** there is no significant correlation between the dimensions of learning styles.
    - **(H_1):** there is a significant correlation between the dimensions of learning styles.

The data was collected from 50 students who were already enrolled in three modules at NTU University, and out of the 50 students who agreed to engage, 10 were female and 40 male. 6 participants were studying at postgraduate level and the other 44 students were undergraduates. Table 35 presents some descriptive statistics.

Table 35: Descriptive Statistics of Participants - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments.

	N	Minimum	Maximum	Mean	Std. Deviation
Years Of Computer Use	50	3	18	8.72	2.83
Active Style	50	18	44	32.12	6.56
Passive Style	50	10	41	21.85	6.97
Visual Style	50	12	41	31.44	6.23
Verbal Style	50	6	37	21.42	7.42

The preferred learning styles of the participants were measured twice by using a developed instrument (ALSI instrument) and a VARK instrument. The results of both were compared and data was analysed using SPSS Version 22. Figure 33 illustrates the distribution of participant preferences based on the VARK instrument as well as the ALSI instrument.

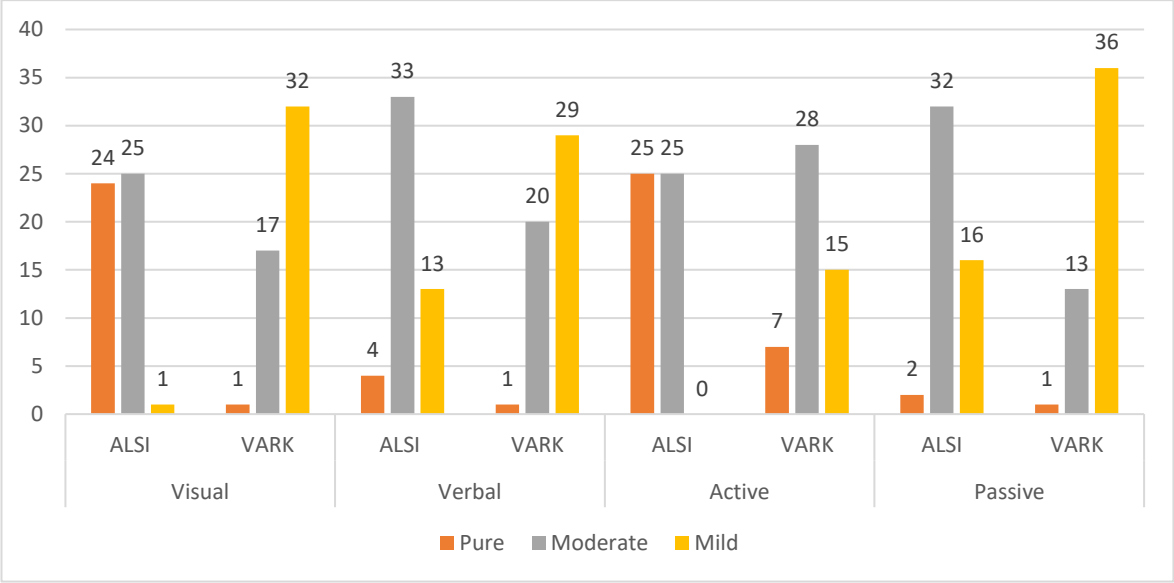

Figure 33: Visual Presentation of Participant Distribution Based on Learning Styles - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments.

Learning Style Instruments and Effect of Content

With reference to the hypothesis 5, "*Constructing the instruments of learning style using the visual and active content will not impact measuring of learning preferences*", a paired *t*-test was conducted to determine if there were any significant differences between the mean student learning styles scores. The results of the paired *t*-test are presented in Table 36.

Table 36: Paired t-test Results - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments.

			Paired Differences					*t*	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95 % Confidence Interval of the Difference				
						Lower	Upper			
Visual	Pair 1	VARK - ALSI	-17.72	9.38	1.36	-20.47	-14.96	-12.94	49	.000a
			Paired Differences					T	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95 % Confidence Interval of the Difference				
						Lower	Upper			
Verbal	Pair 1	VARK - ALSI	-5.40	9.56	1.39	-8.21	-2.59	-3.87	49	. 000a
			Paired Differences					T	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95 % Confidence Interval of the Difference				
						Lower	Upper			
Active	Pair 1	VARK - ALSI	-12.55	8.67	1.26	-15.10	-10.00	-9.91	49	. 000a
			Paired Differences					T	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95 % Confidence Interval of the Difference				
						Lower	Upper			
Passive	Pair 1	VARK - ALSI	-8.06	9.16	1.33	-10.75	-5.37	-6.03	49	. 000a

a Significantly different

As seen in Table 36, there were significant differences among student preferred learning styles, whereby the value of (*p)* in each dimension is less than 0.5:

- Visual style (t = -12.94, p = 0.000) ;
- Verbal style (t = -3.87, p = 0.000) ;
- Active style (t = -9.91, p = 0.000) ;
- Passive style (t = -6.03, p = 0.000).

These results confirm the alternative hypothesis, and not disprove that using different forms of information (visual and active content) to construct learning style instruments will significantly impact the measuring of learning preferences.

The effect size was also measured for each individual scale. The results of Cohen's *d* revealed that the highest effect size (d = 2.37) was in the visual scale followed by the active scale (d = 1.72) and then the passive scale (d = 1.15), and the lowest effect size (d = 0.71) was in the verbal scale.

Learning Style Instruments and Effect of Content:- Qualitative Study

According to Cagiltay, a phenomenon cannot be completely investigated by quantitative research alone (Cagiltay, Bichelmeyer 2000). For this reason, qualitative research techniques are also used to investigate this issue. Therefore, six interviews were conducted with six Masters Students, in the School of Science and Technology at NTU University. Table 37 shows details of participants.

Table 37: Participant Details - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments - Qualitative Part.

Coding name	Gender	Age
P1	Male	24
P2	Female	24
P3	Male	27
P4	Male	26
P5	Male	25
P6	Male	25

P = Participants.

The participant preferred learning styles were measured twice by using two different instruments and then six interviews were conducted. Table 38 and Figure 34 show the results of measuring the preferred learning styles in each dimension based on both VARK questionnaire and ALSI instrument.

Table 38: Results of Measuring of Participants Preferred Learning Style Using the (VARK, ALSI) Instruments - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments - Qualitative Part.

	Visual		Verbal		Active		Passive	
	VARK	ALSI	VARK	ALSI	VARK	ALSI	VARK	ALSI
Pure preference	0	6	1	1	1	3	0	0
Moderate preference	2	0	2	5	3	3	1	5
Mild preference	4	0	3	0	2	0	5	1

For visual impact, these results can be displayed as shown in Figure 34.

By comparing the number of students in each dimension, we can see that there was a notable difference between the results of two instruments, for example, based on the ALSI instrument, all of the participants (6 students) have a pure visual preference, whereas the results of VARK questionnaire suggests that no participant has a pure visual preference. Another difference is the increase in the number of students who have moderate passive preference, from one student according to VARK questionnaire to five students based on the ALSI instrument. On the other hand, the number of students who have moderate verbal preference decreased from five students (based on the ALSI instrument) to only two students according to VARK questionnaire. See Figure 34 below.

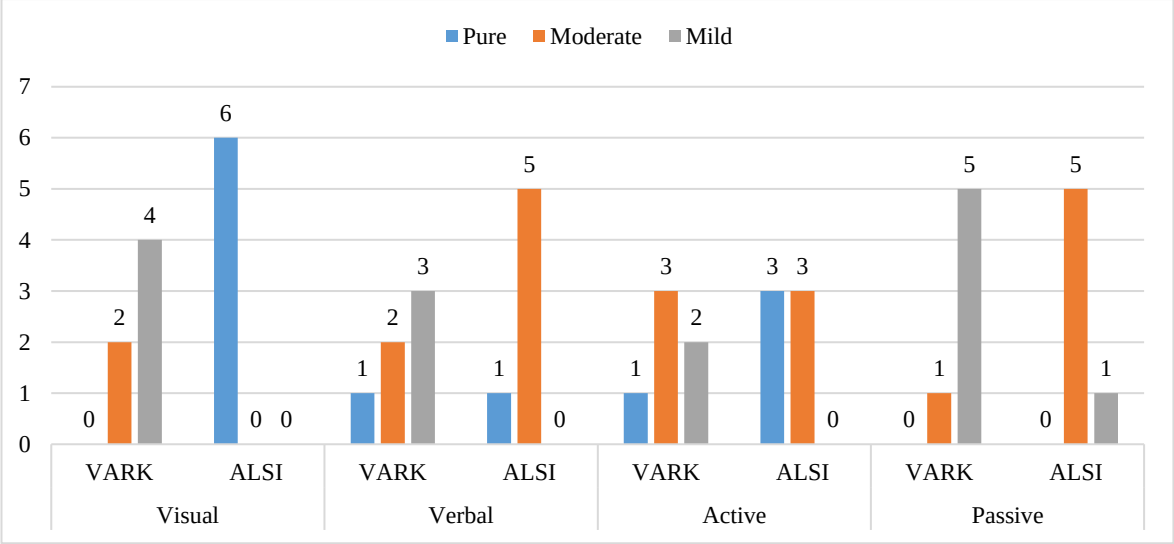

Figure 34: The Preferred Learning Styles of Participants Using the (VARK, ALSI) Instrument - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments - Qualitative Part

Although some researchers argue that 30 participants is the minimum acceptable sample size to ensure the normal distribution of data and conduct statistical analysis (Cohen et al. 2013), others write that statistical analysis could be conducted with a much smaller number of participants (de Winter 2013, Janušonis 2009). Accordingly, for more investigation, a paired *t*-test was conducted in this study (with 6 participants) to determine if there were any significant differences between the mean of student learning styles scores. The results of the paired *t*-test are presented in

Table 39. Based on the results of the paired *t*-test, there were significant differences between the means of student learning style scores within three preferences out of four, whereby the values of (*p*) in active, visual and passive preferences were less than 0.5:

- Passive style (t = - 4.91, p = 0.004);
- Visual style (t = - 7.99, p = 0.0005);
- Active style (t = - 3.09, p = 0.027).

The results also revealed that there were no significant differences ($p > 0.5$) between the averages of student preferred learning styles in terms of verbal style where (t = -1.780, p = 0.135). This result may be interpreted by the fact that both instruments (VARK and ALSI) depended on the textual form of information to present the questions related to this type of learner (Verbal).

Table 39: Paired t-test - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments

a Significantly different

Paired Samples Test										
			Paired Differences					*t*	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Passive	Pair 1	VARK - ALSI	-12.83	6.40	2.61	-19.55	-6.11	-4.911	5	0.004 a
Paired Samples Test										
			Paired Differences					*t*	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Visual	Pair 1	VARK - ALSI	-25.33	7.763	3.16	-33.48	-17.18	-7.993	5	0.0005 a
Paired Samples Test										
			Paired Differences					*t*	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Active	Pair 1	VARK - ALSI	-12.50	9.89	4.03	-22.88	-2.11	-3.095	5	0.027 a
Paired Samples Test										
			Paired Differences					*t*	df	Sig. (2-tailed)
			Mean	Std.	Std. Error Mean	95% Confidence Interval of the Difference				
						Lower	Upper			
Verbal	Pair 1	VARK - ALSI	-8.33	11.46	4.68	-20.36	3.69	-1.780	5	0.135

Before starting the interview, the researcher explained the purpose of the study and each participant was made aware of key issues related to the concept of learning style and their right to withdraw from the study. The interviews were semi-structured, since the sessions of the interview were not restricted to specific questions, and the nature of the interview was determined by participant response. At the start of each interview, the participants were made aware of their preferred learning styles, which were measured by both instruments.

The participants were asked about the importance of considering the individual differences among students in teaching methods. All of the participants indicated that the individual differences should be considered in teaching, because one teaching method cannot fit all students:

> "Teaching should always include everything; we cannot depend on only one method" (P5).
>
> "Teachers should use different materials as much as they can because that will help students to keep the knowledge for a long time" (P4).
>
> "Teachers should be considering individual differences between students that will be very useful, especially for students who have less concentration" (P6).

With reference to the impact of the instrument content on participant answers, the majority of participants (five out of six) think that the new visual and active features of the developed instrument (ALSI) affected their responses. In this context, participants P2 and P3 responded that:

> "Students understand the text differently" (P2).
>
> "These features will attract the whole class; it will also attract those students who are not more interested in learning" (P3).

In line with participants P2 and P3, the participant P1 responded that:

> "Using graphs rather than text makes the information easier to understand" (P1).

He also reported:

> (P1) "Using only text form, may get confused sometimes, it should be inclusive both visual and verbal."

However, participant P5 has raised another issue that related to the first language of the participants. P5 thinks that:

> "There is a possibility if someone does not understand English very well. Obviously, for them, the answers will be affected because they may miss something when there is complete text" (P5).

Regarding the impact of content on the time needed to complete the instrument, the participants were asked whether they believe that the content of the instrument played any role in decreasing the time needed to finish the questionnaire. All of the participants stated that the visual and active content played a key role in reducing the time needed to complete the questionnaire. For example, participant P1 reported that:

> (P1) "Yes, that is effect, for example, if we don't know the mean formula we need to read and break down the text to extract the formula and that takes time and may get confused sometimes".

In line with participant P1, participant P4 and P5 reported that:

> (P4) "The style of question presentation will affect the answer and the time needed for the answer, for example, provide students with the equation of Pythagoras is easier and faster than providing them with a description of Pythagoras' theorem".

> (P5) "I prefer both (visual and verbal forms) but when I see the things I can understand more quickly than reading … the only difference is the complete text one takes the time to understand the question first of all, but as soon as I see a formula or graph I will get the idea. So, the answer will not be affected but time will be affected".

In general, it is clear that the results of this qualitative study aligns with the results of previous quantitative study, and not disprove the hypotheses that claims "construct learning style instruments using different forms of information will significantly impact the measuring of learning preferences".

Learning Style and Gender of Participants

With reference to the hypothesis 6, *"there is no significant differences in terms of learning style between males and females"*, a Chi-square test was conducted to find if there was any dependency between student learning styles and gender. The results of this statistical test are presented in the Table 40.

