The Influence of Interfaces on the Understanding of Mathematics in Secondary Schools in Afghanistan

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Thesis presented in fulfilment
of the requirements for the degree of
Master of Science
at the University of the Western Cape

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December 2010

Declaration

I, Abdul Rahman Mojadadi, declare that this thesis "*The Influence of Interfaces on the Understanding of Mathematics in Secondary Schools in Afghanistan*" is my own work, that it has not been submitted before for any degree or assessment at any other university, and that all the sources I have used or quoted have been indicated and acknowledged by means of complete references.

Signature: ..... Date: .....

Abdul Rahman Mojadadi.

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Abstract

According to a 2003 USAID report, many teachers in Afghanistan have little more than a primary school education. The report indicates that less than 15% of teachers are formally trained in the profession. It is thus important to create a supportive teaching and learning environment to assist these teachers especially in the teaching of mathematics. It is envisaged that e-learning could bridge this gap. It will allow students to become acquainted with new material at their own pace but will also assist the teachers by providing the necessary teaching material.

The focus of this research is to establish whether there is a difference in the way the genders perceive the visualization of mathematics, with specific reference to set theory. The influence of the computing experience of students on their perceptions was also investigated.

Interfaces were created for the teaching of set theory for learners in the first class of secondary school. Since the mother tongue of most the pupils is Dari the interface was made available in both Dari and English. The interfaces were used to gather the data for the research.

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Key words

e-learning

secondary schools

Computer Aided Instruction

Internet

ANGeL

set theory

mother tongue

gender

Graphical User Interface

Human Computer Interaction

user interface design

visual programming

Acknowledgment

This thesis is a compilation of the efforts of many people that helped and me through the years. I would first like to thank my supervisor Prof. Isabella Venter and Dr Jan Plane for supporting and encouraging me during my Masters study. Without our weekly meetings, this work would not have been possible. At this time I would like to extend a very special thanks to Verna Connan. Without their help I would certainly not be where I am today.

I would also like to thank USAID for their unwavering financial assistance without which our efforts would have been impossible.

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Glossary

ACCC Afghan Canadian Community Centre.

Action Script is an object-oriented programming language for creating customized web-based learning aids. Action script is a language that allows the creation of web-based games and rich Internet applications with streaming media such as video and audio.

ANGeL Afghan Next Generation environment for Learning is an e-learning environment adapted from KEWL for Afghanistan.

CHI Computer Human Interaction. Computer scientists deal with the hardware and software that drive the interface and thus put the computer before the human, namely, CHI.

CSV Comma separated variables.

ERTV Educational Radio and Television.

FLASH is an abbreviation for Adobe, Shockwave or Macromedia Flash. It is a set of multimedia technologies first introduced in 1996 that has become a popular method for adding animation and interactivity to web pages. It is also used to develop rich Internet applications (Allaire, 2002).

HCI Human Computer Interaction. It is the physical and mental boundary between users and input/output devices of a computer. All interactive computer processes require that a human gives some instruction to the computer, e.g. to store data, and receives feedback from the computer.

Informant Design is a framework used to involve various participants in the design process. "It allows making maximal use of the input of the participants at different stages of the design" (Scaife et al., 1997).

KEWL Knowledge Environment for Web-based Learning. An e-learning management system developed at the University of the Western Cape, South Africa.

Participatory Design Is an approach that respects users as partners in the design process and "in doing so explicitly gives them a more equal and responsible role" (Scaife et al., 1997).

UNESCO United Nations Educational, Scientific and Cultural Organization.

UNICEF The United Nations Children's Fund.

USAID United States Agency for International Development.

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Chapter 1

Statement and analysis of the problem

1.1 Introduction

In this chapter the background of the research as well as the reason for embarking on it, is sketched. The focus of the study will be highlighted as well as the constraints that limit the study. Finally the research questions are stated and briefly discussed.

1.2 A sketch of the background

The school population of Afghanistan, particularly girls, was marginalized in the previous regime; therefore education has become one of the key priorities for reconstruction and development agreed to in Bonn (Government of the Federal Republic of Germany, 2001). The Ministry of Education of Afghanistan is seriously considering issues related to quality in education such as classroom teaching, the curriculum, and teacher preparation (Ono et al., 2007, p. 7).

To explain mathematical concepts to learners can at best be challenging, and mathematics teachers often find it difficult to impart their understanding to students in such a way that students grasp the important concepts. In secondary schools in Afghanistan this problem is more pronounced probably because most teachers in Afghanistan are poorly qualified and many teach at secondary schools without a formal university or college qualification (Asian Human Rights Commission, 2003). Ono et al. state it very aptly:

> "*Teachers need support in their teaching, especially in a traditional context where they have been marginalized by conflict and devaluation of education, especially when they have little training of any sort, and most especially when new classroom behavior is expected.*" (Ono et al., 2007, p. 85).

It is the contention of the researcher that the educational process in Afghanistan will be improved by providing teachers with a method to visualize mathematical concepts. The importance of visualization and interaction with the student are both important to the learning process (Elliott and Bruckman, 2002).

The visualization of mathematics in the mother tongue of Afghan pupils has not been attempted as yet. Creating a tool for the understanding of mathematics for secondary schools will be very useful especially if the interface is in the mother tongue of the pupils. It will almost certainly encourage and motivate students to learn mathematics. If this intervention is successful it can be applied to other domains like physics, biology, chemistry and so on. This could result in the improvement of education in Afghanistan.

1.3 Focus and constraints

The focus of our research is to determine if students have different preferences for interfaces based on their previous computing experience or their gender, and to determine whether the type of visualization affects the learning of mathematics using the computer-assisted instruction methods. It is our aim to design the software to visualize set theory lessons to simplify the teaching of set theory for teachers but at the same time to allow learners to gain from learning mathematics in a graphically enabled environment.

Since December 2006, according to Ono et al., "all new textbooks for primary schools subjects were to be completed in the two official languages, Dari and Pashto" (Ono et al., 2007, p. 79). However the lingua franca is Dari in most provinces and also in Kabul and thus the language of instruction in these areas is Dari. The user interface was thus designed in the Dari language, but also includes English. For the time being, the interface does not include Pashto but a Pashto version will be added later. This interface should thus help the Afghanistan school teachers in the process of teaching mathematics.

1.4 Motivation for the research

According to the literature, teachers in Afghanistan are poorly qualified with little or no formal university or college qualification. To teach mathematics,

it is both important to know the mathematical concepts well but also to be able to impart the knowledge to students. With computer aided instruction this becomes easier for teachers with less experience. Visualization and interactivity may allow learners to get "hands-on" experience with unknown concepts.

Mother tongue education fits in well with the suggested framework's policy objectives and curriculum development principles which emphasizes the importance of Afghan tradition and values (Ono et al., 2007, p. 77).

According to (Ono et al., 2007, p. 80) the new curriculum has non-discrimination as one of its objectives. This is also emphasized by the international community as well as the government. They have expressed the need for education for girls as well as equal access to education for girls.

For the above reasons, creating an interface and program to visualize set theory in Dari and to determine how it is accepted by the genders will not only assist teachers, but will make learning more accessible for all learners irrespective of their language or gender.

Some non-governmental organizations have made computer education available to Afghanistan public school children. Governmental schools, in general, have limited computer equipment and thus have limited ability to teach computer literacy. Therefore the pupils that were considered in this study had varying degrees of previous computing experience.

1.5 Research Questions

The research questions are:

1. What factors of the interface and e-learning system are perceived as important to make it more accessible for the secondary school learners of mathematics in Afghanistan?

2. How do these factors differ between groups when divided based on gender?

3. How do these factors differ between groups when divided based on previous use experience?

1.6 Approach and methodology

To determine the preferences, an application for 9th grade secondary learners in Afghanistan was designed to help the students understand set theory. A survey was be distributed and the students were asked about their experience while using this computer aided lesson. It was be analysed using both quantitative and qualitative methods.

We considered the view of students about the interface such as their answers to the questions about the size of buttons, colour of Venn diagrams, colours of other parts of the interface, and the position of menus, to determine the pattern of answers. The answers were considered again—this time comparing the answers looking for patterns between groups, for example, based on gender or computer use experience.

In the design of the prototypes both informant and participatory design was used. Participatory design is an approach that actively involves the end-user in the process of design with the end-user as the informant (Harnish, 2008). Qualitative and quantitative research instruments were used to collect data and a mixed method approach was used to analyse the data (Johnson and Onwuegbuzie, 2004).

1.7 Thesis organisation

In this chapter the research questions were stated and the background sketched. In Chapter 2 the relevant literature is discussed and in Chapter 3 the research approach is stated. The research process is discussed and the results of the research presented in Chapter 4 and finally in Chapter 5 the results are discussed and conclusions are drawn.

1.8 Conclusion

In this chapter the background of the research as well as the reason for embarking on it, was sketched. The focus of the study, its constraints and the research questions, were stated and briefly discussed. In the next chapter, the literature that underpins the research questions will be expanded on.

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Chapter 2

Literature Review

2.1 Introduction

In the previous chapter the research problem was outlined. In this chapter the literature regarding Human-Computer Interaction (HCI) for Educational Technology will be reviewed.

The research will be divided into sections according to the research questions posed, namely: how gender and previous computer experience influence users' perception of interfaces and e-learning systems. This will be discussed with particular reference to secondary school learners of mathematics in Afghanistan.

2.2 What is human computer interaction?

In this section we will consider the definition of HCI as described by several researchers:

Norman describes HCI as the mental and physical boundary between the *computer user* and the input and output devices of a *computer*. He further states that in all computer processes, the user of the computer gives some instructions or stores data in the computer and receives feedback and some information from the computer. In other words, HCI is a "dialogue or interchange of information between the human and the computer" (Norman, 2001).

Ford and Gelderblom are of the opinion that the human computer interface, because it facilitates communication between the user and the computer, is designed to increase the usability of computer systems to improve user performance levels (Ford and Gelderblom, 2003).

According to the definition of Shaun Marsh (1990) HCI contains many separate communication paths between the users, the computer's natural en-

vironment, the computer's own ergonomics, the operating environment and the application environment.

The view of Nicky Danino on HCI, is that it is the enquiry, scheme, and design of what occurs when the user and computers work together. According to her definition, HCI contains three parts: the *human user*, the *computer system*, and the *way that they work together* (Danino, 2001).

The definition of HCI used in this thesis is as follows: HCI is an interdisciplinary field which concentrates on the dialogue and interaction between the user and the computer system. It also includes the results gained during the interaction between the user and the computer. HCI thus refers to the study, design and evaluation of the human requirements for a computer system and fulfilment thereof. Interface preference based on gender and previous computer experience

2.3 Gender

"Gender HCI" refers to research into how software relates to gender differences. We have focused on software aimed at helping everyday users and doing problem solving, for example, educational authoring systems, media authoring systems, macro builders, and software including spreadsheets. Research in HCI has focused on the cognitive processes on the part of the *computer user*. From the view of psychology, the human computer interface is best and most effectively tested from the cognitive viewpoint (Norman, 2001).

From the view and scope of designer, research in HCI prepares design guidelines and good design practices for interface development.

At present, the importance of the human computer interface is becoming pervasive mostly as the way of managing and controlling and interacting with technology. The ubiquity of HCI in everyplace is clear, for example: communication devices, automatic teller machines, personal organizers, medical devices, and monitors, educational toys, exercise machines and so on all make use of human computer interface.

In a research project to identify the attitude changes towards interface elements in early age conducted by Passig and Levin in Israel, it was found that "there are interface elements that draw girls to interact with multimedia

contents, and other multimedia elements that appeal to boys" (Passig and Levin, 2001). They are thus of the opinion that content and the way the learner interfaces with the content are important for the learning environment of children. From their research it seems as if boys express a higher positive attitude towards computers than girls, and that younger children from both genders express "higher intrinsic satisfaction than the older children do" (Passig and Levin, 2001).

Girls thought the computer-based systems had fewer advantages for learning, than boys. Boys and girls have different views about the worthiness of computers in mathematics lessons. A mathematics/computer curriculum model may interest boys because they like computers in general. The girls, however, may not agree that computers help with their learning and achievement in mathematics (Vale and Leder, 2004).

The goal of a research study done by Robin Kay in 2006 was to determine if there were gender differences in computer attitudes for pre-service teachers. Kay explored whether ubiquitous computing, especially when using the Internet and laptops, differed for the genders with regard to computer treatment, power, and use. According to the study, there were no considerable gender differences, with the exception of programming, here the laptops seemed to favour males more than the females. This finding implicates that a rather short, but largely gathered, technology-based program will decrease gender imbalances (Kay, 2006).

According to Robin Kay, studies in 1992 about gender differences and overall computer-related attitude, signified that males had more positive behaviour and had also more ability than females. On the other hand males used computers more than females. After these studies, 5 years later another scholar, Whitely, according to Kay, did an in-depth and detailed study about this matter and detected that gender inequalities do exist with regard to computer behaviour. Males had more powerful computer skills and perceived computers primarily as masculine tools. They had a more positive view about computers. Recent literature reviews indicate that males had more dominance with regard to computer behaviour, use and ability. Several girls in elementary schools have negative feelings with regard to computer attitudes. Some have discussed that a large number of computer games are created for boys, thereby

encouraging their increased confidence. Others have revealed that elementary teachers who are mainly female, are role models for young students. If these teachers have less confidence and are not computer competent, it will have a significant impact on the apprehension for computers by both girls and boys.

It is strange that sometimes, the existing research does not indicate gender differences in computer ability between boys and girls in elementary schools. On the other hand, no formal research has been done for this age group. Studies on computer ability for older and adult students show that there is a significant relationship between confidence and computer ability. Males are more often power users and are more confident when using the computer, than females.

In a study (Kay, 2006) done on 6800 students, Kay indicated that the use of computers by girls and boys in the fourth grade was equal, but by the eighth grade, "boys reported significantly higher use. The findings of this report are supported by a number of large-scale literature reviews" (ibid).

2.4 Previous Computer Experience

Lampert did a research project where he exposed thirty kindergarten children to interactive multimedia stories (Lampert, 1981). He compared their previous experience of computers, with level of covert time-on-task, and their level of satisfaction. This was done with Lampert's "pollimeter". He found that various interfaces have different effects on boys and girls especially in terms of covert time-on-task and their level of satisfaction with the interface. Boys that had more experience with computer games, showed a higher level of satisfaction and also a greater covert time-on-task than girls.

2.5 Computer and HCI exposure of secondary school learners of mathematics in Afghanistan

At most schools in Afghanistan access to computers is still limited. Most secondary learners/students have not been exposed to computers and neither have they been exposed to different types of interfaces.

Before the initiation of the One Laptop per Child program in Afghanistan, the numbers of computers were minimal in Afghanistan schools. The One Lap-

top per Child project was launched, supported by a U.S. non-profit organization, in 2003. The goal of this program is to improve and support education in underdeveloped countries by providing low cost computers to schools. It is hoped that this project, besides expanding education in the developing world, will also promote and expand economic growth and eradicate poverty (Sadiqi, 2009).

Very few computer-based systems are used in classrooms in Afghanistan. In fact less than three percent of Kabul people know how to use a computer, even less have been exposed to computers in the other parts of the Afghanistan (Perraton, 2004).

2.6 E-learning in Afghanistan

What is e-learning and how is it defined in this thesis? We will be using the definition of Tavangarian et al. who define e-learning as:

> "*All forms of electronic supported learning and teaching, which are procedural in character and aim to effect the construction of knowledge with reference to individual experience, practice and knowledge of the learner. Information and communication systems, whether networked or not, serve as specific media to implement the learning process*" (Tavangarian et al., 2004).

E-learning is increasingly being used in Afghanistan. UNESCO also supports the expansion of e-learning in Afghanistan. The Educational Radio and Television (ERTV) project, started in 2003 in Afghanistan, is supported and funded by Italian Government. The implementation of distance learning by radio and television is perceived as a key to improving literacy and providing access to information. UNESCO Office in Kabul, and the Ministry of Education intend to create several distance learning (e-learning) programs for schools (Sadiqi, 2009).

An educational program by satellite television has been started by a San Francisco-based group with the intention to improve and develop literacy for children in rural areas of Afghanistan. This program is named "Master Teachers by Satellite for Afghanistan". This program is funded and assisted

by some Americans and some Afghans. Satellite television courses added to help the Afghan school students at the start of March 2007 (Velinov, 2006).

According to the United Nations Childrens' Fund (UNICEF), the literacy rate in Afghanistan is 43 percent for adults 14 percent for female adults and 1.2 million girls who should be in primary school are not (Velinov, 2006).

According to Carol Silver, plans to start learning programmes for up to 30 children in each of the 100 villages chosen by UNICEF from among 2,680 villages in need of schools. The responsible organization provides the facilities and the equipment needed to view the lessons. The satellite dish and a panel of solar cells is put in the home of one of the pupils, or some other secure place, for example in a shed or in a tent. The equipment is easy to wrap and hide during dangerous times and trouble in the village. The learning runs for two hours a day, six days a week, and forty weeks a year, just like a regular school system. The two-hour educational programming is shown 15 minutes segments. The show is dubbed into Dari and Pashto, native languages of Afghanistan (Velinov, 2006).

E-learning has been implemented in Afghanistan in the so called Afghanistan Next Generation e-Learning (ANGeL) centres funded by both Washington State University and USAID. At present, Kabul University, Kabul Medical University and Polytechnic University, and the University of Kandahar have ANGeL centres. In these centres, equipped with computers, students are taught basic computer skills. Kabul's ANGeL centres have expanded their activities to other provinces like Herat, Khost, Nangarhar, Balkh and Kandahar.

Another centre that is active and supports distance learning in Afghanistan is the Afghan Canadian Community Centre (ACCC). This project was launched by a group of Canadian and Afghan volunteers working to support education in Afghanistan. ACCC is a post-secondary school in Kandahar—a province in Afghanistan—that helps and provides many facilities, focused education, the Internet and post-secondary education. This centre provides the school's program for pupils with the skills required for employment so that can get jobs in the future and expand the economy in their country and help themselves and their families and simultaneously allow students access to the Internet for learning. The funds are paid to the Afghan-Center Via Canadian Women-for-

Women in Afghanistan.

All of the funds are used to facilitate payments for operating the school-paying teachers, salaries, rent of the school building. Courses in English, ICT, management and health care were launched. At this time almost 700 students are enrolled for these courses (Pressrow, 2006).

2.7 Conclusion

In this chapter, the main focus was on literature that supports the actual research questions, namely: "What factors of the interface and e-learning system are perceived as important to make it more accessible for the secondary school learners of mathematics in Afghanistan?"; "How do these factors differ between groups when divided based on gender?" and finally "How do these factors differ between groups when divided based on previous user experience?" It was furthermore decided to define HCI as "the study, design and evaluation of the human requirements for a computer system and the fulfilment thereof". In the next chapter the research design and methodology will be stated and expanded on.

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Chapter 3

Research design and methodology

3.1 Introduction

The literature reviewed in the previous chapter, clarified the topic of the thesis in terms of the research questions. In this chapter the research design and methodology used for the data collection, the instruments used as well as the motivation and reasons for choosing these, are explained. The boundaries, limitations and shortcomings in the data are also discussed.

We first present the methodological paradigm which underpins our study, namely mixed method research. We will proceed by illuminating the research design used in the study. This will be followed by a discussion on the research instruments used to collect the data and that will be followed by a brief look at the method of analysis used.

Issues relating to validity and reliability will also be covered. We will end this chapter with the ethical considerations.