Table 40: Independence Between Learning Styles and Gender - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments (N = 50).

Style	X^2	Sig. (*p* value)
Visual	0.473	0.492
Verbal	2.363	0.124
Active	1.776	0.183
Passive	0.552	0.457

As seen in Table 40, there were no significant differences between males and females in terms of preferred learning style whereby (*p* value) in each preference is greater than 0.05.

Learning Style and Participant Experience with a Computer

With reference to the hypothesis 7,*" There is no significant correlation between the dimensions of learning style"*, and hypothesis 8,*" There is no significant correlation between learning styles and years of computer use"*

To determine whether a correlation exists among different learning styles and years of computer use, a Pearson correlation test was conducted. As seen in Table 41, the results revealed that there is a positive significant correlation between the years of computer use and visual style ($r = 0.397$, $p = 0.006$). There is also a positive significant correlation between verbal and passive style ($r = 0.458$, $p = 0.001$).

Table 41: Correlation Between Dimensions of Learning Style and Years of Computer Use - Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments (N = 50).

		Years of Computer Use	Active Preference	Passive Preference	Visual Preference	Verbal Preference
Years of Computer Use	Person Correlation	1	-.051	.129	.397**	.259
	Sig. (2-tailed)		.734	.386	.006	.079
	N	50	50	50	50	50
Active Preference	Person Correlation	-.051	1	.103	.265	-.065
	Sig. (2-tailed)	.734		.489	.072	.662
	N	50	50	50	50	50
Passive Preference	Person Correlation	.129	.103	1	.153	.458**
	Sig. (2-tailed)	.386	.489		.305	.001
	N	50	50	50	50	50
Visual Preference	Person Correlation	.397**	.265	.153	1	.039
	Sig. (2-tailed)	.006	.072	.305		.797
	N	50	50	50	50	50
Verbal Preference	Person Correlation	.259	-.065	.458**	.039	1
	Sig. (2-tailed)	.079	.662	.001	.797	
	N	50	50	50	50	50

**. Correlation is significant at the 0.01 level (2-tailed).

5.5.2. Investigating the Effect of Content on the Efficiency of Learning Style Instruments: Discussion of Results

This part of the research investigated empirically the effect of using visual and active content on constructing the instruments of learning style, and the impact of that on the efficiency and accuracy of these instruments. Generally, the findings indicated that using the visual and active content in the instrument construction has a considerable influence on the measurement of learning styles. The results showed that the number of students whose learning style was characterised as “visual” increased significantly when they used the ALSI instrument, which was built using visual and active content. This result comes in line with the concept of learning style theory, which states that the visual type of learners responds strongly to the visual forms of information such as (figures, charts, pictures… etc.). The results also showed an increase in the number of students whose learning style was characterised as “active” when they used the ALSI instrument that contained active content. In contrast, the “verbal” and “passive” preferences did not see a big difference as much as the “visual” and “active” type. This may be interpreted by the fact that the textual content is extensively used in the construction of previous instruments.

Although, these results have emerged from a quantitative experiments and later supported by the qualitative, there is still a need for more investigation into the impact of instrument content types on the accuracy of measuring the learning styles. These instruments have been used by most of adaptive educational systems for the purpose of matching the teaching style with student preferred learning styles (Özyurt, Özyurt 2015). Accordingly, before we build our teaching approach based on learning style instruments, it is important to investigate to what extent these instruments measure what we think is being measured

An important implication of these findings is the possibility of changing the learning preferences according to the content of the instrument, which is used to measure these preferences. Therefore, although matching the teaching strategies with the student preferred learning styles has been found to have a positive impact on student performance, it seems to be critical to build our teaching systems in light of the consequences of the instrument, especially if the instrument itself does not reflect reality.

The outcomes have additionally shown that:

(i). There was no significant difference between males and females in terms of preferred learning styles. This result comes against the hypothesis that said the male students are usually tend to be more active than female and vice versa.

(ii). There was a positive significant correlation between years of computer use and visual style. This result comes in line with the opinion of the researcher, that the learning style could be affected by exposing the learner continually to a specific educational environment. Therefore, using the computer for a long time could increase the learner tendencies to be more visual.

(iii). There was a positive significant correlation between verbal and passive style. This result will be later used along with the results of a number of experiments to explore the correlation between the dimensions of learning style. That will boost our recommendations regarding the misuse of learning style, whereby this research recommended that the dimensions of learning styles should not be treated as opposites (dichotomies).

Finally, the results of this study generate new insights into the effect of different patterns of content on the measuring of learning styles, which are widely used in adaptive learning systems.

5.5.3. Conclusion of the Experiment of Investigating the Effect of Content on the Efficiency of Learning Style Instruments

The findings of this study indicated that the participants' answers were varied according to the maner in which the questions presented. In this case, the researcher argues that items of the instruments ought to be presented in a manner that corresponds to different learning styles, in light of the fact that the learners will respond strongly to the patterns of information, which correspond to their preferred style. Consequently, this will provide some solutions for the problems that might arise from using only textual information to construct learning styles instruments. This will also decrease the expected time for answering the questionnaire.

The outcomes have additionally shown that the visual style correlated significantly and positively with the years of computer use, and this implies the likelihood of visual style expanding with the years of computer use.

In conclusion, it is quite clear that researchers agree that students respond differently to information patterns, and this response depends on their preferred learning styles.

However, what is also striking is that the existing learning style instruments were not presented in a manner that corresponds to these learning styles because they completely depended on only textual information to present the items. Consequently, the efficiency of these instruments might be negatively affected.

5.6. Implementation of Five-Arrows Framework Using LAES System

5.6.1. Introduction

As described in Chapter 4, the Five-arrows is a technological pedagogical framework aiming at effective teaching by understanding and describing how to consider the individual differences between students, as well as providing the most suitable content and teaching activities in a technology-enhanced educational environment. In this section of research, the Five-arrows Framework will be implemented using the LAES system, which can adapt the content based on the preferred learning style of students. In order to evaluate the Five-arrows framework and LAES system, experimental evaluation approach was used. This approach is recommended by several researchers in this field. (Mulwa, Lawless et al. 2011, Gena 2005, E. J. Brown, Brailsford et al. 2009, Weibelzahl 2001).

According to (Alshammari 2016), conducting only one experiment will not be sufficient to evaluate the adaptive system, because the number of participants and time of learning will be limited. Therefore, three different experiments were conducted, each with a different module, subject and participants. Each experiment was carried out in three sessions, and each session lasted for about 120 minutes.

Firstly, the researcher discussed with the participants some of the key issues including: the concept of learning style, learning style instruments, how learners can know their preferred learning style, how they can use it to manage their learning, adaptive education system and how it works. The researcher also explained to the participants the procedure and aim of this experiment.

The participants were first taught without using LAES system, and they were asked to complete a pre-test and a post-test to know the learning outcomes. The learning outcomes were also tested in the next experimental session, in which the participants were taught

using LAES system, and the learning outcomes of two experimental sessions were compared.

5.6.2. Hypothesis under Investigation

As mentioned above, the key issue that was considered in the following three experiments was the learning outcomes, and to investigate if students who learnt using LAES system were better off than others who learnt without the system, in terms of the knowledge gained. In the following three experiments, the following two hypotheses were investigated:

- Hypotheses 12:
  - **(H_0):** there is no significant difference in terms of the knowledge gained between students who learn using the new adaptive system and students who learn without it;
  - **(H_1):** there is a significant difference in terms of the knowledge gained between students who learn using the new adaptive system and students who learn without it;
- Hypotheses 13:
  - **(H_0):** there is no significant correlation between dimensions of learning style.
  - **(H_1):** there is a significant correlation between dimensions of learning style.

Moreover, the effect size was also tested in each experiment. The effect size is a statistical technique used with quantitative data for exploring the difference between two groups (Cohen et al. 2013, Creswell 2013).

The effect size could be calculated by "dividing the difference between the means of the two groups being compared by the standard deviation of the comparison group" (Jack. R Fraenkel, Wallen 2006).

According to (Cohen et al. 2013), the effect size (Cohen's *d*) can lie between 0 to 1:

- From 0 to 0.20 = weak effect
- From 0.21 to 0.50 = modest effect
- From 0.51 to 1.00 = moderate effect
- > 1.00 = strong effect

5.6.3. Experiment I

This experiment was conducted in April 2017 by the researcher with a number of undergraduate students (n = 10) studying for (Formal Languages and Automata Theory) module, which is offered by the Faculty of Information Technology at Misurata University in Libya.

In the experiment, the mean age of participants was 21, the minimum age was 20 and the maximum age was 23. The participants were found to be more visual and active than verbal and passive, and the majority of the participants had moderate learning preferences. Figure 35 shows the number of participants in each sub-category.

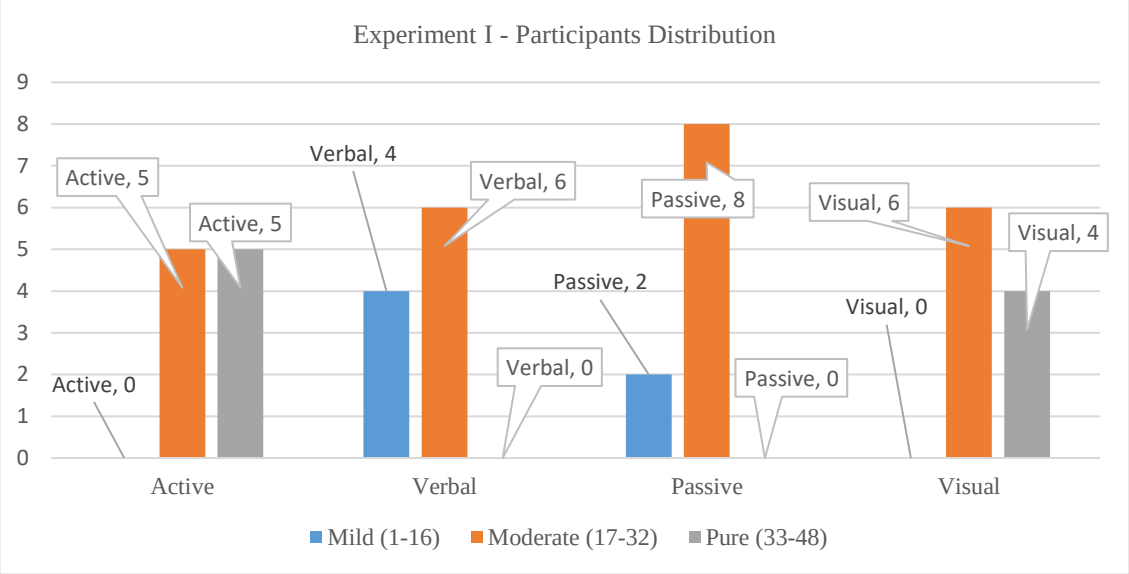

Figure 35: the Five-Arrows Framework Implementation Using the LAES System, Experiment I - Participants Distribution Based on the Learning Styles.

Experimental Results

In this experiment, the learning outcomes were measured. Generally, the mean participant scores when they learnt using the adaptive system (Mean = 9.60) is higher than the mean participant scores when they learnt without it (Mean = 5.30).

A dependent sample *t*-test was also conducted, and the results of a paired *t*-test showed that there was a statistically significant difference between the mean scores of the participants when they learnt using the system and the mean participant scores when they learnt without it.
t (9) = -2.294, p = 0.047. Therefore, it can be inferred that the students who learnt using

this system were better off than others who learnt without it in terms of the knowledge gained. See Table 42 and

Table 43.

Table 42: the Five-Arrows Framework Implementation Using the LAES System, Experiment I - Paired Samples Statistics (N = 10).

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	WithOutSystem	5.30	10	4.547	1.438
	WithSystem	9.60	10	5.038	1.593

Table 43: the Five-Arrows Framework Implementation Using the LAES System, Experiment I - Results of Paired Samples Test (N = 10).

Paired Samples Test									
		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	WithOutSystem - WithSystem	-4.30	5.926	1.874	-8.539	-0.061	-2.294	9	0.047

In this experiment, the effect size was also measured for each individual scale using Cohen's *d* test. The results revealed that the highest effect size ($d = 1.31$) was in visual style followed by the active style ($d = 0.89$).

In order to investigate the correlation between dimensions of learning style, Pearson Correlation test was also conducted. The results showed that there was a statistically positive significant correlation between visual and active style, $r(8) = 0.715$, $p = 0.020$. See Table 44.

Table 44: the Five-Arrows Framework Implementation Using the LAES System, Experiment I – Results of Pearson Correlation Test (N = 10).

Correlations

		Active Preference	Verbal Preference	Passive Preference	Visual Preference	Years Of Computer Use
Active Preference	Pearson Correlation	1	0.082	0.520	**.715***	0.129
	Sig. (2-tailed)		0.822	0.124	0.020	0.723
	N	10	10	10	10	10
Verbal Preference	Pearson Correlation	0.082	1	-0.219	-0.231	0.449
	Sig. (2-tailed)	0.822		0.543	0.521	0.193
	N	10	10	10	10	10
Passive Preference	Pearson Correlation	0.520	-0.219	1	0.352	-0.242
	Sig. (2-tailed)	0.124	0.543		0.318	0.500
	N	10	10	10	10	10
Visual Preference	Pearson Correlation	**.715***	-0.231	0.352	1	-0.372
	Sig. (2-tailed)	0.020	0.521	0.318		0.289
	N	10	10	10	10	10
YearsOf ComputerUse	Pearson Correlation	0.129	0.449	-0.242	-0.372	1
	Sig. (2-tailed)	0.723	0.193	0.500	0.289	
	N	10	10	10	10	10

*. Correlation is significant at the 0.05 level (2-tailed).

5.6.4. Experiment II

This experiment was conducted with a number of undergraduate students (n = 16) studying for (Computer Basics) module, which is offered by the Faculty of Education at Misurata University in Libya.

In the experiment, the mean participant age was 20, the minimum age was 18 and the maximum was 23. The participants were found to be more active and visual than passive and verbal, and the majority of the participants had pure or moderate learning preferences. Figure 36 shows the number of participants in each sub-category.

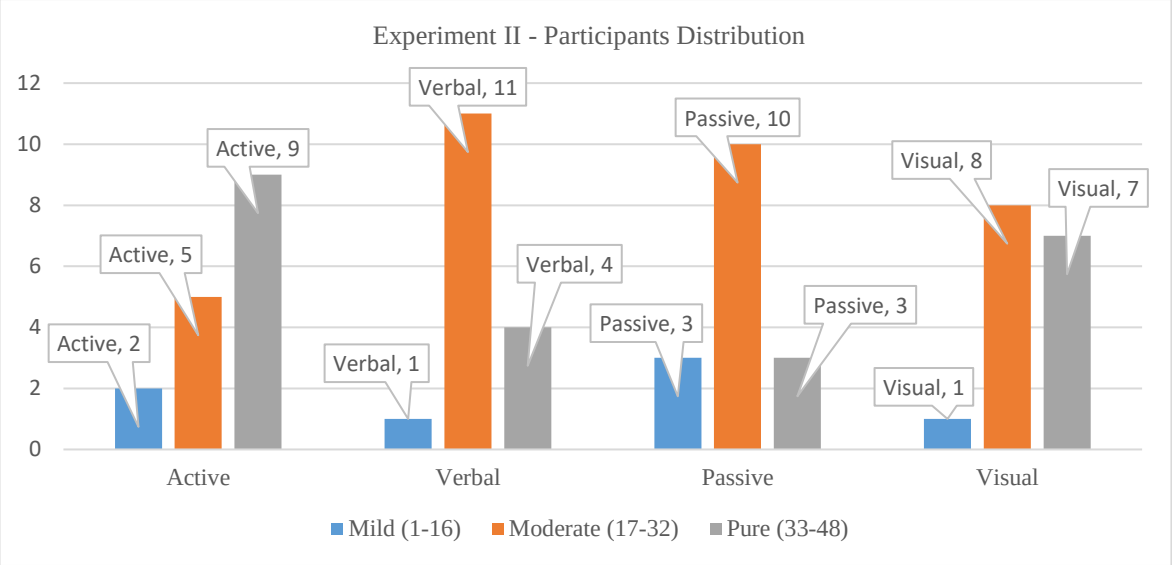

Figure 36: the Five-Arrows Framework Implementation Using the LAES System, Experiment II - Participants Distribution Based on the Learning Styles.

Experimental Results

In this experiment, the mean participant score when they learnt using the LAES system (Mean = 16.13) was higher than the mean participant scores when they learnt without it (Mean = 9.94). In order to investigate if there is any significant difference between the two, a dependent sample *t*-test was conducted. The results of this test showed that there was a statistically significant difference between the mean scores of the participants when they learnt using the LAES system and the mean participant scores when they learnt without it. t (15) = -2.289, p = 0.037. Therefore, it can be inferred that the students who learnt using this system were better off than others who learnt without it in terms of the knowledge gained. See Table 45 and Table 46.

Table 45: the Five-Arrows Framework Implementation Using the LAES System, Experiment II - Paired Samples Statistics (N = 16).

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Without System	9.94	16	8.744	2.186
	With System	16.13	16	9.667	2.417

Table 46: the Five-Arrows Framework Implementation Using the LAES System, Experiment II - Results of Paired Samples Test (N = 16).

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Without System – With System	-6.188	10.815	2.704	-11.950	-0.425	-2.289	15	0.037

The effect size was also measured for each individual scale. The results of Cohen's *d* test revealed that the highest effect size ($d = 0.77$) was in the visual style followed by the verbal style ($d = 0.32$).

Regarding to hypothesis (H13), "*there is no significant correlation between dimensions of learning style*", the results of Pearson Correlation test showed that there was a statistically positive significant correlation between passive and active style, $r\ (14) = 0.799$, $p = 0.000$. There was also a statistically positive significant correlation between passive and verbal style, $r\ (14) = 0.765$, $p = 0.001$. See Table 47.

Table 47: the Five-Arrows Framework Implementation Using the LAES System, Experiment II – Results of Pearson Correlation Test (N = 16).

Correlations

		Active Preference	Verbal Preference	Passive Preference	Visual Preference	Years Of Computer Use
Active Preference	Pearson Correlation	1	0.467	**.799****	0.449	0.125
	Sig. (2-tailed)		0.068	0.000	0.081	0.645
	N	16	16	16	16	16
Verbal Preference	Pearson Correlation	0.467	1	**.765****	-0.115	0.121
	Sig. (2-tailed)	0.068		0.001	0.672	0.654
	N	16	16	16	16	16
Passive Preference	Pearson Correlation	**.799****	**.765****	1	0.171	0.137
	Sig. (2-tailed)	0.000	0.001		0.526	0.612
	N	16	16	16	16	16
Visual Preference	Pearson Correlation	0.449	-0.115	0.171	1	0.124
	Sig. (2-tailed)	0.081	0.672	0.526		0.648
	N	16	16	16	16	16
Years Of Computer Use	Pearson Correlation	0.125	0.121	0.137	0.124	1
	Sig. (2-tailed)	0.645	0.654	0.612	0.648	
	N	16	16	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

5.6.5. Experiment III

This experiment was conducted with a number of undergraduate students (n = 14) studying for (Programming Languages) module, which is offered by the Faculty of Education at Misurata University in Libya.

In the experiment, the mean age was 21, the minimum age was 19 and the maximum age was 34. The participants were found to be more active and visual than passive and verbal, and the majority of the participants had pure or moderate learning preferences. Figure 37 shows the number of participants in each sub-category.

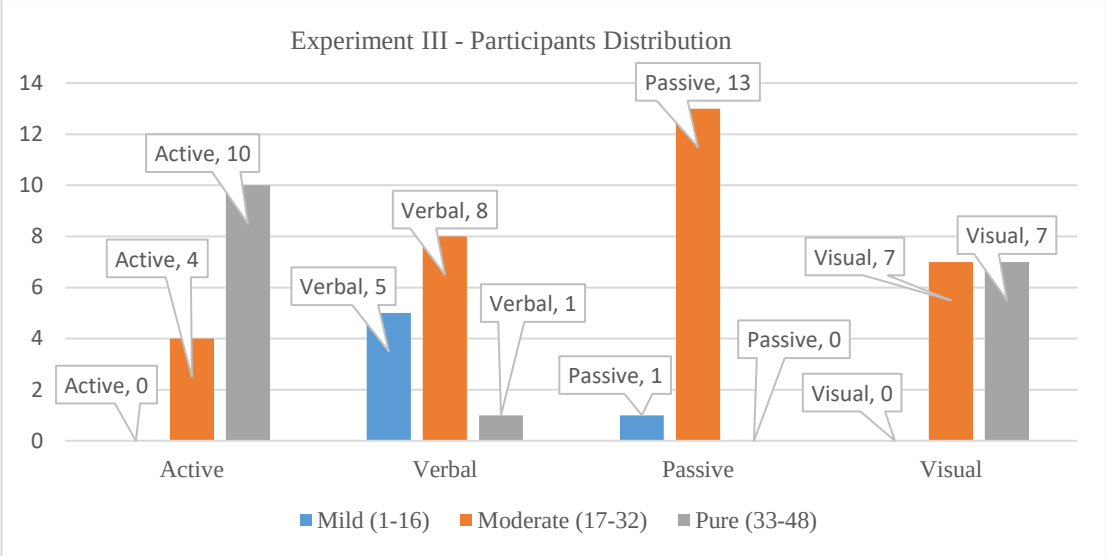

Figure 37: the Five-Arrows Framework Implementation Using the LAES System, Experiment III - Participants Distribution Based on the Learning Styles.

Experimental Results

The learning outcomes were measured. Generally, the mean participant score when they learnt using the LAES system (Mean = 22.14) was higher than the mean participant scores when they learnt without using this system (Mean = 14.29).

A dependent sample *t*-test was also conducted, and the results of this test showed that there was a statistically significant difference between the mean score of the participant when they learnt using the LAES system and the mean participant scores when they learnt without it.

t (13) = -1.724, p = 0.048. Therefore, it can be inferred that the students who learnt using

this system were better off than others who learnt without it in terms of the knowledge gained. See Table 48 and Table 49.

Table 48: the Five-Arrows Framework Implementation Using the LAES System, Experiment III - Paired Samples Statistics (N = 14).

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	WithOut System	14.29	14	12.83	3.43
	With System	22.14	14	11.21	2.99

Table 49: the Five-Arrows Framework Implementation Using the LAES System, Experiment III – Results of Paired Samples Test (N = 14).

Paired Samples Test

		Paired Differences					t	df	Sig. (1-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	WithOut System – With System	-7.857	15.281	4.084	-20.160	4.445	-1.724	13	0.048

The effect size was also measured for each individual scale, and the results of Cohen's *d* test revealed that the highest effect size ($d = 0.56$) was in active scale followed by the visual scale ($d = 0.55$).

With reference to the hypothesis (H_{13}), " *there is no significant correlation between dimensions of learning style*", a Pearson Correlation test was conducted, and the results showed that there was a statistically positive significant correlation between visual and active style, $r\ (12) = 0.610$, $p = 0.020$. There was also a statistically positive significant correlation between visual style and years of computer use, $r\ (12) = 0.584$, $p = 0.028$. See Table 50.

Table 50: the Five-Arrows Framework Implementation Using the LAES System, Experiment III – Results of Pearson Correlation Test (N = 14).

Correlations

		Active Preference	Verbal Preference	Passive Preference	Visual Preference	Years Of Computer Use
Active Preference	Pearson Correlation	1	-0.050	0.122	**.610***	0.380
	Sig. (2-tailed)		0.865	0.679	0.020	0.180
	N	14	14	14	14	14
Verbal Preference	Pearson Correlation	-0.050	1	0.331	-0.255	0.035
	Sig. (2-tailed)	0.865		0.248	0.379	0.905
	N	14	14	14	14	14
Passive Preference	Pearson Correlation	0.122	0.331	1	-0.025	0.095
	Sig. (2-tailed)	0.679	0.248		0.932	0.746
	N	14	14	14	14	14
Visual Preference	Pearson Correlation	**.610***	-0.255	-0.025	1	**.584***
	Sig. (2-tailed)	0.020	0.379	0.932		0.028
	N	14	14	14	14	14
Years Of Computer Use	Pearson Correlation	0.380	0.035	0.095	**.584***	1
	Sig. (2-tailed)	0.180	0.905	0.746	0.028	
	N	14	14	14	14	14

*. Correlation is significant at the 0.05 level (2-tailed).

5.6.6. Implementation of Five-Arrows Framework Using LAES System - Quantitative Study: Discussion of Results

This part of the research investigated empirically the implications of applying the Five-Arrows Framework using the LAES system, and the impact of that on the performance of student. It also investigated the effect size of each individual scale to identify the most affected students. Finally, the correlation between dimensions of learning style was also investigated.

The experiments were carried out with different modules, teachers and students.

Generally, the findings indicate that using LAES system to teach students (in a matched way) based on their preferred learning style has a positive influence on the performance of the students. The results also revealed that the visual and active students were the greatest beneficiaries from the adaptation process. A possible explanation for this result is that the existing curricula and teaching approaches are more suitable for students who are more verbal and passive than visual and active; in relation to this, one of the participants stated that, *"curriculums are much more theoretical than practical"*.

In the first experiment, the results showed that the mean student scores increased from (Mean = 5.30) to (Mean = 9.60) when they learn using the LAES system. Moreover, the results of a paired *t*-test revealed that there was a statistically significant difference between the mean scores of the participants when they learnt this system and the mean participant scores when they learnt without it (t (9) = 2.294, p = 0.047). That was also enhanced by the results of the second experiment, which revealed that the mean student scores increased from (Mean = 9.94) to (Mean = 16.13) when they learn using the LAES system. Moreover, the results of a paired *t*-test revealed that there was a statistically significant difference between the mean scores of the participants when they learnt using the LAES and the mean participant scores when they learnt without it (t (15) = 2.289, p = 0.037).

More encouraging results emerged from the third experiment where the findings showed that the mean student scores increased from (Mean = 14.29) to (Mean = 22.14) when they learn using the LAES system. Moreover, the results of a paired *t*-test revealed that there was a statistically significant difference between the mean scores of the participants when they learnt using the system and the mean participant scores when they learnt without it (t (13) = -1.724, p = 0.048).

In general, the results revealed that the students had significantly higher learning outcomes when they used the LAES system to learn in a matched way. In addition, and the effect size was medium. The results concur with Alshammari, who reported that, *"Examination of the means of learning outcome indicated that the matched group had significantly higher learning outcomes than the mismatched group, t (58) = -2.18, p = 0.03, d = 0.57. In addition, the effect size of the finding was between medium and large"* (Alshammari 2016). The results of this study also come in line with the findings reported by a number of other studies, which support the idea of adaptation based on learning style. Franzoni et al argue that, "*If the teaching style employed closely matches the student preferred style of acquiring knowledge, learning becomes easier and more natural, results improve and learning time is reduced*" (Franzoni et al. 2008), see section 2.7.

When attempting to link the results of this study with previous studies in the Arab region (section 2.9) in the area of adaptive education systems based on learning style, although only a small number of related studies were conducted in the Arab region, these studies revealed encouraging results in terms of student performance when they learn using adaptive systems. In 2012, Al-Jojo conducted a similar research study in Saudi Arabia, where the research investigated the effectiveness of learning when matching the materials according to the preferred learning style of students. The results of this research were encouraging (Al-Jojo 2012). Moreover, Alshammari and Mampadi also reported that adapting to the learning styles has a positive impact on student performance and engagement (Alshammari 2016, Mampadi, Chen et al. 2011). However, the current research was the only study that used a new learning style instrument, which was developed using the Arabic language, whereas all of the other studies conducted in the Arab region used translated versions of existing learning style instruments such as Index of Learning Style (ILS).