3.2 Methodological paradigm

Mixed methods studies can be defined as a class of research which integrates two different approaches, namely qualitative and quantitative research. This approach merges the methods, techniques, and meanings of both qualitative and quantitative research into a unique study. In fact mixed methods include philosophical perspectives and a pragmatic approach; combining theory and practice. Mixed methods studies endeavour to legitimize the application of several methods in answering research questions. It is important and fundamental for researchers to follow the best way to answer the research questions. Several research questions and integration of questions are significantly answered by mixed research methods. We now turn our attention to the strengths and weaknesses of doing mixed-method research (Johnson and

Onwuegbuzie, 2004).

3.3 Strengths of mixed method research

Words, images and stories can be used to enhance the meaning of numbers. Numbers can be applied to increase the precision of words, pictures and narratives. According to Johnson and Onwuegbuzie, a researcher

- can use the strengths of an additional method to overcome the weaknesses in another method by using both in a research study,
- can provide stronger evidence for conclusions through convergence and corroboration of findings,
- can add insights and understanding that might be missed when a single method is used and
- can use alternate methods to improve the generalizability of his results.

Qualitative and quantitative research brought together produce more complete knowledge necessary to inform theory and practice (Johnson and Onwuegbuzie, 2004, p. 21).

3.4 The Weaknesses of mixed method research

It can turn out to be difficult for a single researcher to carry out both quantitative and qualitative research. The researcher has to learn about multiple methods and approaches and understand how to mix them appropriately. Methodological purists contend that one should always work exclusively within either a qualitative or a quantitative paradigm. Mixed method research tends to be more time consuming (Johnson and Onwuegbuzie, 2004, p. 21).

In the above discussion we illuminated the strengths and weaknesses of doing mixed method research. We now proceed to look at two types of mixed method research models as suggested by (Johnson and Onwuegbuzie, 2004), who identify two major types of mixed method research: the *mixed model*—mixing qualitative and quantitative approaches within and across the stages of the research process, and the *mixed method*—the inclusion of both approaches in an overall research study. In this study we used a "within-stage

mixed-model" approach. We applied a questionnaire which comprised of both closed-ended questions—with clearly quantitative responses, and open-ended questions—that solicit qualitative answers. Table 3.1 indicates the features of mixed-method research and how our study fits into this paradigm. The features are taken from the article by (Lowenthal and Leech, 2009) on mixed research and online learning.

Table 3.1: Research study

Features	**My research study**
Uses both quantitative and qualitative approaches in the same study	The research instrument; the questionnaire used contains both quantitative and qualitative types of questions
The research questions must entail at least one quantitative research question and one qualitative research question or one research question that engulfs both quantitative and qualitative aspects	The research sub-questions contain both qualitative (How?) and quantitative aspects—based on gender or based on experience of computer usage
Sample size (the number of participants) and sample schemes (how they are selected) are important in mixed method research.	Sample size—120 participants more synonymous with quantitative studies. The sample scheme—purposeful sampling—which is synonymous with qualitative studies.
Can employ one of four research designs: triangulated design, embedded design, explanatory design or exploratory design.	Our study uses the exploratory design since we developed and tested an instrument, i.e. a prototype.

3.5 Research Design

According to (Creswell and Plano Clark, 2006, p. 117) mixed method research contains four research designs: triangulation design, embedded design, explanatory design and exploratory design. Exploratory design is well suited to develop and test an instrument. We will be using exploratory design. We created a small application that will help the students who participate in the study to understand the concepts and notation used in set theory. Through the use of this application we will determine preferences about the human-computer interface as expressed by the students who participate in the study.

For designing and creating interface we will use some tools like Flash to create a graphical application. We put the interface within context of ANGeL (Afghanistan next generation e-learning). It is a part of ANGeL with a Dari interface. The design of the human computer interface requires a multidisciplinary approach. Research teams consist of specialists from a variety domains such as computer scientists, psychologists, and experts in subject matter domains like business and management, library and medicine, information science and so on (Skaalid, 1999).

Some researchers in HCI are based in computer science and engineering. Psychologists tend to put the human before the computer, therefore call it HCI, but many computer scientists are more concerned with the software and hardware behind the interface and are inclined to place the computer before the human being, so they typically prefer to call the field of research Computer Human Interface (CHI).

Involving users and the value of involving people as users or participants in the design process has become more popular in recent years. Nowadays involving users is deeply ingrained in HCI practice and it would be difficult to imagine otherwise. The design process has different approaches involving users at different stages: informant design, participatory design, user observation, user testing, etc. (Triantafyllakos et al., 2008). After designing and creating two interfaces, we evaluated and compared the design of the two interfaces by getting feedback from university students—the 20 used in the pilot study—who volunteered to try out the software.

Their perceptions of what would make the use of the software better helped us understand the human-computer interface preferences of Afghan children.

We first conducted a pilot study. We performed a pre-survey or pilot study with college/adult students (10 male and 10 female students). The survey was done in the AnGel centre at Kabul University on Thursday, October 21, 2010. Each of the students had one desk top computer. The venue is well-equipped with a video projector, sound system, writing boards and other facilities. We wanted to gain detailed information from a small number of university students about the prototypes, and use their input to test the questionnaire and bring about improvements on it. First we explained and

imparted the prototypes to them using the projector, and then we gave them time to familiarize themselves with the prototypes. After that we distributed the questionnaire to them. All of them had the same time and equal opportunity to complete the task. The aim of the pilot survey was to determine the appropriateness of the prototype and questionnaire.

3.6 Research instruments

The questionnaire used to collect the data consisted of both closed-ended questions and open-ended questions. According to the view of specialists there are various types of questions in questionnaire for example: closed questions, open ended questions, multiple choice questions, rating scale, etc. (Wilson and McClean, 1994). Among the several types of questions, rating scales, closed questions and multiple choice questions are easy to code and to classify (Wilson and McClean, 1994, p. 21). On the other hand, open ended questions enable participants to give their views freely and do not have any limitation to the replies, but the responses are problematic to classify and to code. We used two questionnaires to collect the data. The first questionnaire was related to the pre-survey or pilot survey and the second one was the more refined questionnaire or actual questionnaire. Both of the questionnaires had closed questions, multiple choice questions and open-ended questions. The questionnaire focused on two variables, gender differences and previous computer use and experience that support the actual thesis question. This is in line with the within-stage mixed-model research (Johnson and Onwuegbuzie, 2004).

3.7 Sampling

(Creswell and Plano Clark, 2006) identify two types of sampling: *purposeful sampling*—a qualitative sampling method—and *probabilistic sampling*—a quantitative sampling method. Purposeful sampling means that the researcher intentionally selected participants who have experience with the central phenomena or the key concepts being explored (qualitative approach), whereas probabilistic sampling involves randomly choosing the individuals based on a systematic procedure, such as applying random numbers from a table for the selection (a quantitative approach). We used a mixed method approach.

Two schools were selected using purposeful sampling. We based our selection on the following criteria: they had to be secondary schools, a boys' school and a girls' school, the school had to have computer labs with computers and projectors, and participants had to be in the 9th grade. The participants (sample size equals 120), were randomly selected thus keeping in line with the mixed-model approach. For achieving our goal, it will be necessary to compare student views selected from two classes in two selected Kabul secondary schools. We solicited participants from the 9th class (9th grade) in both schools; 60 students from the boys' class and 60 students from the girls' class. The students were invited to participate in the study. Those who chose to participate were introduced to the basics of how the software works and were given a short period to learn the material presented in the software.

Once they completed their time with the software, the students participated in a survey so that we could determine their perception of the software. We distributed the survey to the students, and asked some questions about their experience as shown in Appendix A.

Next we considered the views of students about the interface, such as their answers to the questions about the size of buttons, colour of Venn diagrams, colours of other parts of the interface, and the position of menus, to determine the pattern of answers. The answers will be considered again—this time comparing the answers by looking for patterns between groups, for example based on gender or computer use experience.

We aim to show how informant design can be used to design interactive learning environments that can be used for teaching and learning difficult concepts in set theory in the secondary schools of Afghanistan. We believe this framework can be generalized to other domains for teaching and learning.

3.8 Data Analysis Method

We will incorporate the seven-stage mixed method data analysis process of (Onwuegbuzie and Teddlie, 2003), cited in (Johnson and Onwuegbuzie, 2004, p. 22). The seven steps are as follows: (a) data reduction, (b) data display, (c) data transformation, (d) data correlation, (e) consolidation, (f) data comparison, and (g) data integration.

Data reduction—involves reducing the dimensionality of the qualitative data, e.g., via exploratory thematic analysis and quantitative data via descriptive statistics.

Data display—involves describing pictorially the qualitative data and quantitative data.

Data transformation—the stage, wherein quantitative data are converted into narrative data that can be analyzed qualitatively.

Data correlation—involves the quantitative data being correlated with the qualitative data.

Data consolidation—wherein both quantitative and qualitative data are combined to create new or consolidated variables or data sets.

Data comparison—involves comparing data from the qualitative and quantitative data sources.

Data integration—characterizes the final stage, whereby both quantitative and qualitative data are integrated into coherent whole legitimation step involves assessing the trustworthiness of both the qualitative and quantitative data and subsequent interpretations.

3.9 Objectivity, validity and reliability

(Niemann et al., 2000) regard objectivity in quantitative research as the absence of bias and subjective opinion, whereas in qualitative research, researchers acknowledge their participants' subjective opinions. In using a mixed method model, as done in this study, we were able to draw on the strengths of both quantitative and qualitative research to ensure the validity of the data. (Johnson and Onwuegbuzie, 2004, p. 1) note that a key feature of mixed method research is its methodological pluralism or eclecticism, which could result in better research, as opposed to using mono-method research.

(Gibbert et al., 2008, p. 1497) suggest four criteria to assess the rigor of field research: construct validity, internal validity, external validity, and reliability. These have been adapted to fit the mixed-model method we used.

3.9.1 Construct validity

Construct validity refers to the extent to which a study investigates what it claims to investigate, that is, to the event to which a procedure leads to an

accurate observation of reality (Denzin and Lincoln, 1994).