With reference to the second hypothesis, which is concerned with the correlation between dimensions of learning style, the results were varied. While the first experiment revealed that there was a statistically positive significant correlation between visual and active style, r (8) = 0.715, p = 0.020, the second experiment revealed that there was also a statistically positive significant correlation between passive and verbal style, r (14) = 0.765, p = 0.001. Importantly, the results revealed that there was a statistically positive significant correlation between passive and active style, r (14) = 0.799, p = 0.000. These results confirm the points explained in the literature (subsection 2.4.3), which is that the

dimensions of learning style must not be treated as dichotomies (either/or options). Therefore, to avoid a misunderstanding of the learning style, it is important to know that the learners could have visual and verbal preferences at the same time, and it is also quite possible to have both active and passive tendencies at the same time.

Although the results of the current research, as well as results of a huge number of related studies, support the view that adapting to the learning styles, has a positive impact on student performance, a few studies reported that adapting to the learning styles has no impact on student performance in terms of knowledge gained (Özyurt, Özyurt 2015). For example, in 2007 Brown carried out a similar research study and reported that, "*it seems as though the use of a visual-verbal learning style model to provide matched or mismatched content to university students is unlikely to enhance learning in a statistically significant way*" (E. Brown 2007).

These opposite results could be interpreted by the fact that these studies used different learning style models, different instruments and sample size. Importantly, they were also conducted in a different environment and tested only one dimension of learning style.

In conclusion, the main difference is that this research used a developed instrument (ALSI), which considered the various ways of presenting the instrument items (Alzain et al. 2016) , see subsection 1.6.2 and 4.4.2 . Moreover, the validity has been tested, see section 5.3. In addition, the research results reflect the results of the majority of the previous research, which found a positive impact on student performance when using an adaptive learning system.

5.6.7. Implementation of Five-Arrows Framework: Qualitative Study

For more investigation, qualitative research techniques are also used. Four semi-structured interviews have been conducted with four experts (officials in LHES). Table 51 shows the characteristics of participants.

Table 51: the Five-Arrows Framework implementation, Qualitative Study - Characteristics of the Participants.

Id	Job title	Gender	Years of Experience
E1	Head of Computer Department at College of Technical Science	Male	6
E2	Head of General Computer Department at Faculty Information Technology	Male	7
E3	Head of Computer Department at Faculty of Education	Male	18
E4	Head of Computer Science Department at Faculty Information Technology	Male	7

Table 52 shows the objectives and questions that were addressed by this qualitative study.

Table 52: the Five-Arrows Framework implementation, Qualitative Study _ Objectives and Questions of Interview

No	Objectives	Question
1	To examine teacher and student understanding of learning style	Q1: Do you think that computer tutors in LHES understand the meaning of learning style?
		Q2: Do you think that computer tutors in LHES consider the individual differences between students in their teaching?
		Q3: Do you think that students in LHES understand the meaning of learning style?
		Q4: Do you think that students in LHES know their preferred learning style?
2	To investigate effect of considering the student learning style on students a) Performance b) Engagement c) Time needed to learn	Q1: Do you think that considering the preferred learning styles of students in the educational process, helps students to a) Increase their performance? b) Increase their engagement? c) Reduce the time needed for learning?
3	To explore barriers that may hinder adoption of Libyan Adaptive Education System (LAES) in LHES a) Infrastructure b) Training c) Curriculum	Q1: What are the barriers that may hinder adoption of Libyan Adaptive Education System (LAES) in LHES?

Teachers and Student Understanding of Learning Style

This part of the study attempts to investigate understanding of teachers in terms of learning style concept and considering the individual differences between students. The participants were required to respond to the questions:

Do you think that computer teachers in LHES understand the meaning of learning style and consider the individual differences between students in their teaching?

Generally, participant responses in this part revealed that the teachers have a general idea about the learning style, and they need to know more about it. For example, the participant E2 reported that:

> "E2: I think most of the teachers have like a general idea about the theory of learning style, but they do not know the tiny details that are related to the learning style. Therefore, they might consider the individual differences between students unintentionally".

In line with expert E2, experts E3 and E4 responded that:

> "E3: By virtue of experience, some teachers have an idea about the students who are teaching them, and how they prefer to learn. For example, some teachers try to use more than one way to present the information to make it easier to understand. However, I think these practices needed to be more professional".

> "E4: I think some teachers know something about how their students like to learn. As evidence, when you ask the teacher about a particular student, the teacher will give you an impression about that student. For example, the teacher might say that, the student is good and active, or he is not active".

However, expert E1 responded that:

> "E1: That depends on the teacher himself, but I think some teachers have pedagogical qualifications, especially who have graduated from the Faculty of Education. I think, those teachers have a good background about the learning style, and they try to consider the differences between students as much as they can".

The participants were also asked whether the students in LHES understand the concept of learning style, and know their preferred learning style or not. The participants were required to respond to the questions:

Do you think that the students in LHES understand the meaning of learning style and know their preferred learning style?

Generally, participants think that most students do not have a clear idea about the concept of learning style, and their preferred learning style. For example, participants E1 and E2 reported that:

> "E1: I think the majority of students do not have any background about their preferred learning style".

> "E2: I think most students do not have a sound understanding regarding the concept of learning style. But, some of them, especially who are in advanced stage have an idea about their preferences. For example, some students might declare that they like a specific module because the content depends on textual information or the teacher depends on particular teaching activities or particular evaluation method".

However, some of the participants think that the students may acquire more details about their preferred learning style over time. In this context, the participants E4 and E3 reported that:

> "E4: I think students may have their perceptions about their preferred learning style with the passage of time. However, these perceptions may not reflect reality".

> "E3: I think, some students have acquired an idea about their learning preferences by virtue of experience, for example, some students sometimes declare that they prefer a particular style of questions such as editorial questions more than others. However, I think they did not ever use any instrument to measure their preferred learning style".

Expert 3 also thinks that:

> "E3: I think female students tend to be more verbal than male students".

In connection with this, Expert 2 reported that:

> "E2: I think male students are more active than female students".

Effect of Considering Learning Style on Student Performance, Engagement and Learning Time

This part of the study investigated the impact of considering the student learning style on student performance, engagement and learning time. The participants were asked to respond to the question:

Do you think that considering the preferred learning styles of students in the educational process helps students to

a) Increase their performance?
b) Increase their engagement?
c) Reduce the time needed for learning?

Here, the dominant opinion of participants was that considering the learning styles of students and taking into account the individual differences has a positive impact on the performance and engagement of student. In relation to this, the participants E1and E2 reported that:

> "E1: In my opinion, there are three main axes in the educational process, which are a student, curriculum and teacher. So, if the teacher succeeds to teach and present the curriculum in the manner that fits student needs and preferences, the student interaction and engagement will be increased, and as a result, student performance will increase".

> "E2: If the student knows his/her preferred learning style and understands how to harness it in the educational process, that will help the student to manage his/her learning. For example, when the student is looking for some resources that are related to a particular topic, if the student does not know his/her style, the resources will be picked up randomly. In contrast, if he knows his style he will select the resources that fit his style, and I think that is very important for both student and teacher".

In line with expert E1 and E2, experts E3 and E4 responded that:

> "E3: Sure, that will positively affect student engagement and performance, and that will contribute to reducing the learning time".

"E4: It is too important to take into account the different styles in our teaching, that will significantly affect student engagement and time needed to learn. For example, as a teacher sometimes I teach the same module for two different groups of students, with the same learning time (ex: four hours a week). However, I may notice that the topics that have been taught to group X, are more than the topics that have been taught to group Y. I think the main reason behind that is the engagement of students, because if the student likes the teaching style and content, he will interact with the teacher and that will reduce the learning time. And one important way to make the student like the teaching approach and increase his engagement level is to consider his preferred learning style".

Barriers That May Hinder Adoption of Libyan Adaptive Education System (LAES) in LHES

A further outcome of this study was to identify the barriers to the adoption of LAES systems in LHES. Regarding this, the participants were asked to respond to the question:

What are the barriers that may hinder adoption of Libyan Adaptive Education System (LAES) in Libyan Higher Education System?

In terms of infrastructure, most of the participants think that there are no barriers that may hinder adoption of (LAES). For example, expert E1 reported that:

"E1: Such systems are relatively new. So, I think it has not been applied in our educational system before. However, I think we have good resources in terms of infrastructure to adopt this idea".

In line with expert E1, expert E3 responded:

"E3: I think an adaptive education system is a good and applicable idea, and we have infrastructure that allows us to adopt it in the Libyan higher education system".

However, the participants have raised some concerns that may hinder adoption of such systems in Libya. For example, expert E3 stated**:**

> "E3: I think the main barrier, which may hinder adoption of this idea is the curriculum. I think the curriculum needs to be refined and reformulated to be more suitable".
>
> "E4: I think the success of applying these systems depends mainly on the teacher attitude toward these systems. Therefore, I think some teachers need to be trained in terms of pedagogical issues related to use of technology in education".

With reference to the system usability and users training, expert E1 and E2 responded that:

> "E1: In terms of system usability, students and teachers do not need any training about using the system. But, I think some of the teachers need to be trained in terms of pedagogical practices in education"
>
> "E2: I think adaptive education systems should be adopted in our educational system because it will be very useful especially if it is provided as a smartphone application. In terms of using the system, I think students and teachers especially computer students are very familiar with this kind of software. Therefore, they will not face any difficulties to use the system".

Moreover, Expert E2 also reported that:

> "E2: I think the different ways of content presentation should not be treated as alternatives because it is complementary to each other. Therefore, I think the systems should guide the student to the style which fits him, and allow the student to show the other styles as well".

5.6.8. Implementation of Five-Arrows Framework - Qualitative Study: Discussion of Results

Results from this qualitative study revealed that the common belief of the participants is that the teachers with relatively long years of experience are more familiar with pedagogical practices related to the learning styles, and they also think that teachers with relatively older age are less confident with the use of technology in education. However, such results were not statistically significant (see Table 12). Where the results found no significant correlation between years of teaching experience and pedagogical practices, the results also found no significant correlation between using technology and age of teachers. These results are not surprising because the previous related studies, which investigated the influence of teaching experiences on the technology integration in education, revealed conflicting results (Shin 2010). For example, in this context, (Kisanga 2015) and (Males 2011) found no significant correlation between teacher attitudes towards technology integration and years of teaching experience. In contrast, (Shin 2010) investigated the factors influencing the use of technology in education in Korea, and found that the years of teaching experiences were positively associated with the use of technology in education, thus, the teachers with long years of experience had positive attitudes towards using technology in education more than others. On the contrary, (Tuparova, Tuparov et al. 2006) found that the years of teaching experience were negatively associated with the use of technology in education, and this result was supported later by (Inan, Lowther 2010), who found a negative significant correlation between technology integration in education and years of teaching experiences. He stated that the, *"veteran teachers may have less computer proficiency and confidence to integrate technology"*. Similar results were declared by (Karaca, Can et al. 2013), who investigated the factors that might influence integrating technology into elementary schools in Turkey. Karaca found that the years of teaching experiences had a negative impact on the technology integration into the education process.

These conflicting results could be interpreted by the fact that these studies were conducted with different samples of participants with different cultures in a different environment and context.

The qualitative study also revealed that some participants think that learning styles are associated with the gender of students. For example, some participants think that the female students tend to be more verbal than male students, and male students are more

active than female students. Although this claim was supported by some researchers (Koçakoğlu 2010, Alghamdi 2010), for example Lee and Wise reported that "*The female engineering students tended to be more sequential, more sensing, and less visual than the male engineering students, but the practical implications of these trends and their generality remain to be investigated*" (Litzinger et al. 2005). However, in this study such results were not statistically significant (see Table 40). Where the results found no significant differences between males and females in terms of preferred learning style. This result concurs with that from (Austin 2003, Koçakoğlu 2010, Pierart, Pavés 2011, Ates, Altun 2008, Alghamdi 2010) studies which found no significant correlation between learning style and gender.

This qualitative study also provided a sound understanding regarding the barriers that can hinder the adoption of adaptive education systems in LHES, these barriers have also been explored in a number of related studies including (A. Othman, Pislaru, Kenan, and Impes 2013b, Kenan et al. 2012, A. Elzawi, Underwood 2010, Tamtam et al. 2011, A. E. Elzawi 2015, A. Othman et al. 2013a, Alzain et al. 2014).

Consistent with (Rhema, Miliszewska 2012, El Zoghbi et al. 2010, Tamtam et al. 2011) as well as (Abod-her 2013), it is clear that there are still curriculum problems that need to be addressed. E-curriculum in Libya, as in the rest of the Arab region, is still in its infancy (Abod-her 2013, Rhema et al. 2013). The results from this study revealed that the existing curriculum has not been designed to be applied in adaptive education systems and e-learning systems. Therefore, the curriculum needs to be redesigned and developed to be more suitable for such systems. (Andersson, Grönlund 2009) reported that, *"Because e-learning is different from traditional learning, the curriculum and pedagogical methods need to be modified and developed to employ ICT application effectively and they should be specifically designed to fit the e-learning setting*". In order to overcome this barrier, we recommend running professional training programmes on ways of integrating ICT into the curriculum.

The lack of professional training programmes is another key barrier that was revealed by this study, and this result concurs those of (Abod-her 2013), which considered a lack of inadequate teacher training opportunities for ICT projects as a key barrier to adopting ICT in LHES.

Although a number of related studies revealed the lack of developed infrastructure was considered to be a key barrier to the adoption of ICT in LHES (A. Elzawi, Underwood 2010, A. Othman et al. 2013b, Kenan et al. 2012, A. E. Elzawi 2015, Rhema et al. 2013, Abod-her 2013), results from this study revealed a common belief that the ICT infrastructure is developed enough to adopt such systems. However, the researcher thinks that the Libyan officials in LHES should keep enhancing the ICT infrastructure to keep pace with rapid technological changes. Moreover, they should provide an adequate technical support for instructional institutes. This would not only enhance teacher confidence but also it would save the learning time.

5.6.9. Impact on Future Work

This research provided a clear idea about the learning styles and learning style instruments. It also provided an example of how the instruments of learning styles can be used in an adaptive education system. The research revealed encouraging results in terms of student performance and engagement when they learn in a way that matches their preferred learning styles.

Importantly, it is the first study to examine carefully the impact of content on the efficiency of learning style instruments. Therefore, this study has opened new doors of research in the field of learning style instruments.

This adds to the originality of this work because most of the adaptive education systems depend on learning style instruments to find out the preferred learning styles of students and then match it with the learning objects.

5.7. Summary

This chapter has presented in detail the results of investigating the current situation of Libyan Higher Education System including teacher attitudes and needs regarding using technology in the education process. The chapter has also discussed the issues of reliability and validity of the first Arabic Learning Style Instrument (ALSI), as well as the impact of using visual and active information in constructing the instruments of learning styles and impact of that on the efficiency and accuracy of the instruments. It also investigated the preferred learning style of computing students in Libya and compared it with a dominant

learning style across a number of related studies around the world. Finally, this chapter has presented in detail the results of implementing the Five-Arrows Framework using the LAES system.

The following chapter will conclude this thesis by summarising the outcomes and highlighting the implications, contributions and limitations of this research, as well as discussing the possible avenues of future research.

6. Chapter Six: Conclusion

6.1. Introduction

The preceding chapter presents in detail the results that emerged from a number of experiments, conducted in this research.

This chapter presents a summary of the work carried out during the study. Under a number of subheadings, the chapter sets out the major findings, the contribution to knowledge in the field, the limitations of the study and the areas for further research.

6.2. Summary of Findings and Research Questions Re-visited

This research used both qualitative and quantitative approaches to investigate the phenomena of learning styles as well as the efficiency of the existing learning style instruments. As the researcher found from reviewing the literature, earlier related studies, with minor exceptions, lack qualitative analysis and rely on a quantitative approach to investigate the validity and reliability of the learning style instruments. This situation was the same with the earlier studies that investigated the effects of using adaptive education systems on student performance. A scientific approach was considered, and qualitative evidence was taken into account to support the empirical evidence. See section 2.7, 2.9.

This research is also the first study to investigate the nature of the information that could be used to construct the instruments of learning style, and the impact of that on the efficiency of these instruments. See sections 2.10 and section 5.5.

This research is also distinctive in designing and incorporating a new learning style instrument (ALSI), which is the first reliable learning style instrument designed for an Arab community and culture in the Arab region.

The following subsections provide more details of major findings based on the eleven research questions presented in Chapter 1 subsection 1.11.

6.2.1. The Current Situation and Practices in Computing Teaching in the Libyan Higher Education System

This was investigated in order to get a clear insight and understanding into the current practices of computing education in LHES. Experiment 1 was conducted with 46 participants (See section 5.2), and the experiment investigated teacher needs and perceptions as well as the current practices of computing teaching in the LHES.

Research question 1. What are teacher needs in terms of using technology and pedagogy in the teaching process?

The first research question investigated the needs of computing teachers in LHES in terms of using technology and pedagogy in the teaching process. Results from this research revealed that the teachers in LHES have different needs. Regarding using technology in education, 46 teachers (100 %) declared that they would like to be involved in professional training courses in technological practice in education (See Figure 23). The majority of teachers (87 %) also said that they would like to be involved in professional training courses in pedagogy and content (See Figure 24 and Figure 22). On the other hand, only (6 %) of participants did not wish to be involved in pedagogical training courses.

In order to improve teacher skills in terms of using technology and pedagogy in the education process, the strategy recommended by the study is to provide professional training courses on:

- Technological practices in education;
- Pedagogical practices in education;
- Curriculum design and presentation in these contexts.

These recommendations are consistent with the results that have been reported in the literature. Section 2.2.2 (Kenan et al. 2012, Abdelsalam 2013).

Research question 2. What is the teacher perception about using technology in the education process?

The second research question investigated teacher beliefs towards using technology in teaching. Results from this study show that 65 % of participants think that using technology in education predominantly has a positive impact on student performance (See Figure 25). However, 35% of them think that using technology in education sometimes has

a negative impact. Generally, they think that the technology will be useful only if the teacher uses it in a professional and elaborate way. (See Figure 25 subsection 5.2.4).

Research question 3. What are the current practices in computing teaching in the LHES?

The third research question investigated the opinion of computing teachers about the teaching approaches. Although more than 75 % of participants think that the student-centred teaching approach is better than the teacher-centred approach, only 39% of participants indicated that they are using a student-cantered teaching approach in their teaching (See subsection 5.2.5, Table 11).

Research question 4. Is there any association between teacher age, experience and using technology, pedagogy in the education process?

This research question explored the correlation between some independent variables such as years of teaching experience, age and the dependent variable using technology and pedagogy in teaching. Results from this research revealed that there was no statistically significant correlation between these variables (Alzain et al. 2014). See section 5.2.7.

6.2.2. Developing and Validating the First Arabic Learning Style Instrument

The fifth and sixth research questions:

Research question 5. How can we develop the first Arabic learning style instrument?

Research question 6. How can we validate the new instrument?

The process of developing and validating the first Arabic Learning Style Instrument (ALSI) was investigated. To answer these two questions, a number of experiments and rigorous statistical procedures were conducted (See section 4.4, 5.3 and 5.3.2).

The ALSI instrument has undergone internal reliability tests at Misurata University in Libya and Nottingham Trent University in the UK, and it scored accepted Cronbach alpha values for each dimension (See Table 17, Table 18, Table 19, Table 25, Table 26 and Table 27). Moreover, the results of test re-test reliability revealed that there was no significant difference between the means of scores on the four scales of measurements (p. value > 0.05). Consequently, the results of the t-test provide evidence of repeatability for the ALSI instrument (See section 5.3).

In order to investigate the content validity of ALSI, a Content Validity Index (CVI) test was conducted. The items of ALSI were judged by 6 experts in the subject area. The items of ALSI scored an accepted (I-CVIs > 0.8) (See section 5.3). Moreover, factor analysis was conducted to explore the construct validity of ALSI. The results of factor analysis revealed that the visual and verbal scale maintained a stable structure (See section 5.3).

Overall, these results were significant and provide empirical evidence, comparable with the results of previous work on translating instruments of learning style (Al-Jojo 2012). However, to develop a new learning style instrument, a number of rigorous procedures are required to ensure the scale validity and reliability. In this study, a set of well-known procedures were conducted such as Cronbach's alpha, classical item analysis, test-retest reliability, content validity index and factor analysis. The reliability test of the four scales of the ALSI show that the values of Cronbach alphas range from 0.577 to 0.711: this is an accepted score, because it is greater than 0.5 (Tuckman, Harper 2012). Moreover, the classical item analysis revealed that the reliability of the scales can be enhanced by eliminating the weakest question in each scale, and the greatest improvement occurring for the passive scale, which increased from 0.591 to 0.644. These results, as well as the results of test-retest reliability, content validity index and factor analysis provide evidence of reliability and validity for the ALSI, and confirm that this instrument seems to be a suitable psychometric instrument to detect the preferred learning style of learners.

6.2.3. Preferred Learning Style of Libyan Students

The seventh and eighth research questions:

Research question 7. What is the preferred learning style of Libyan students?

Research question 8. Is there any difference between the preferred learning styles of Libyan students and the other students around the world?

Research questions 7 and 8 aim to investigate the dominant preferred learning style of computer students in LHES and present the results along with the results of a number of relevant studies around the world. To answer these two questions, the preferred learning style of 111 students from Misurata University and 50 students from NTU University were measured, and the findings were compared with the results of a number of relevant studies around the world (See sections 5.3.35.4.1, 5.4.2 and 5.4.3).

The results of this experiment revealed that the students at both Misurata University and NTU University are more active and visual than passive and verbal (See Table 31 and Figure 31). Moreover, an independent sample *t*-test was conducted and the results revealed that there were no significant differences between the means of scores on the four scales of measurements (*p*. value > 0.05). See Table 32.

The preferred learning style of students at Misurata University were also compared with the preferred learning style of students at King Abdul-Aziz University as well as the students at the American University of Sharjah.

Generally, the results indicate that the students in the three universities are more active and visual than passive and verbal, but the students at Misurata university are more active than the students in the other two universities where (85%) of students in Misurata University were active in comparison with (65%) of them in King Abdul-Aziz University and (51%) in American University of Sharjah. On the other hand, the students of King Abdul-Aziz University are more visual than the students in the Misurata University and the American University of Sharjah where the percentage of visual students in the three universities are 87%, 85%, and 79% respectively (See Table 33 and Figure 32).

The results of this experiment were also compared with the results of fifteen related studies across the world (See Table 34). By comparing the percentages in Table 34, it is clear that the dominant learning style is visual and active

These results are consistent with the results of similar studies carried out in the Arab region as well as across the world (Al-Jojo 2012).

6.2.4. Efficiency and Effectivity of Previous Learning Style Instruments

The ninth and tenth research questions:

Research question 9. To what extent are the existing learning style instruments are precise in measuring the preferred learning styles of students?

Research question 10. To what extent are the use of visual and active content in instruments affecting measurement of the learning styles?

The literature review revealed that no current learning style instruments present information in different styles, and the content of these instruments depends only on the textual form of information, which might be leading to a bias in measuring of learning style, as the textual forms information are more accessible to verbal learners. This encouraged the researcher to investigate the impact of using the visual and active content in the learning styles instrument construction, because the researcher claims that the instrument items should be presented in different forms of information to correspond the different styles of students. To answer these two questions, two experiments (quantitative and qualitative) were conducted. Firstly, the quantitative experiment was conducted with 50 participants and then, the qualitative experiment was conducted with 6 participants (See section 5.5). In both experiments, the preferred learning styles of participants were measured twice using a developed instrument (ALSI), which was constructed using visual and active content, and by using a VARK instrument, which was constructed using text only. The results of both were compared and data was analysed using SPSS Version 22. (See Table 35). Paired *t*-tests were conducted to determine if there were any significant differences between the preferred learning styles of students. The results revealed there were significant differences between the means of scores on the four scales of measurements (*p*. value < 0.05) (See Table 36).

- Visual style (t = -12.94, p = 0.000);
- Verbal style (t = -3.87, p = 0.000);
- Active style (t = -9.91, p = 0.000);
- Passive style (t = -6.03, p = 0.000).

The results also revealed that there was no significant difference in learning style based on gender (See Table 40). On the other hand, there was a positive significant correlation between the years of computer use and visual style (r = 0.397, p = 0.005) as well as a

positive significant correlation between verbal and passive style (r = 0.458, p = 0.001) (See Table 41).

In order to see things from more than one perspective (data triangulation), a qualitative study was conducted with 6 participants. Firstly, preferred learning style of participants was measured twice, using the ALSI instrument (built using a visual and active content) and subsequently by using a VARK instrument (text only). Secondly, the results were compared and statistically analysed. Finally, six interviews were conducted with the participants about their preferred learning style and their opinion about the effect of using the visual and active content in the construction the instruments of learning styles (See Figure 34, Table 37 and Table 38).

The results revealed significant differences between the means of scores in three scales out of four (p. value < 0.05) (See

Table 39).

- Passive style (t = -4.911, p = 0.004);
- Visual style (t = -7.993, p = 0.0005);
- Active style (t = -3.095, p = 0.027).

The results also revealed that there were no significant differences between the means of preferred learning styles of students in terms of verbal style, where (t = -1.780, p = 0.135). This result may be interpreted by the fact that both instruments (VARK and ALSI) used the textual form of information to present the items that related to this type of learner (verbal students).

Furthermore, to triangulate the quantitative results, the participants were interviewed. They were asked about the importance of considering the individual differences among students in teaching methods. All of the participants indicated that the individual differences should be considered in teaching because one teaching method cannot fit all students:

> "Teaching should always include everything; we cannot depend on only one method" (P5).
>
> "Teachers should use different materials as much as they can because that will help students to keep the knowledge for a long time" (P4).
>
> "Teachers should be considering individual differences between students that will be very useful especially for students who have less concentration" (P6)

With reference to the impact of content type on participants answers, the majority of participants (five out of six) think that the new visual and active features of the ALSI instrument affected their responses to the point where it altered the assessment of their preferred learning style.

> "Students understand the text differently" (P2).
>
> (P1). "Using graphs rather than text makes the information easier to understand". P1, also said "Using only text form, may get confused sometimes, it should be inclusive both visual and verbal."
>
> "These features will attract the whole class; it will also attract those students who are not more interested in learning" (P3).

Only one participant (P5) thinks that the answer will not be affected.

> "There is a possibility if someone does not understand English very well. Obviously, for them, the answers will be affected because they may miss something when there is complete text" (5).

Regarding the impact of content on the time needed to complete the instrument, the participants were asked whether they believe that the content of the instrument could affect the time needed to finish the questionnaire. All of the participants stated that the visual and active content played a key role in reducing the time needed to complete the questionnaire.

> (P1) "Yes, that is effect, for example, if we don't know the mean formula we need to read and break down the text to extract the formula and that takes time and may get confused sometimes".
>
> (P4) "The style of question presentation will affect the answer and the time needed for the answer, for example, provide students with the equation of Pythagoras is easier and faster than providing them with a description of Pythagoras theorem."
>
> (P5) "I prefer both (visual and verbal forms) but when I see the things I can understand more quickly than reading … the only difference is the complete text one takes the time to understand the question first of all, but as soon as I see a formula or graph I will get the idea. So, the answer will not be affected but time will be affected."

In summary, the findings of this research provide new insights into the impact of content on the efficiency of learning style instruments, which are widely used, especially in

adaptive education systems. The findings indicate that the different forms of content have a considerable impact on the measurement of learning styles and the time needed to complete the instrument. Moreover, results from this study showed that the number of students who are classified as a “pure visual type” increased significantly when they used the ALSI instrument, which is constructed partly using visual forms of information. This may be interpreted by the fact that the visual type of learners respond strongly to the visual content such as (pictures, charts, figures ...etc.). In contrast, the number of “pure verbal students” and “pure passive students” did not see any significant differences, and this may be explained by the fact that both instruments use the textual form of information to present the questions related to these types of learners (verbal, passive).

In conclusion, one main implication of this study is that the result of measuring the learning style could be changed according to the type of instrument content. Therefore, it is critical to design and build our teaching strategies, especially adaptive education systems, based on the outcomes of learning style instruments, which depend on only one form of information.