3.9.2 Internal validity

'Internal validity' is also called "logical validity", e.g., by (Cook and Campbell, 1979) and (Yin, 1994); and refers to the causal relationships between variables and results.

3.9.3 External validity

'External validity', or 'generalizability', is grounded in the intuitive belief that theories must be shown to account for phenomena not only in the setting in which they are studied, but also in other settings, e.g. (Calder et al., 1982); and (McGrath and Brinberg, 1983).

3.9.4 Reliability

'Reliability' refers to the absence of random error, enabling subsequent researchers to arrive at the same insights if they conduct the study along the same steps again (Denzin and Lincoln, 1994).

3.10 Ethical considerations

Ethical issues crop up in many types of research. Ethical principles are appropriate and necessary for doing good and avoiding harm. The maintenance of human rights in any research is necessary and imperative. Ethical issues are very important in research, especially for help in avoiding plagiarism. To ensure that this study was conducted ethically we obtained written permission from the Ministry of Education in Afghanistan to conduct the research in the two secondary schools in Kabul, the capital city of Afghanistan. We also received ethical clearance from the University of the Western Cape (UWC). (Hatch and Wisniewski, 1995) noted that the vulnerability of subjects is a real concern since exposing one's self to another in the research process involves issues of trust, truthful-telling, fairness, respect, commitment and justice. We ensured these qualities in our research, throughout the data collection process.

3.11 Conclusion

In this chapter the main focus was on design research and methodology. Mixed method research—combining of both qualitative method and quantitative method—plus types of data analysis method clarified in details. After that objectivity in the mixed method research additionally as well as the validity and reliability of data were discussed. The chapter ended with discussion about data ethical consideration.

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Chapter 4

Development and design of the prototypes

4.1 Introduction

In the previous chapter we clarified the research design and methodology used for data collection namely mixed methods by combining quantitative and qualitative methods. In this chapter we discuss the development and design of the prototypes of the lessons that were used in this investigation. We first cover the development of the prototype lesson that eventually led to the development of Lessons 1 and 2, and then describe those two lessons.

4.2 Development of the initial prototype

Macromedia Flash 4 (Flash, 1999) was used to design the initial prototype. The prototype starts off with a picture of a set and a table of contents from

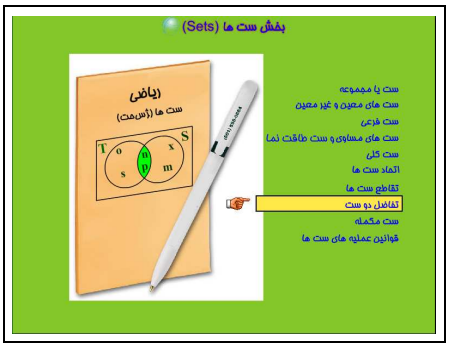

Figure 4.1: The home page with cursor over an index entry

Figure 4.2: The introductory page to intersection

which any one of ten pages can be selected. We will trace the selection of the pages that describe the intersection of sets to illustrate the functioning of the

prototype. Figure 4.1 shows the home page of the prototype with the cursor moved over the eighth entry in the index and a pointer hovers over the entry inviting the user to click it.

Clicking here will take the user to the section on set intersection. The illustration in Figure 4.1 shows the cursor hovering over the link to the pages on the intersection of sets. When the selection is clicked the lesson moves into the introductory page for the lesson on the intersection of sets. This is illustrated next. Figure 4.2 shows the introductory page to the section on set intersection. Here the idea of intersection is briefly introduced. The definition $A \cap B = \{x | x \in A \ \wedge \ x \in B\}$ is given, i.e. the intersection of two sets is the set of all coincident elements that each lies both in set A and also lies in set B. In Figure 4.3 the user is invited to click to see what the intersection of the set $A = \{m, n, p, t, s\}$ and the set $B = \{o, p, n, t, s\}$, i.e. $A \cap B = \{n, p, t\}$, yields.[1]

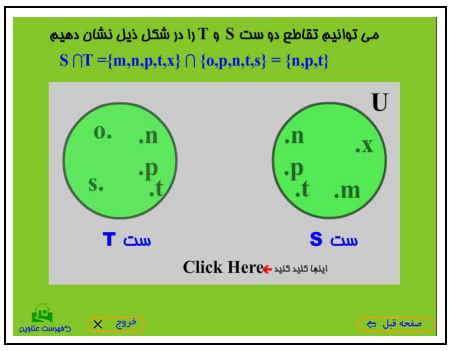

Figure 4.3: Intersection page with invitation to click

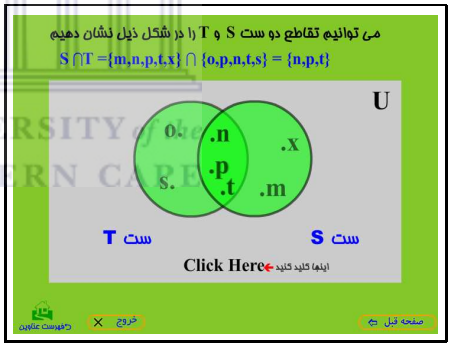

Figure 4.4: The intersection is shown after clicking

When the user clicks on the "Click Here", Figure 4.4 opens showing the intersection $A \cap B = \{n, p, t\}$. Every one of the subsidiary pages has a link to the home page and an exit link. The link at the bottom right of each page usually returns to its parent page.

This prototype was not interactive and its navigation was poor. Furthermore too many sound effects were used. It was decided to discard this prototype rather than trying to improve it as the licence for our version of

[1]For the English reader it is interesting to note that although the Dari runs from right to left, the mathematics runs in the other direction, i.e. in a left-to-right direction. Numbers are also written from left to right.

Flash also lapsed. We had, however, learned a bit more about how to improve the linkage and the feel of the lesson.

4.3 The next two lessons

Two further prototypes were designed: one using Macromedia Flash 5 with Action Script and the other using Visual Basic. These prototypes differed in their design. The first prototype—Lesson 1—was not interactive, however, its navigation was easy due to the use of a standard menu bar with several standard buttons. The second prototype—Lesson 2—was designed to be more interactive. It allowed the student to click on a button to, for example, see which part of two sets forms the intersection of these sets. We go into some detail showing the linkage used in Lesson 1 next.

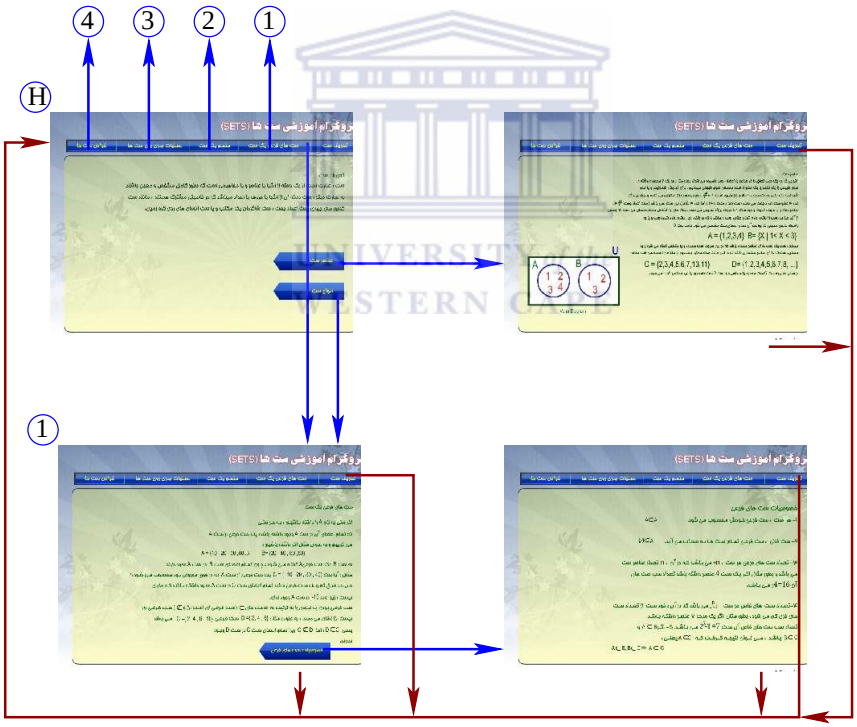

Figure 4.5: The main links leaving from the home page and the links to and from Part 1.

4.3.1 Lesson 1

Lesson 1 was developed in Macromedia Flash 5 using 17 linked pages. In this discussion we refer to the main page as the home page and represent it in the

diagrams with the symbol Ⓗ. Figure 4.5 shows the links to the introduction and to Part 1 of Lesson 1. Every page has a banner with five buttons. Since Dari is written from the right to the left these buttons are arranged in order from the right to the left. The first button returns to the home page, or exits from the application when the user is on the home page. The other four buttons link to one of the four parts of the lesson, i.e. Part 1—set description, Part 2—the universal set and the empty set, Part 3—union, intersection, and difference, and Part 4—the distributive and associative laws. By clicking on any of these buttons the user is sent to the main page of the selected lesson. Each of the four parts in our illustrations is marked similarly to the home page using one of the symbols ①, ②, ③, ④. Figure 4.6 shows Part 2 where

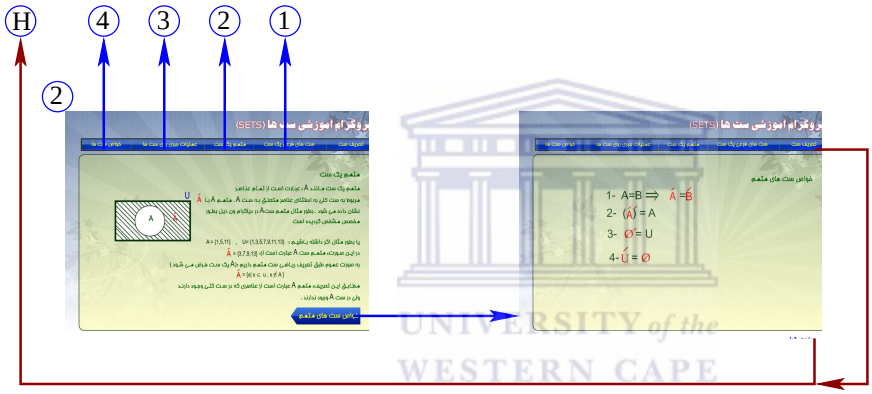

Figure 4.6: Part 2—the universal and empty sets

the empty set, written as '∅' and the universal set, written as '**U**', and their relationships are discussed. All the buttons in the banners function the same as usual, i.e. the first button—on the right—points to the home page, and each of the other buttons points to the introductory page of its part. Each of the introductory pages always links to a page of comprehensive examples topically related to the introductory page. Since Part 3 is more comprehensive than the other parts it seems much more complex than the previous two parts because it covers three operators. The three set operators union, written as '∪', intersection, written as '∩', and difference, written as '/' are discussed.

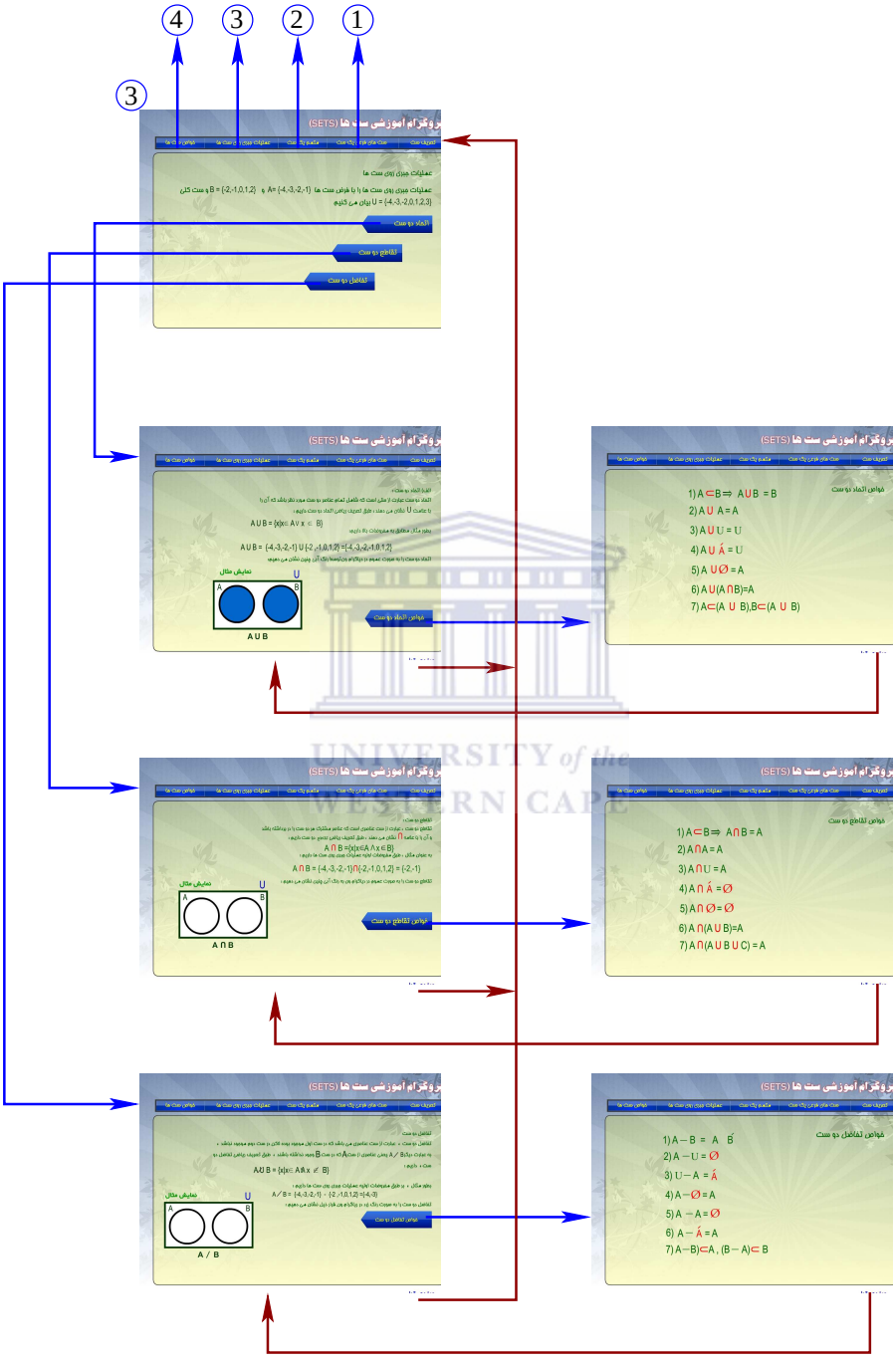

Figure 4.7: Part 3—union, intersection, and difference of sets

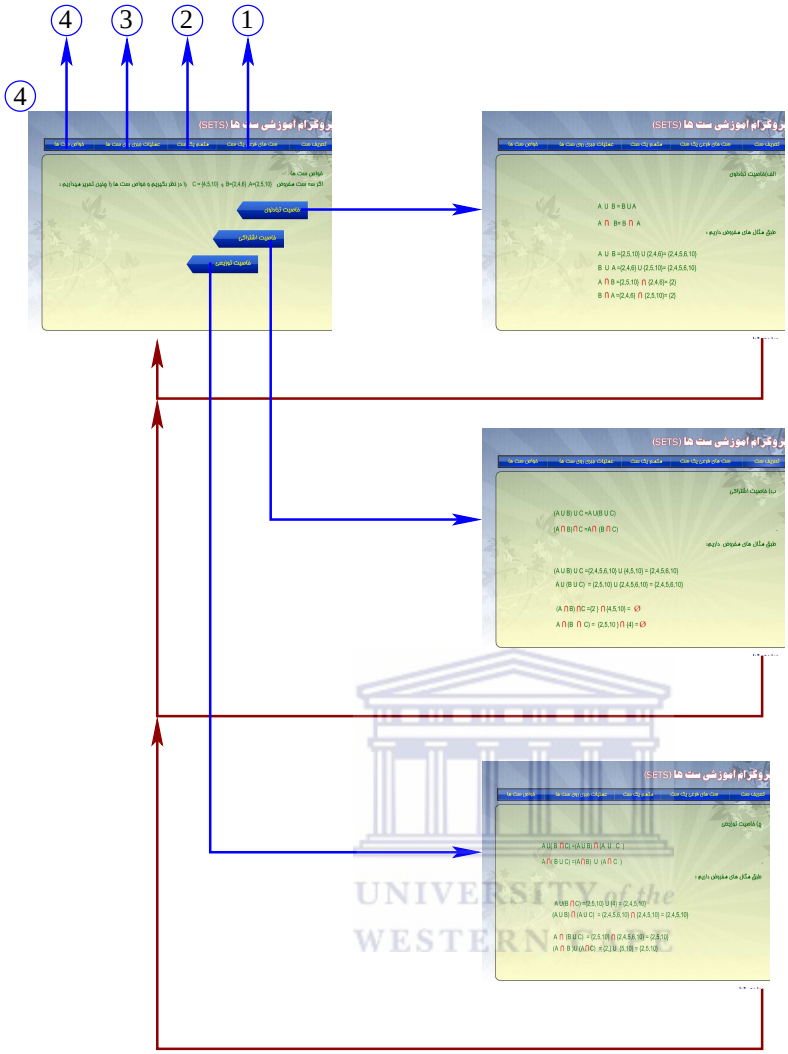

Figure 4.8: Part 4—the set commutative, associative, and distributive laws

Figure 4.9: Part 4—the associative law in more detail

The introductory page at the top, marked with the symbol ③, has three large pointers pointing separately to the first page of each operator.

The operator pages function similarly to one another. Each has a large pointer pointing to a list of examples of the use of the operator.

Figure 4.7 shows Part 3 where the lesson pages discuss the three set operators union, '∪', intersection, '∩', and difference, '/'.

The back button at the bottom right-hand corner of each example page returns to its corresponding introductory page and the back button of the introductory page returns to the main page of Part 3. The home button on all the pages returns to the main home page.

Figure 4.8 shows Part 4 where the set commutative, associative and distributive laws are discussed.

Figure 4.9 shows the page from Part 4 that gives examples using the associative law in more detail. The content of the page is fairly clear even though the interface is in Dari.

4.3.2 Lesson 2

Lesson 2 was developed in Visual Basic.net in the 2005 edition of Visual Studio to incorporate some interactivity. It has a linkage structure similar to that of Lesson 1 so very little will be gained by illustrating all the linkage again. The main difference between Lesson 1 and Lesson 2, besides a slightly different look-and-feel, is that the *examples* are now a bit more interactive, permitting students to visualize their own examples. The effort to incorporate even a small amount of interactivity seems to pay off in an increase of valency of the lessons which is evidenced by the appreciation of the students for interactivity. The students responded overwhelmingly in Question 30 of the questionnaire in favour of the interactivity—97.48% responded positively.

Figure 4.10 shows the home page of Lesson2.

Figure 4.11 shows the page in Lesson 2 that corresponds to Part 3 in Lesson 1. The buttons are each point to a subsection on union, ∪, intersection, ∩, and complement, /.

The following Figure 4.12 shows the page that displays when the second button, is clicked. This is the start of the intersection, ∩, lesson of Part 3.