6.2.5. Implementation of Five-arrows Framework Using LAES System and Impact of that on the Performance of Students

The final research question:

Research question 11. What is the impact of using the Libyan Adaptive Education System (LAES) on the performance of students?

The Five-arrows framework was implemented using the LAES system, and the impact of that on the performance and engagement of students was investigated. To answer this question, three experimental studies were conducted (See subsections 5.6.3, 5.6.4 and 5.6.5).

The first experiment was carried out at the Faculty of Information Technology at Misurata University with 10 participants. The results of this experiment revealed that there was a statistically significant difference between the mean scores of the participants when they

learnt using the LAES and the mean participant scores when they learnt without it. t (9) = -2.294, p = 0.047 (see Table 42 and Table 43).

The results also revealed that the highest effect size (d = 1.31) was in visual scale followed by the active scale (d = 0.89). Moreover, the results of correlation tests showed that there was a statistically positive significant correlation between visual and active style, r (8) = 0.715, p = 0.020 (see Table 44).

The second experiment was conducted at the Faculty of Education at Misurata University with 16 participants. The results of paired *t*-tests showed that there was a statistically significant difference between the mean scores of the participants when they learnt using the LAES system and the mean participant scores when they learnt without it. t (15) = -2.289, p = 0.037 (see Table 45 and Table 46).

The experiment also explored the effect size for each single scale. The results of Cohen's d test revealed that the highest effect size (d = 0.77) was in visual scale followed by the verbal scale (d = 0.32). Moreover, the results of a correlation test showed that there was a statistically positive significant correlation between passive and active style, r (12) = 0.799, p = 0.000. There was also a statistically positive significant correlation between passive and verbal style, r (12) = 0.765, p = 0.001 (see Table 47).

The last experiment was conducted at the Faculty of Education at Misurata University with 14 participants. In this experiment, the results of a paired *t*-test showed that there was a statistically significant difference between the mean scores of the participants when they learnt using the adaptive system and the mean participant scores when they learnt without using the adaptive system. t (13) = -1.724, p = 0.048 (see Table 48 and Table 49).

The results also revealed that the highest effect size (d = 0.56) was in active scale followed by the visual scale (d = 0.55). Moreover, the results showed that there was a statistically positive significant correlation between visual and active style, r (12) = 0.610, p = 0.020. There was also a statistically positive significant correlation between visual style and years of computer use, r (12) = 0.584, p = 0.028 (see Table 50).

Based on these results, it can be inferred that the students who learnt using the LAES system were better than others who learnt without it in terms of the knowledge gained. However, for more investigation and to see things from more than one perspective (data

triangulation), qualitative research techniques were also used. Four semi-structured interviews have been conducted with four experts in the subject area. See Table 51 and Table 52.

This part of the research investigated teacher understanding and attitudes towards learning styles and adaptive education systems. It also explored the barriers that may hinder adoption of an adaptive education system in LHES.

Generally, participant responses revealed that some teachers have simple ideas about the concept of learning styles, whereas the participants said, the teachers should know more about the tiny details related to the learning style.

> "E2: I think most of the teachers have like a general idea about the learning style, but they do not know the tiny details that related to the learning style. Therefore, they might consider the individual differences between students unintentionally".

In the second part of this qualitative study, the effect of considering learning style on student performance and engagement was considered.

In this part of the study, the dominant opinion of participants was that considering the learning styles of students and taking into account individual differences has a positive effect on student performance and engagement.

> "E4: It is too important to take into account the different styles in our teaching, that will significantly affect student engagement and time needed to learn. For example, as a teacher sometimes I teach the same module for two different groups of students, with the same learning time (ex: four hours a week). However, I may notice that the topics that have been taught to group X, are more than the topics that have been taught to group Y. And, I think the main reason behind that is the engagement of students, because if the student like the teaching style and content, he will interact with the teacher and that will reduce the learning time. And one important way to make the student like the teaching approach and increase his engagement level is to consider his preferred learning style".

Another issue investigated in this study is identifying the barriers that can hinder the adoption of an adaptive system in LHES.

Most of the participants think that there are no barriers that may hinder adoption of adaptive education systems in LHES.

> "E1: such systems are relatively new. So, I think it has not been applied in our educational system before. However, I think we have good resources in terms of infrastructure to adopt this idea".

E1 also reported:

> "E1: in terms of system usability, students and teachers do not need any training about using the system. But, I think some of the teachers need to be trained in terms of pedagogical practices in education".

However, experts have raised some issues that may hinder adoption of Libyan Adaptive Education System (LAES). For example, expert E3 reported that:

> "E3: I think the main barrier, which may hinder adoption of this idea is the curriculum. I think the curriculum needs to be refined and reformulated to be more suitable".

6.3. Contribution of this Research to Knowledge

The research reported in this thesis has revealed some important contributions to knowledge in the field of learning styles and adaptive education systems.

Research on learning style instruments has been dominated by application in the western culture and English language, with some translations into other languages, such as Japanese, Portuguese, French, and Arabic (Shaw 2012). However, little research has been conducted in applying such instruments to other languages, cultures and communities such as the Arab community and culture (Truong 2016, Al-Jojo 2012, Abdelsalam 2013)

One of the major contributions resulting from this research is the development of the first reliable and valid Arabic Learning Style Instrument (ALSI).

A second unique aspect resulting from this research is using both visual and active content to construct a new learning style instrument. This part of the study added value to the current knowledge by providing experimental evidence of the effectiveness and efficiency of the use of different forms of information in the construction of learning style instruments (Alzain et al. 2016).

Another major contribution resulting from this study is the development and use of the new pedagogical technological framework (Five-arrows Framework). The application of this model added value to the current knowledge by providing empirical evidence of an efficient framework that can be used to improve the outcomes of an education process.

The research has also added to the current body of knowledge by implementing a set of empirical studies that were conducted in the Higher Education sector in Libya and the UK, and the results revealed that considering learning style aspects seems to give a statistically significant benefit for students.

6.4. Limitations of the Work

Despite the encouraging results, this work has some limitations that warrant some further consideration, and these limitations relate to the adaptive system and experimental evaluation.

- Although there are a number of learner characteristics that could be considered in the adaptive system such as learner knowledge and behaviour, LAES system depends on only the preferred learning styles of students as a key characteristic to achieve the adaptation.
- The participants of all experiments were undergraduate students from the same university in Libya, studying Computer Science or Information Technology. Therefore, to boost our results, it might be useful to conduct more experiments with new participants from other disciplines, universities or other countries.
- The sample was slightly small. In addition, the experiments were short-term. These circumstances could not have been avoided, because of the currently unstable situation in Libya.

6.5. Recommendations

Based on the results and conclusions of this research, this thesis highlights in the following subsections some general recommendations and recommendations for possible avenues of future work.

6.5.1. General Recommendations

The first recommendation is about the effective harnessing of technology in teaching and learning in LHES, this research suggested that the teachers needed more training. Although the teachers think that the technology has a positive impact on student performance, unfortunately they clearly declare that they needed to improve their skills and awareness in terms of employing technology in education process. Therefore, to improve teacher skills and awareness, this study recommends that the teachers need to be involved in professional training courses. The courses should be organised in order to allow teachers to enhance their awareness, knowledge and skills, because the knowledge of technology and pedagogy plays a significant role in avoiding the misuse of technology as well as determining which technology is more suitable to use for the different instructional situations. Moreover, instructional institutions should provide professional technical support teams, which ensure that all provided equipment are always working and in good order, this might be useful to help the teachers, especially those who have not had enough experience, and less confidence with the new emerging instructional tools, particularly as we are living in an age of rapid changes in technology. Furthermore, the instructional materials should be continually updated and revised.

The second recommendation is about considering the individual differences among the students. Results from this research revealed that no one teaching approach can ideally fit all learners. Therefore, the learners should be aware of their preferred ways to learn, because that will allow them to manage their learning. Therefore, to improve learners awareness and help them to manage their learning as well as to select the most suitable instructional content and activities, this study recommended that the concept of learning style needed to be clarified to the learners. Moreover, teachers should explain to the learners how they can harness their learning style to manage their learning. In order to improve learners awareness about their preferred style, and to help them to manage their learning using this style, this study suggested that the teachers, at the beginning of each

term, should explain these issues to the students as well as help them to measure their preferred learning style using the instruments of learning style. This study also recommends the instructional institutions to adopt incorporating the adaptive education systems in their strategic plans.

A third recommendation is about increasing the level of cooperation between the LHES and the other sectors, especially the industrial sector. Results from this research revealed that there is a lack of connection, cooperation and coordination and between the LHES and the other sectors in Libya, this situation negatively affected graduates suitability to job market needs. Therefore, to address this issue, this study recommends increasing the level of cooperation between the LHES and the other sectors such as the healthcare sector and industrial sector, and this could be achieved by establishing joint research groups and conducting the research and workshops together.

6.5.2. Recommendations for Future Work

Based on the results of this research, the following subsections present some recommendations as well as some insights into the possible avenues of future research.

In future, more work could be conducted in terms of learning style instruments and adaptive education systems. To set the pace for the discussion, we will begin with learning style instruments, and then move to the second part, which is the adaptive education learning style.

Learning Style and Learning Style Instruments

The findings from this study have provided new insights regarding the existing learning style instruments, and to what extent these instruments are precise. Although, the results indicated that the different forms of information (charts, figures, equations) that could be used to construct the instruments have a considerable impact on the measurement of learning style, the efficiency and effectiveness of learning style instruments is still a key issue and main direction of future work.

Constructing the learning style instruments using different forms of information might contribute to increasing the efficiency and effectiveness of the instruments. Based on evaluating experts, gathering feedback as well as comparing the results of measuring with

results of more than one instrument, new insights regarding developing an accurate instrument can be gained.

Another area of future work will be to improve the validity and reliability of the ALSI instrument. The ALSI is a new learning style instrument built using different forms of information, such as figures, charts and equations; yet, more work and improvements in the content and experimental design could support the results that emerged from this research and boost validity and reliability.

Another possible track to extend this research to is to conduct more investigations by replicating the experiments with larger sample sizes and longer times in different courses and different institutions. For example, the LAES system could be used throughout the academic year, rather than a few instructional sessions. Long-term research with larger sample size will provide more accurate results that might support the results of this study. Moreover, more work could be conducted in future in terms of adaptation trails. For example, more investigations can be conducted on the results to know if there is a dimension or feature that has more effect on student performance than others.

Finally, the stability of learner preferred learning style over time is also challenging because it is a widely arguable issue. Therefore, evaluating this aspect of learning style considers a possible way of future work and requires lots of work with a large sample size and a long time.

Adaptive Education Systems

Results from this research indicated that learning style instruments are widely used in the adaptive education system as a tool to measure the preferred learning style of learners. In this context, another clear avenue of future research is to investigate, discover and develop new intelligent approaches to detecting the preferred learning style. In this area, there are interesting issues to investigate such as monitoring the behaviour of learners when they receive new different forms of information, and how they interact with the new knowledge. This will provide the researchers with sound understanding and new insights into the possible avenues to develop a new valid and reliable way to measure the learning styles.

Another possible way to extend this research is to develop the LAES system by developing the mechanism of detecting the preferred learning style of learners. This might be

conducted by combining more than one learning style instrument as well as monitoring the student behaviour, and then using all of that to achieve the adaptation process and generate the most suitable content and activities.

6.6. Final Conclusion

This work has explored background research related to technological pedagogical frameworks, learning style theory, learning style instruments and adaptive education systems. After reviewing the literature, the research started with investigating the current situation of the Libyan Higher Education System (LHES) in terms of computing teaching. The results of this phase provided a sound understanding regarding the current practices in computing teaching, as well as teacher needs.

The literature review of previous work as well as investigating the current situation of LHES was used to construct a new pedagogical technological framework, which is called (the Five-arrows Framework), this framework was tested later using a new adaptive education system (the LAES system).

One significant result of this research is producing the first Arabic Learning Style Instrument (the ALSI). The validity and reliability of this instrument were examined carefully by conducting a number of rigorous procedures including Cronbach's alpha, test-retest, content validity index and factor analysis. The results of these procedures revealed that the new instrument (ALSI) seems to be a suitable psychometric instrument to detect the learning style of Arab learners. The ALSI instrument was also integrated into a new adaptive education system called LAES system, which was also offered by this research.

Using the LAES system, three experiments were conducted to implement and test the Five-arrows Framework, and the experiments were concerned with the effectiveness of adaptation based on the preferred learning styles of students. The results indicate that adaptation based on the preferred learning style has a positive impact on the student performance, engagement and reducing the learning time.

Finally, although the adaptation based on learning styles is a somewhat controversial issue, this research revealed encouraging results in terms of student performance and engagement as well as reducing the learning time. However, there is a clear and pressing need to pursue quality-assured research, especially regarding the forms of information that could be used

to build the instruments of learning style and impact of that on the efficiency of these instruments.

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Appendix A: Learning Style Instrument

A1: Learning style instrument in Arabic

العمر: ..... الجنس: ☐ ذكر ☐ أنثى عدد سنوات استخدام الحاسوب : .....

الرجاء كتابة مستوى الأهمية وذلك من 1 إلى 3. حيث أن (1 الأقل أهمية) (3 الأكثر أهمية) وذلك في المربع المقابل لكل خيار من الخيارات في الأسئلة التالية. مع ملاحظة أنه يمكن اعطاء نفس مستوى الأهمية لأكثر من خيار في نفس السؤال.

س 1: في البيئة التعليمية اجمالا. أنا أتذكر وأفهم بشكل أكبر الأشياء التي

A	
E	
R	
V	

1. أجربها عملياً
2. أسمع أو أقرأ عنها
3. أتأمل وأفكر فيها
4. أشاهد حولها (فيديو – صور توضيحية – عروض مرئية)

س 2: في المحتوى التعليمي (المنهج). أي أسلوب عرض للبيانات تفضل من الأساليب التالية

E

بلغ التعداد السكاني لبريطانيا في العام ألفان وثلاثة عشر ما مقداره 63.9 مليون نسمة وذلك من أصل 52.4 مليون سجلت للعام ألف وتسعمائة وستون. حيث بلغت نسبة الزيادة ما مقداره اثنان وعشرون في المائة خلال الخمسين سنة الأخيرة مع العلم بأن ما يقارب من أحد عشر مليون منهم دون سن الرابعة عشرة.