The examples in Figure 4.13 are displayed when the rightmost button

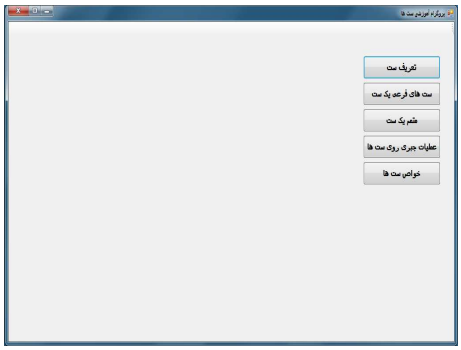

Figure 4.10: The home page of Lesson 2

Figure 4.11: Lesson 2 Part 3—union, intersection, and difference of sets

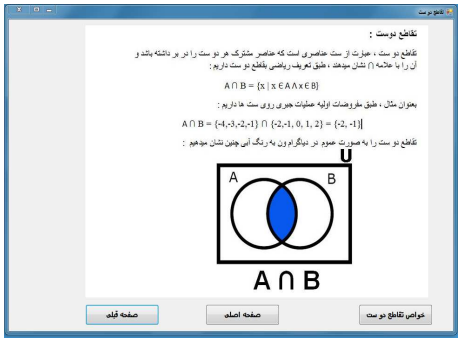

Figure 4.12: Lesson 2: The introductory page to intersection

Figure 4.13: The examples for intersection in Lesson 2

of Figure 4.12 is clicked. The interactive examples are invoked by the middle button of Figure 4.13.

The next few diagrams attempt to explain the interactivity. In the initial configuration of the interactive page the text boxes and sets are empty. In order to enter the set $A = \{1, 2, 3, 4\}$ the elements $1, 2, 3, 4$ should be entered into the four blank text boxes to the right. Clicking the bottom right hand button enters the data into set A. Figure 4.14 shows how A has been filled up. Similarly entering 1 and 2 into the first two text boxes, and putting 7 and 8 into the other two text boxes and then clicking the second bottom right button fills set B with $1, 2, 7, 8$, as shown in Figure 4.15. Finally, clicking the $A \cap B$, shows the contents of the intersection in Figure 4.16 as $A \cap B = \{1, 2\}$.

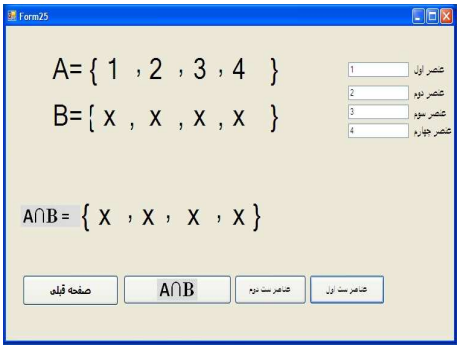

Figure 4.14: $A = \{1, 2, 3, 4\}$ entered by pressing the bottom right button

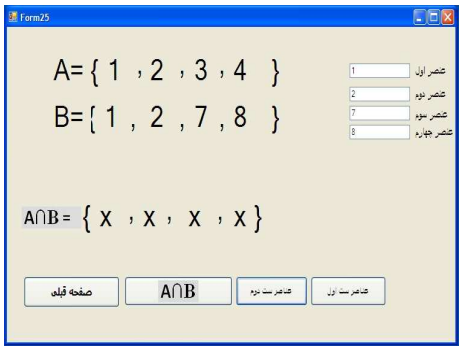

Figure 4.15: $B = \{1, 2, 7, 8\}$ entered by pressing the second bottom right button

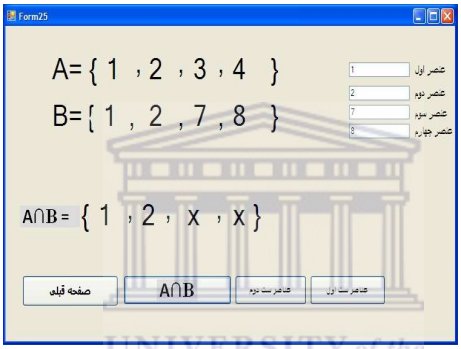

Figure 4.16: $A \cap B$ has been clicked, giving $A \cap B = \{1, 2\}$

The union and complement pages have similar interactive examples, where the student can enter up to four elements into each of the sets A and B and then try out the operation by clicking its appropriate button.

4.4 Conclusion

In this chapter we discussed the initial prototype and its two follow-up lessons. Each prototype depicted a lesson in set theory. The prototypes differed in terms of size of buttons, colours used as well as interactivity. Students were asked to compare and evaluate the prototypes and the results of this process will be discussed in the next chapter.

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Chapter 5

Results: Presentation and Discussion

5.1 Introduction

The design of two prototypes was discussed in the previous chapter. Data was collected from 120 pupils who used and compared the two prototypes. The pupils were introduced to the lessons by an instructor and were allowed to work through the lessons individually. A questionnaire—see Appendix A—was administered in which the students were asked to make choices and respond directly on the questionnaire. We report and discuss the results here. We analyse the sample and make data comparisons and cross tabulations. The main results of the quantitative data analysis are based on two variables, namely gender differences and previous computer use and experience. This chapter ends with a review of the main findings.

5.2 The correctness of the captured data

Two persons captured the *quantitative* data from the questionnaires directly onto two separate spreadsheets, typing the letter responses directly. The one data set was captured with each question occupying a vertical column of the spreadsheet—so each questionnaire occupied a row of the spreadsheet. The other data set was captured the other way round with each respondent occupying a separate column and all the responses being entered vertically into the spreadsheet. The latter data set was later transposed by Excel to conform to the layout of the first data set. The next step was to save each of the files separately as comma-separated-value (CSV) files using the spreadsheet. In order to find capturing discrepancies in the data we ran the `diff` program (Hunt and McIlroy, 1976) to determine differences between the two files.[2] When

[2] `diff` is used to compare the contents of two files line-by-line. Seen the `man` pages in Linux. It has been widely available since 1974.

such a difference was uncovered we looked up the original questionnaire and corrected the incorrect file. This process was continued until the two files were exactly the same, i.e. the `diff` output was empty.

There were a total of 120 respondents with 35 quantitative responses. The first data capturer had made 16 identified errors with a probability of $p_1 = \frac{16}{35 \times 120} = 0.0038095$ of making an error. The second data capturer made 19 detected errors with a probability of $p_2 = \frac{19}{35 \times 120} = 0.0045238$ of typing an error. The probability that both data capturers made the same error and that it thus stayed undetected is $p = p_1 p_2 = 0.000017234$. So it is most unlikely that any error in the data crept through to the statistics.

The final step in the data preparation of the quantitative data was simply to translate the letters to digits programmatically to prepare the data for the statistical package SAS.

The *qualitative* data, being in Dari, had to be translated into English so that we could present it here in an understandable form. Each sentence was translated into English by a fluent Dari-and-English speaker and the response was typed into a list of replies that we present in Appendix C on Page 77. We discuss the qualitative responses in Section 5.5 on Page 45.

5.3 Descriptive statistics

120 students in their 9th grade were selected, from two selected Kabul schools, to participate in this study. These schools were chosen specifically because they offered computer classes and have computers.

Half of the sample, 60, consisted of girls from a school for girls and the other 60 students were from a school for boys. Children start school at the age of 6 or 7, and after 9 years of schooling it would be expected that these children would be between 15 and 16 years old, however the majority of the students, 55.83%, were 16 or older. It was surprising to find that the majority of the students, 81.67%, *have access to a computer at home* and that most of the students, 87.5%, *own a cell phone*. Most of the students, 84.17%, said that their home language is Dari, 14.17% have Pashto as their mother tongue and 1.67% speak another language at home. Some of the other languages are

Uzbek[3] or Hazaragi. As can be seen in Figure 5.1 the majority of students, 34.17%, performed very well in their last mathematics test—scored 80% or more—44.16% did quite well—between 50% and 79%—and only a few 21.67% did not pass the test—they had a mark below 50%.

Most students, 86.67%, *learned about computers at school* or at a technology centre. Half of the students said that they often use a computer, 40% of students said that they sometimes use computer, and 10% of them said that they seldom use computer. Only 15.00% of students had their first contact with computers at pre-school. See Figure 5.2. The majority were only introduced to computers at school—37.50% of students said that their first contact with computer was at primary school and 47.50% of them had their first contact with computers at secondary school. A smaller percentage, 15.83%, of students said that they *often* use e-mail to write to friends or family, 35.83%, of students said that they *sometimes* use e-mails to write to friends or family, and 48.33% of them *never* use e-mail.

To *retrieve information*, 30% of students said that they often browse the internet, 35% of students said that they sometimes browse the internet to get some information, and 35% said that they never use it.

Of all students, 23.53% felt that *playing computer games* are often enjoyable for them, 60.50% felt that computer games are sometimes enjoyable for them, and 15.97% felt that they never enjoy playing computer games.

[3]Or Ozbeki.