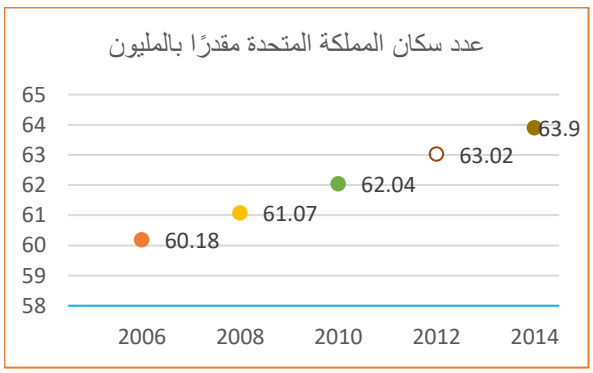
R

تعداد سكان بريطانيا في سنة 2013 بلغ 63.9 مليون نسمة

ما يقارب من 11 مليون منهم دون سن 14

بينما كان 52.4 مليون نسمة في العام 1960

V



A

إذا علمت أن تعداد سكان المملكة المتحدة لسنة 2013 بلغ 63.9 مليون نسمة. مع العلم أن نسبة الذين هم دون سن 14 بلغت 17%

س: كم يبلغ عدد الذين هم دون الرابعة عشرة

س 3: في المحاضرة القادمة ستقوم بمناقشة موضوع محدد وتريد تجهيز نفسك لهذه المناقشة. لذلك هل تفضل

1. مشاهدة بعض (فيديو – صور توضيحية – العروض مرئيه) حول الموضوع	V
2. أفكر وأتأمل في الموضوع بروية	R
3. أسأل أشخاص آخرين لهم خبرة حول الموضوع	A
4. أكتفي بالقراءة حوله	E

س 4: أنا أفضل الأستاذ الذي

1. يستخدم تقنيات العرض المرئي في الشرح (مثل : عارض البيانات - Data Show)	V
2. يستخدم التقنيات التقليدية في الشرح (مثل : السبورة)	E
3. يقسم الطلبة إلي مجموعات للقيام بنشاطات محدده	A
4. يعطي معلومات أقل تفصيلا ويشجع الطلاب على التدبر والتأمل فيها	R

س 5: أستملت أوراق (شيت) للمحاضرة. هل تفضل أن تقوم بـ

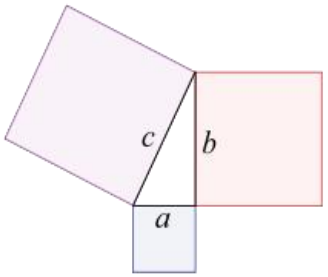
1. وضع خطوط تحت الجمل المهمة أو تضليلها	V
2. قراءتها والتحقق منها	E
3. تلخيصها وإعادة كتابة المهم منها مع الإجابة على التمارين	A
4. الاعتماد على شرح الاستاذ فقط	R

س 6: المجموعات التالية عليها ان تتعامل مع جهاز جديد بالمعمل. ضمن أي مجموعة تفضل أن تكون

1. المجموعة الأولى – مهمتها قراءة الدليل الإرشادي الخاص بالجهاز	E
2. المجموعة الثانية – مهمتها محاولة تشغيل الجهاز	A
3. المجموعة الثالثة – مهمتها مشاهدة مقاطع مرئية (فيديو) حول الجهاز	V
4. المجموعة الرابعة – مهمتها تنتظر وتستمع إلى الملخص المقدم من المجموعات السابقة وتقيمها	R

س 7: أي عرض من العروض التالية تفضل

V



$a^2 + b^2=c^2$

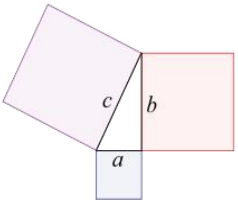
$C = \sqrt{a^2 + b^2}$

E

تنص نظرية فيتاغورس على أنه في المثلث القائم الزاوية مجموع مربعي الضلعين المجاورين للزاوية القائمة يساوي مجموع مربع الضلع المقابل لها

R

مربع الضلع المقابل للزاوية القائمة يساوي مجموع مربعي الضلعين الآخرين

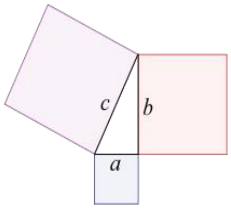


بما أن $a^2 + b^2=c^2$ فإن

$C = \sqrt{a^2 + b^2}$

A

مربع الضلع المقابل للزاوية القائمة يساوي مجموع مربعي الضلعين الآخرين



$C = \sqrt{a^2 + b^2}$

إذا كان طول الضلع a=4 & b =3

فإن c = ...

س 8: شخص ما طلب منك أن توضح له السؤال السابق (سؤال رقم 7) للقيام بذلك هل تفضل أن

V
E
A
R

1. تستخدم بعض الأشكال والصور التوضيحية
2. توضيح ذلك شفهيا
3. تستخدم السبورة مع إعطاء أمثلة على ذلك
4. تعطيه رابط لموقع على شبكة الإنترنت حول الموضوع

س 9: من الكتب. هل تستفيد أكثر من

1. النصوص المكتوبة	E
2. المخططات والأشكال والجداول	V
3. الأمثلة المحلولة	R
4. الإجابة على التمارين	A

س 10: في المحاضرة القادمة سوف تقوم بتقديم عرض مرئي. هل تفضل أن

1. تستخدم المخططات والصور والفيديو أكثر من النصوص المكتوبة	V
2. تستخدم النصوص المكتوبة والتسجيلات الصوتية	E
3. حل بعض الأمثلة خلال العرض المرئي	A
4. إعطاء معلومات أقل تفصيلا مع توفير المراجع	R

س 11: الأستاذ المشرف على المادة قسم الطلبة إلى أربع مجموعات وزود كل مجموعة بمنهج مختلف. ضمن أي مجموعة تفضل أن تكون

1. المجموعة الأولى – منهج يعتمد بشكل كبير على المحتوى المرئي (الصور – المخططات - الأشكال)	V
2. المجموعة الثانية – منهج يعتمد بشكل كبير على الجانب العملي والتجارب	A
3. المجموعة الثالثة – منهج يعتمد بشكل كبير على النصوص المكتوبة	E
4. المجموعة الرابعة – منهج ملخص أو يحتوي على معلومات أقل تفصيلا	R

س 12: مجموعة بحثية قسمت إلى أربع مجموعات صغيرة، لكل مجموعة مهام مختلفة. ضمن أي مجموعة تفضل ان تكون

1. المجموعة الأولى – مهمتها البحث عن مصادر جديدة متعلقة بموضوع البحث	A
2. المجموعة الثانية – مهمتها قراءة المصادر التي تم توفيرها	E
3. المجموعة الثالثة – مهمتها عرض وتقديم نتائج البحث في ندوات علمية	V
4. المجموعة الرابعة – تقييم عمل المجموعات الأخرى	R

س 13: في الفصل الدراسي القادم. يجب أن تدرس مادة اختيارية واحدة من أصل أربع مواد متوفرة. هل تفضل ان تدرس المادة التي

1. تعتمد على التدريب العملي والمجموعات البحثية
2. تعتمد على الدراسات النظرية
3. تعتمد في منهجها على المؤثرات الحركية والصور
4. توفر معلومات ملخصة ومركزة

A
E
V
R

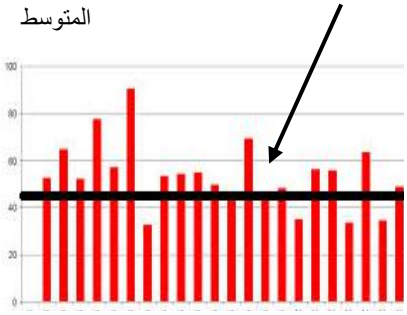
س 14: ما هي الطريقة التي تفضلها من الطرق التالية وذلك لشرح المتوسط الحسابي

V

المتوسط الحسابي = مجموع ÷ عددها القيم

$$م = \frac{س1 + س2 + س 3 + \cdots + س ن}{ن}$$

المتوسط



E

في علوم الرياضيات والإحصاء المتوسط الحسابي يعبر عنه ايضا بمصطلح آخر وهو (المعدل). حيث يتم حساب المتوسط الحسابي عن طريق جمع كل القيم معاً ومن ثم بقسمة مجموعها على عدد هذه القيم

A

المتوسط الحسابي = مجموع القيم ÷ عددها

$$م = \frac{س1 + س2 + س 3 + \cdots + س ن}{ن}$$

مثال

المتوسط للأعداد (10,2,7,1) = 20÷ 4

س: أوجد المتوسط الحسابي للأعداد (11,3,7)

R

المتوسط الحسابي = مجموع القيم ÷ عددها

المتوسط للقيم (10,2,7,1) = 20÷4

= 5

س 15: طلب منك الاستاذ أن تختار أحد طرق التقييم التالية ليتم تقييمك حسبها. أي طريقة تفضل

A
E
V
R

1. إجراء دراسة عملية شاملة
2. كتابة تقارير اسبوعية
3. تقديم عروض مرئية (Presentation) اسبوعياً
4. إجراء امتحان نظري في نهاية الفصل الدراسي

س 16: خلال المحاضرة الدراسية. هل تفضل أن

A
R
V
E

1. التفاعل مع الأستاذ والنقاش معه
2. ملاحظة الأستاذ
3. التركيز على الصور والمخططات والأشكال والرسوم البيانية
4. الاستماع للأستاذ مع تسجيل الملاحظات

A2: Learning style instrument in English

*** Age……..……..** *** Gender: Male ☐ Female ☐**

***I have been using a computer for ……. years**

Please write priority level from (1 least important) to (3 most important) in the boxes for the respective choices, you can give the same priority level for different choices.

Q1: In a learning environment, I remember and understand things that

A
E
R
V

- I have tried
- I have listened or read about
- I have thought about
- I have watched (video, seen)

Q2: In a learning context, which presentation style do you prefer?

E

The total population in United Kingdom was last recorded at 63.9 million people in 2013 from 52.4 million in 1960, changing 22 percent during the last 50 years. Population in the United Kingdom averaged 57.45 Million from 1960 until 2013, reaching an all-time high of 63.90 Million in 2013 and a record low of 52.37 Million in 1960. Population in the United Kingdom is reported by the Eurostat-1

R

- UK population in 2013 is 63.9 million

It was 52.4 m in 1960

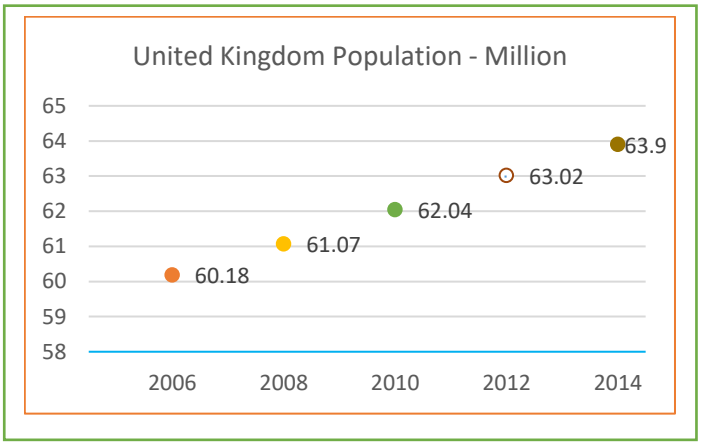
the number of under is about 11 million

A

The total population in UK recorded at 63.9 million people in 2013 from, and the percent of under 14 is 17%

Q: what is the number of under 14?

V



Q3: You are going to discuss a specific topic in the next lecture and you want to prepare yourself, do you prefer to

V
R
A
E

- Watch some related videos about it
- Reflect on it
- Ask somebody else about it
- Read about it

Q4: I prefer an instructor who

V
E
A
R

- Uses visual presentation technologies (ex: data show)
- Uses traditional tools (ex: black board)
- Organises group activities
- Gives less detailed information , supports students to think for themselves

Q5: You have received hand text from a lecturer, do you prefer to

V
E
A
R

- Underline or highlight the important notes
- Read and investigate about it
- Summarise it, rewrite the important notes and solve the exercises
- Rely on lecturer and not take further action

Q6: The following groups have to deal with a new device in the LAB, which group would you prefer to join

E
A
V
R

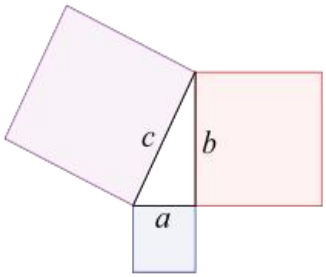
- Group 1- read the device's catalogue
- Group 2- try operating it
- Group 3- watch related videos
- Group 4- wait to listen to the summary of other groups and evaluate them

Q7: Which presentation style do you prefer?

E

Pythagoras' theorem states that the square of the hypotenuse (the side opposite the right angle) is equal to the sum of the squares of the other two sides.

V

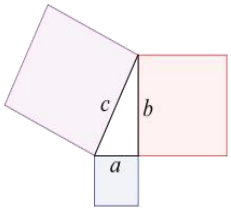


$a^2 + b^2 = c^2$

$C = \sqrt{a^2 + b^2}$

A

Square of the hypotenuse equal the sum of the squares of the other two sides

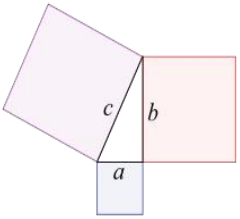


$C = \sqrt{a^2 + b^2}$

If a=3 and b=4 then c =….

R

Square of the hypotenuse equal the sum of the squares of the other two sides



- $a^2 + b^2 = c^2$
- $C = \sqrt{a^2 + b^2}$

Q8: Somebody asks you to explain the previous question (question 7), do you prefer to

V
E
A
R

- Use some figures to explain
- Explain verbally
- Use the board and give some examples
- Give him a link e.g. a website

Q9: In text books, do you get more from

E
V
R
A

- Written text
- Charts, figures and tables
- Solved examples
- Solving exercises

Q10: You have a seminar or presentation in the next lecture, do you prefer to

V
E
A
R

- Use graphs , pictures or video more than written text
- Use text and records
- Solve some examples during the presentation
- Provide less detailed information with some references or links

Q11: The module leader divides students into four groups with different resources, which group would you like to join

V
A
E
R

- Group 1- heavy-graphics resources
- Group 2- heavy-practical or experimental resources
- Group 3- heavy-textual resources
- Group 4- abstract or less detailed resources

Q12: A research group is divided into four small groups with different duties, which group would you like to join

A
E
V
R

- Group 1- looking for new resources about the research area
- Group 2- read the provided resources
- Group 3- present the research results in seminars
- Group 4- evaluate the other groups

Q13: Next term, you have to choose one of four optional modules, do you prefer the module that

A
E
V
R

- Is based on practical training and research group
- Is based on theoretical study
- Provides heavy-animation and graphical resources
- Provides abstract information and focus

Q14: Which way do you prefer to explain the method of mean calculation?

E

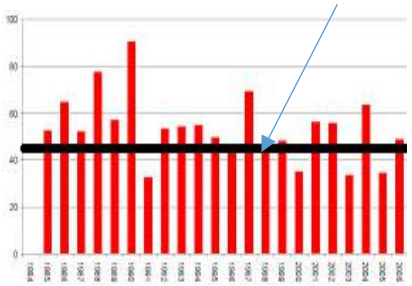
In mathematics and statistics, the mean is another name for the average. The mean is calculated by adding all of the values together, then dividing by the number of values ……..

V

Mean= sum of values ÷ number of values

$$\frac{X_1 + X_2 + X_3 + ... + X_N}{N}$$

Mean



A

Mean= sum of values ÷ number of values

$$M = \frac{X1 + X2 + X3 + \cdots + XN}{N}$$

Ex: Mean of (10, 2, 7, 1) = 20 ÷ 4

Q: Mean of (11, 5, 7, 3, 4) = …….

R

- Mean= sum of values ÷ number of values
- Mean of (10, 2, 7, 1) = 20 ÷ 4 = 5

Q15: Your teacher asks you to select one of the following evaluation methods, which one do you prefer

A
E
V
R

- Conduct extensive practical research
- Write weekly report
- Weekly presentation
- Theoretical exam at the end of the course

Q16: During the lecture, do you prefer to

A
R
V
E

- Interact and discuss with the teacher
- Observe the teacher
- Focus on images, graphs, charts and diagrams
- Listen and take notes

Appendix B: Questionnaires

B1: Questionnaire of investigating Libyan Higher Education System - in Arabic

الغرض من الاستبيان:

هذا استبيان مصمم لغرض الوقوف على مدى استخدام النظريات التربوية والتكنولوجيا من قبل اعضاء هيئة التدريس في الجامعات والمعاهد العليا بمدينة مصراتة.

مصمم الاستبيان:

الاسم - الزين مفتاح الزين

رقم الهاتف - 092552713

البريد الالكتروني – ZMZ_1978@YAHOO.COM

بيانات المشارك

يُدرس في ☐ كلية ☐ معهد عالي

ينتمي الى قسم ☐ علمي ☐ أدبي

العمر ☐ 22 - 30 ☐ 31 - 39 ☐ 40 - 50 ☐ 51 فما فوق

الخبرة بالسنة : ☐ 1 - 5 ☐ 6 - 10 ☐ 10 - 15 ☐ 16 فما فوق

الجنس ☐ ذكر ☐ انثى

	الرجاء وضع علامة تحت أحد الاجابات	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
1	ارغب في الانضمام الى دورات في المجال التربوي					
2	توفير دورات متخصصة في التربية سيكون له اثر ايجابي على مخرجات العملية التعليمية					
3	كعضو هيئة تدريس في التعليم العالي انت تستخدم النظريات والأسس التربوية في العملية التعليمية					
4	أعضاء هيئة التدريس حديثي التخرج لهم خلفية تربوية كافية للتدريس في الجامعات والمعاهد العليا					
5	ارغب في الانضمام الى دورات متخصصة في مجال التكنولوجيا المستخدمة في التعليم					
6	توفير دورات متخصصة في التكنولوجيا سيكون له اثر ايجابي على مخرجات العملية التعليمية					
7	كعضو هيئة تدريس في التعليم العالي انا استخدم التكنولوجيا في العملية التعليمية					
8	توفر المؤسسات التعليمية في التعليم العالي كل التكنلوجيا المطلوبة في العملية التعليمية					
9	يواجه اعضاء هيئة التدريس في التعليم العالي صعوبات في استخدام التكنولوجيا في العملية التعليمية					
10	كعضو هيئة تدريس في التعليم العالي انا استخدم التكنولوجيا في اعداد المحتوى التعليمي					
11	كعضو هيئة تدريس في التعليم العالي انا استخدم التكنولوجيا في تحديث المحتوى التعليمي					
12	كعضو هيئة تدريس في التعليم العالي انا استخدم التكنولوجيا في تطوير مهاراتي التربوية					
13	استخدام التكنولوجيا له اثر ايجابي على المحتوى التعليمي					

	الرجاء وضع علامة تحت أحد الاجابات	أوافق بشدة	أوافق	محايد	لا أوافق	لا أوافق بشدة
14	استخدام التكنولوجيا له اثر ايجابي على الممارسات التربوية					
15	يمكن استخدام التكنولوجيا لتطوير المحتوى بما يتناسب مع احتياجات البيئة المحيطة وسوق العمل					
16	يمكن استخدام التكنولوجيا لتطوير المحتوى بما يتناسب مع الاحتياجات المختلفة للطلبة					
17	ارغب في الانضمام الى دورات في مجال اعداد المحتوى التعليمي					
18	توفير دورات متخصصة في المحتوى التعليمي سيكون له اثر ايجابي على مخرجات العملية التعليمية					
19	طريقة التعليم المرتكزة على الطالب أفضل نتائج من الطريقة المرتكزة على المدرس					
20	كعضو هيئة تدريس في التعليم العالي انا استخدم طريقة التدريس المعتمدة على الطالب					
21	كعضو هيئة تدريس في التعليم العالي انا استخدم طريقة التدريس المعتمدة على المدرس					

	الرجاء وضع علامة تحت احد الخيارات مع ملاحظة ان بعض الاسئلة يترتب عليه اسئلة اخرى	نعم	لا	
22	يمثل المحتوى التعليمي والنظريات التربوية والتكنولوجيا العناصر الرئيسية الثلاثة في العملية التعليمية			إذا اجبت إذا اجبت بـ لا اذهب الي 23 أو نعم 24
23	ما هي العناصر الأخرى برأيك (أكتب باختصار)			
24	هل تعتقد ان استخدام التكنولوجيا في التعليم غالبا يكون له تأثير ايجابي على اداء الطلبة			إذا اجبت بـ لا اذهب الي 25 أو نعم 26
25	ما هي الحالات التي يكون فيها للتكنولوجيا أثر سلبي على العملية التعليمية (أكتب باختصار)			
26	مخرجات العملية التعليمية في الجامعات والمعاهد الليبية ملائمة لاحتياجات سوق العمل المحلي			إذا اجبت بـ لا اذهب الي 27
27	ما هو السبب برأيك (أكتب باختصار)			

B2: Questionnaire of investigating Libyan Higher Education System - in English

Purpose of questionnaire:

Investigating the teachers' attitude towards using technology in education

Researcher details:

Name: Alzain Alzain

Mobile: 0925502713

Email: Zmz_1978@yahoo.com

Personal details:

Faculty:

Department:

Age:

Teaching experience:

Gender:

	Please tick one of the following alternative	Strongest disagree	disagree	neutral	agree	strongly agree
1	Would you like to be involved in professional training courses in terms of pedagogical practices in education					
2	Providing professional training courses in terms of pedagogical practices in education will positively impact the outcomes of LHES					
3	As a teacher in LHES, I am using different pedagogical practices in my teaching					
4	Teachers who are recently graduated have enough pedagogical background to teach in LHES					
5	Would you like to be involved in professional training courses in terms of technological practices in education					
6	Providing professional training courses in terms of technological practices in education will positively impact the outcomes of LHES					
7	As a teacher in LHES, I am using different technological practices in my teaching					
8	LHEIs provide the required technological tools for education process					
9	LHES teachers facing some problems to integrate technology into education process					
10	As a teacher in LHES, I am using technology to prepare the instructional content					
11	As a teacher in LHES, I am using technology to update the instructional content					
12	As a teacher in LHES, I am using technology to improve my pedagogical skills					
13	Using technology has a positive impact on the instructional content					

	Please tick one of the following alternative	Strongest disagree	disagree	neutral	agree	strongly agree
14	Using technology has a positive impact on the pedagogical practices					
15	The instructional content could be developed using technology to be more suitable for job market needs					
16	The instructional content could be developed using technology to consider the different needs of student					
17	Would you like to be involved in professional training courses in terms of instructional content					
18	Providing professional training courses in terms of instructional content will positively impact the outcomes of LHES					
19	Do you think a student-centred teaching approach is more effective than a teacher-centred teaching approach					
20	I am using a student-centred teaching approach in my teaching					
21	I am using a teacher-centred teaching approach in my teaching					

	Please tick one of the following alternative	Yes	No	
22	The instructional content, pedagogical practices and technology represent the three basic components of education process			If no go to 23 If yes go to 24
23	Could you please write (briefly) about the other components			
24	Do you think that using technology in education often has a positive impact on student performance.			If no go to 25 If yes go to 26
25	Could you please explain (briefly) why technology sometimes has negative impact on the performance of students			
26	Do you think that the outcomes of LHES fit the job market demands			If no go to 27
27	Could you please explain (briefly) the reason behind that			

Appendix C: Tutorial of Libyan Adaptive Education System (LAES)

1. يمكن الوصول الى النظام المقترح وذلك عن طريق كتابة العنوان التالي (www.laes.somee.com) في شريط العنوان في أ متصفح انترنت كما هو موضح بالشكل التالي

2. يوضح الشكل التالي القائمة الرئيسة بالنظام والموجودة بالجزء الأيمن من الشاشة

3. اذا كنت مستخدم جديد ولم يسبق لك انشاء حساب اضغط على زر مستخدم جديد لمعرفة كيفية الاشتراك – انظر الشكل التالي

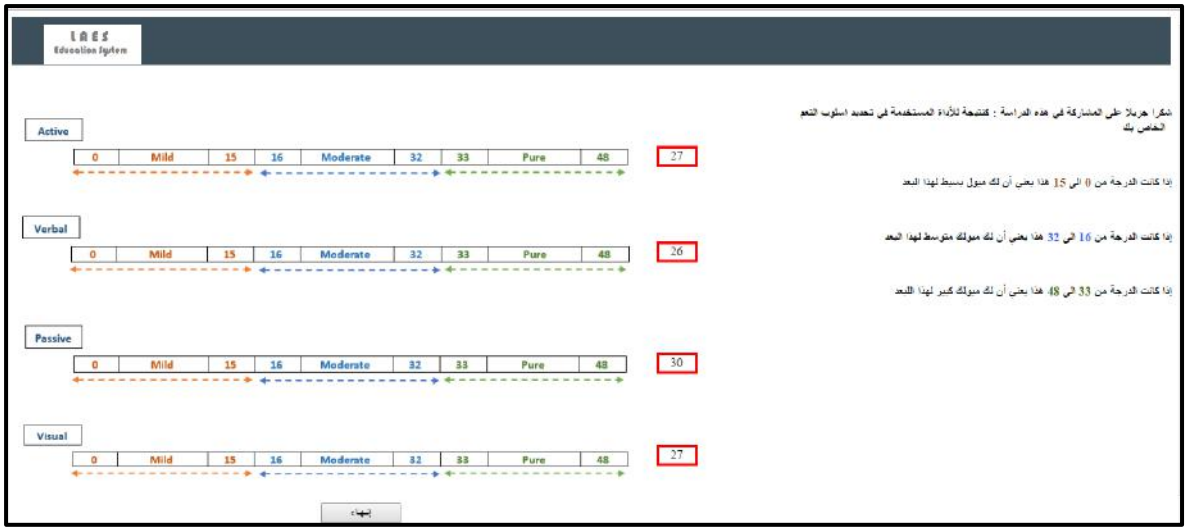
4. مسؤول النظام لدية صلاحية اضافة اي مستخدم جديد وذلك عن طريق منحه اسم مستخدم وكلمة مرور وبريد اليكتروني كما هم موضح بالشكل التالي

5. بعد الانتهاء من تكوين الحساب من قبل مسؤول النظام يمنح الطالب اسم مستخدم وكلمة مرور لكي يتمكن من تسجل الدخول للموقع وذلك عن طريق الزر تسجيل الدخول من القائمة الرئيسة كما هو موضح بالشكل

6. عند تسجيل الدخول لأول مره يقوم النظام بتوجيه المستخدم تلقائيا الى شاشة الموافقة عل الاشتراك حيث توضح الشاشة اهداف البحث والغرض منه وكيفية حماية خصوصيات المشاركين وتطلب منهم تأكيد الموافقة على ذلك كما هو مبين بالشكل التالي

7. بعد تأكيد الموافقة على الاشتراك من قبل المستخدم يقول النظام بتوجيه المستخدم تلقائيا الى شاشة اداةاسلوب التعلم حيث يجب على المستخدم الاجابة على اسئلة الاستبيان كما هو موضح بالشكل التالي

8. بعد الانتهاء من اجابة اسئلة الاستبيان والضغط على زر ارسال الببيانات يقوم النظام بعرض نتائج الاستبيان كما هو موضح بالشكل التالي



9. بعد ذلك يقوم المستخدم بالضغط على زر انهاء ليقوم النظام بتوجيه المستخدم الشاشة الرئيسة للنظام كما هو موضح بالشكل التالي

10. بعد ذلك يمكن للمستخدم تسجيل الدخول عن طريق الضغط على زر تسجيل الدخول كما هو موضح بالشكل التالي

11. بعد القيام بتسجيل الدخول يقوم النظام بعرض الشاشة الخاصة بالمستخدم كما هو موضح بالشكل التالي