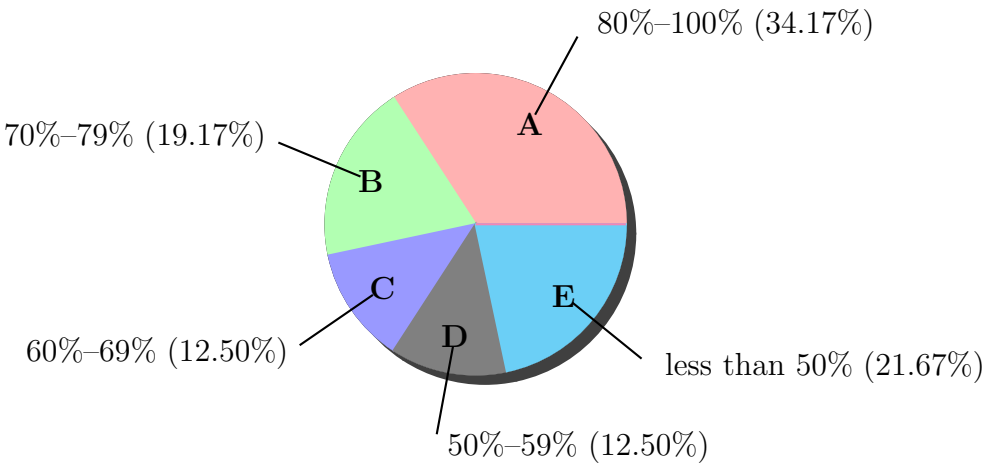


Figure 5.1: Performance in Mathematics during last test written

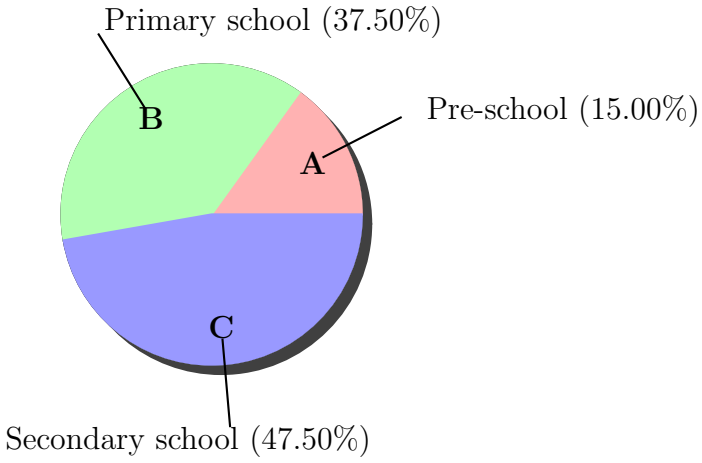


Figure 5.2: First contact with computers

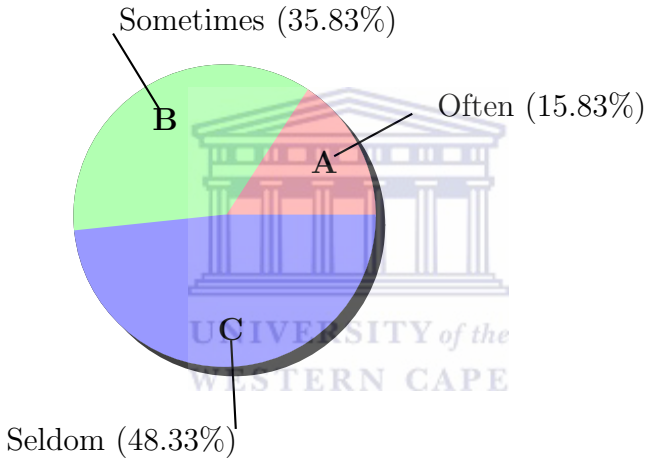


Figure 5.3: E-mail usage by students

A very high percentage, 99.17% of students said *that they used Microsoft Windows before*, and only 0.83% said that they did not. Most of the students, 99.17%, used Microsoft Windows. More students, 78.15%, used Microsoft Word previously than other word processors, and 21.85% had never used it—see Question 14 in Appendix B. More students, 51.26%, used Microsoft Excel previously, than those students, 47.06%, who had not used it beforehand and very few students, 1.68%, used another but similar program.

Less than half of students, 40.00%, used a browser such as Internet Explorer, more than half, 53.33%, had never used it, and few students, 6.67%, had used another but similar programme. More students, 52.50%, liked the colour Blue for the background and of these the majority were girls, and less

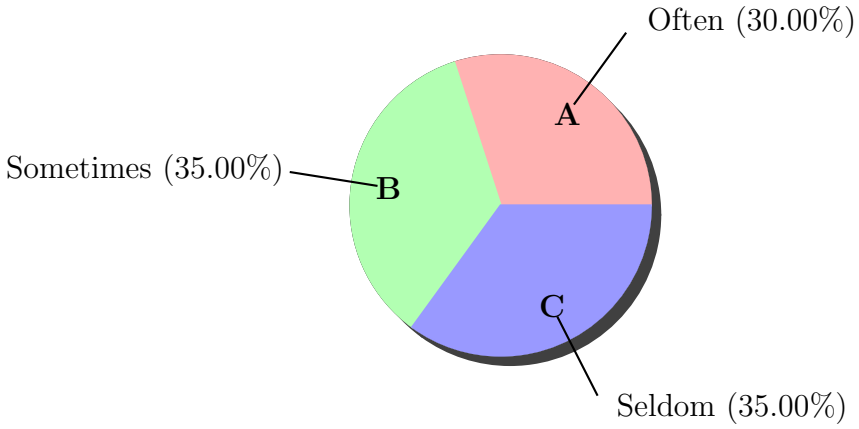


Figure 5.4: Internet usage by students for information retrieval

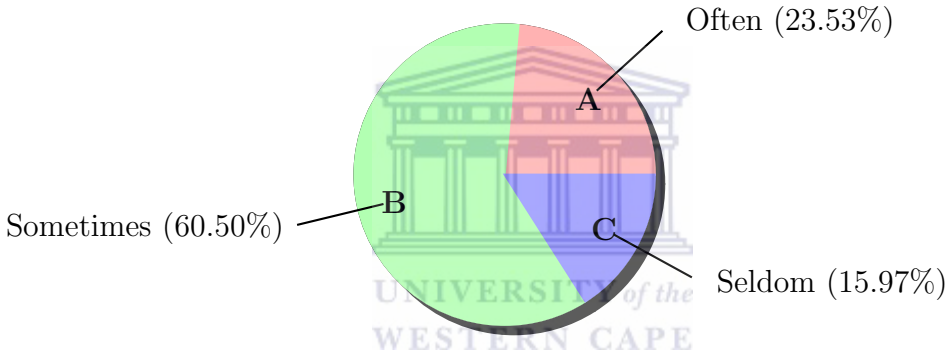


Figure 5.5: Computer game playing by students

than half, 30.00%, liked the colour Grey for the background, the majority now being the boys, and a few students, 17.00%, liked the yellow colour for the background, but a significant number of girls preferred yellow than boys. Only a few colours were used as this was a proof of concept. We discuss this preference in detail later in Section 5.4.1 and tabulate the results in Table 5.1. A few students, 2.50%, liked small buttons, most of students, 89.17%, *liked medium-sized buttons* and few students, 8.33%, said that buttons should be large.

Figure 5.6 shows that most students preferred medium buttons and a few students liked small or large buttons.

Most students, 84.17%, preferred Black for the lettering. A few students,

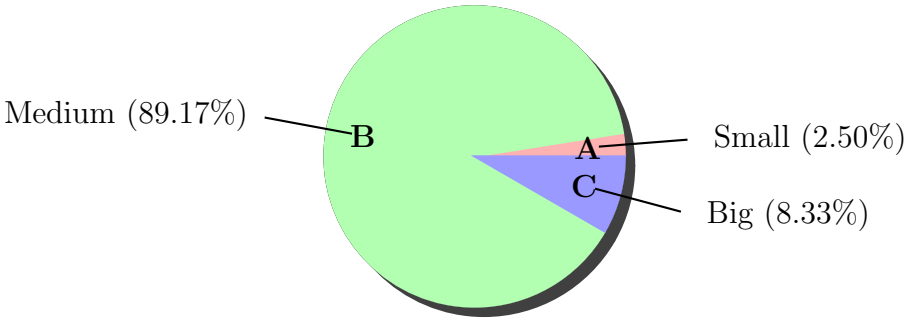


Figure 5.6: 89.17% prefer medium-sized buttons

7.50%, preferred Blue for the lettering, and a few students, 8.33%, preferred Green for the lettering. Most students, 94.17%, said that it is easy to move or navigate between pages, Very few students, 5.83%, stated that it is *not easy to move between pages*. On the other hand, most students, 89.17%, said that they can jump to any part of the lesson easily, but a few students, (10.83%), said that they cannot go to each part of lesson easily. To exit the program, 78.33% said that it is simple and 21.67% said that it is not simple to exit the programme.

Most students, 81.67%, *liked the introduction* and some students, 18.33%, did not like the introduction.

For the background, 21.67% preferred Green, 17.50% preferred Blue for the background, 6.67% preferred Red for the background. 35.83% preferred White for the background, and 18.33% preferred Grey as a background. Most students, 81.67%, preferred Black for the lettering, 6.67% preferred Blue for the lettering, and 11.67% preferred Green for the lettering.

More students, 88.33%, said that it is easy to move between pages and 11.67% said that it is not easy to move between pages. More students, 89.17%, said they always know where they are in the lesson and 10.83% said they did not always know where they were in the lesson.

Most students, 90.00%, said that it is simple to exit the program and 10.00% said that it is not simple to exit the programme. More students, 65.00%, liked the introduction and 35.00% did not like the introduction.

Most students, 97.48%, liked the interactive part of the lesson that shows set operations—union of sets, intersection of sets and difference of sets—by examples and a minority of students, 2.52%, said that they did not like the interactive part of the lesson.

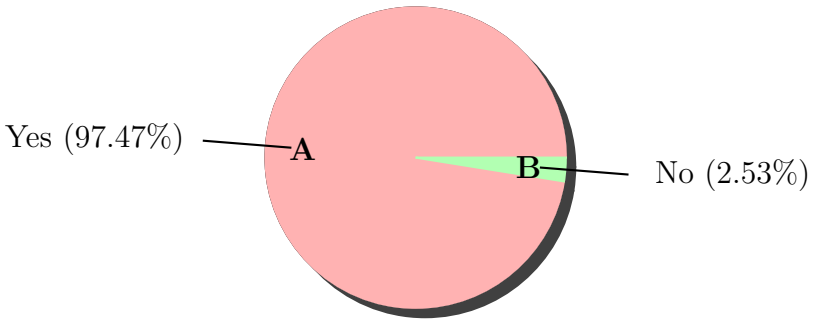


Figure 5.7: Preferences of students for interactivity

As can seen in Figure 5.7, Most students, 97.48%, liked interactive part of the lesson, but only a few students, 2.52%, dislike the lesson. More than half, 58.82%, felt that they prefer Lesson 1 and, 41.18%, felt that they prefer Lesson 2.

More students, 66.67%, preferred the buttons of Lesson 1 and almost half of the rest, 33.33%, preferred the buttons of Lesson 2. More students, 76.67%, preferred the colours of Lesson 1 and, 23.33%, preferred the colours of Lesson 2.

A few students, 38.33%, said that the lesson that best explains how to solve problems in set operations is Lesson 1. More students, 61.67%, said: the lesson that best explains how to solve problems in set operations is Lesson 2.

A little over half, 53.33%, preferred Lesson 1 and a little less than half, 46.67%, preferred Lesson 2. Figure 5.8 shows that slightly more students preferred Lesson 1 over Lesson 2.

5.4 Comparisons and cross tabulations

We focus on the differences in the responses based on gender and the differences based on computing experience.

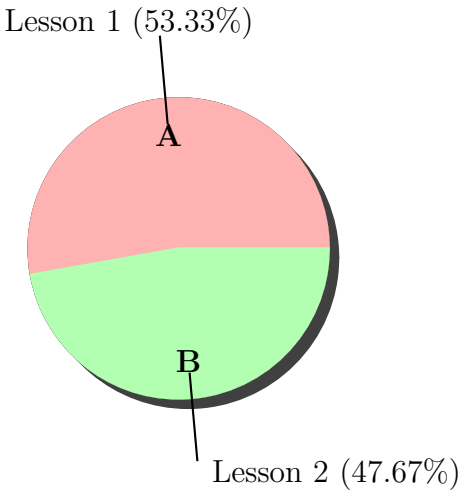


Figure 5.8: Preference of Lesson 1 is by a small majority of the students

5.4.1 Gender differences

Each question was cross tabulated against gender. Barring the difference of colour perception between boys and girls in Question 17 there is no statistically significant difference between the preferences of the genders. Girls and boys, however, showed a significant difference in their preference of background colour. Whereas the girls preferred the background colours Blue and Yellow, the boys preferred the backgrounds to be Grey. The χ^2 (Chi-squared) test for the null hypothesis test gives a value of 11.74 with a probability of 0.0028 for this cross tabulation, which indicates a highly significant statistical difference between their opinions. See Table 5.1 below.

Table 5.1: Cross tabulation for genders vs. Question 17 background colour yields a χ^2 (Chi-squared) value of 11.74 with a probability of 0.0028

	Male	%	Female	%	Total
Blue	28	46.67	35	58.33	63
Grey	26	43.33	10	16.67	36
Yellow	6	10.00	15	25.00	21
Total	60		60		120

5.4.2 Computer experience

According to (Garland and Noyes, 2004) there is little agreement concerning the definition of computer experience. Some researchers focus on the objective measures of computer experience, namely computer use. Others like (Jones

and Clarke, 1995) define computer experience in three components; amount of computer use, opportunities to use computers, and diversity of computer experience.

We have used the views of Jones and Clarke as displayed in Table 5.2 and in Table 5.3, to show aspects relating to computer experience.

The majority, 81.64%, of the respondents *have computers at home*. Of the 120 respondents 87.50% *own a cell phone*. Most, 86.67%, of the respondents learnt about computers at school; 15.00% came into contact with computers in pre-school, 37.50% first experienced computers in primary school and 47.50% came into contact with computers in secondary school.

Table 5.2: Level of computer experience

Use of computer	Email	Internet	Play games
Never	48.33	35.00	15.97
Sometimes	35.83	35.00	60.50
Often	15.83	30.00	23.53

Table 5.3: Use of computer operating system and software

Software	MS Windows	MS Word	MS Excel	Internet Explorer
Yes	99.17	78.15	51.26	40.00
No	0.83	21.85	47.06	53.33
Another	0	0	1.68	6.67

According to Table 5.2 most of the students 48.33% never used e-mail, 35.83% sometimes used e-mails to write to friends or family and a few students used e-mail. According to Table 5.3 most of the students, 99.17%, used Microsoft Windows as an operating system, and very few, 0.83%, did not. Either Microsoft Word or Microsoft Excel were used more often than other similar applications. The table shows that 40% of students used Internet Explorer as browser, and the majority, 53.33%, did not use Internet Explorer, and a few students, 6.67%, used another programme like Mozilla.

Computer experience was defined in terms the responses given to several questions. A weighting of 1, 2 or 3 was given to each question and the weighted

score was added to calculate an estimate of the "computer experience" of the student. Table 5.4 gives the weightings for each response.

Table 5.4: Weightings for calculating of "computer experience"

Question	Response	Weighting	Wording of question
Q3	1	2	I have a computer at home
Q8	1	1	I often use a computer
Q9	1	3	My first contact with computer was at pre-school
Q9	2	2	My first contact with computer was at primary school
Q9	3	1	My first contact with computer was at secondary school
Q10	1	2	I often use e-mail
Q10	2	1	I sometimes use e-mail
Q10	3	0	I seldom use e-mail
Q11	1	3	I often browse the internet
Q11	2	2	I sometimes browse the internet
Q12	1	2	I often enjoy playing computer games
Q12	2	1	I sometimes enjoy playing computer games
Q12	3	1	I never play computer games
Q14	1	1	I used Microsoft Word
Q15	1	1	I used Microsoft Excel
Q16	1	1	I used a browser such as Internet Explorer

The actual calculations were done directly from the responses using a formula where the response is indicate by a variable. For example 'q1' represents the value of Question 1, 'q2' represents the response to Question 2, etc. In the formula a logical expression such as (q3=1) yields the value 1 when q3 is 1 and it yields a 0 value when q3 is not 1. The complete formula for "experience" implementing Table 5.4 follows

$$\begin{aligned}\text{experience} \;=\; & 2\times(q3=1)+1\times(q8=1)+(4-q9)+(3-q10)\\ & +3\times(q11=1)+2\times(q11=2)+(3-q12)+1\times(q14=1)\\ & +1\times(q15=1)+1\times(q16=1)\end{aligned}$$

The median of experience was found to be 10, so we chose this as the point to split the group into those of more experience and those of less experience

by classifying students whose

$$\text{experience} > 9$$

as more experienced and the rest as less experienced.

Appendix B has a listing of all the cross tabulations for the preference questions versus gender and experience. At the end of Appendix B are the results of χ^2 tests to see if the proportions preferring a given option differ by experience level. The smallest P-value is 0.0142 for Q32 and this result would be considered significant. Given the number of tests being done, the value of 0.0335 for Q31 would only be considered marginally significant.

5.5 Qualitative research findings

The open-ended questions yielded some interesting observations. Many school students said that both lessons are very useful and user-friendly for the process of learning and teaching for students in Afghanistan secondary schools. The majority of students suggested that lessons such as these should be used in other Afghanistan secondary schools and also be used in other domains and subjects. They felt that creating such lessons would facilitate the learning process in Afghanistan schools.

"Both lessons have positive and negative aspects. The Lesson 1 has good colours and Lesson 2 has good examples."
"I think interactive part of the second lesson is better than the first lesson but exiting the first programme is better than the second."
"I know well that two lessons are best for our schools or students."
"These two interfaces are very user friendly and helpful for our schools and students."
"These lessons will be useful for improving our learning."
"If add some other examples that will be good."
"I liked the first lesson; it's more interesting than the second lesson."
"I liked both of the lessons."
"I like the first lesson more than the second lesson."
"I like this method becomes generalized and used in other subjects."

"I liked the colours and design of the first lesson, more than the second lesson, especially background and buttons."
"The examples of the second lesson were better than the first lesson."
"It will be better if examples are added in the first lesson." "It will be better if the name of God is on the home page." "If possible, the positive aspects of the two programmes must merge and create one programme."
"I liked the animations of the first lessons."
"I liked the buttons of the first lesson more than the second lesson."

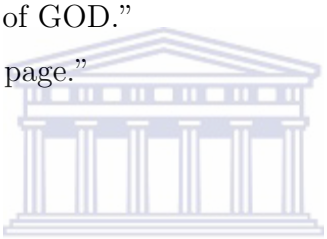
Many remarks were made about the appearance of the lessons. The students have differing views about the size and colour of buttons, Venn diagrams, and the colour of the home pages, the background colours and other parts of lessons, and expressed various viewpoints. Most of the students liked the colours and buttons of the Lesson 1. In Lesson 2 they liked the interactive examples of union of sets, intersection of sets, and set difference. The majority also preferred the home page and background of Lesson 1 to that of Lesson 2. Generally, most students indicated that they enjoyed the first lesson more than the second one.

"I like the colours of the buttons."
"I liked icons and colours."
"I liked the style, sizes and colours of the first lesson than the second lesson."
"I liked the design and the colour of the first lesson."

In other suggestions about both lessons for example, one student said: "The first lesson was better than the second lesson, in view of buttons and background colour but it didn't have enough examples." Another student said that the second lesson was better than the first lesson because it has an interactive part that can solve the examples of sets such as union, intersection and difference of two sets. Most of students suggested that it will be better that more examples must be added in the first lesson as well as the second lesson must become better in the view of colours, buttons, homepage, background and other characteristics. Some students said that the lesson must have security.

A few students said that it is necessary for the home page to start with the name of God.

"The first part of second lesson must have God on the top."
"In my view, if a programme start it must have cover / splash screen containing programmer name, and the name of God on it."
"It will be better that the first page, contains the name of God."
"This programme is very good for students, but only difficulty of this programme there is no name of God on it."
"It will be better if examples are added in the first lesson. It will be better if the name of God is on the home page."
"I preferred visual basic programme than the flash programme. Start of programme must include name of GOD."
"Name of God on the home page."



5.6 Conclusion

In this chapter we discussed our research findings by going into the details of the characteristics of the opinions of the respondents based on the actual sample questionnaire. We noted that there were very few statistically significant differences found by applying the χ^2-test on cross tabulations with the questions based on gender differences and previous computer experience.

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Chapter 6

Conclusion and recommendations

6.1 Introduction

In the previous chapter we discussed our results statistically in terms of gender and experience and presented it in tabular form. We also gave some charts to illustrate trends graphically.

In this chapter our objectives and main results are reviewed and we show that our thesis research questions have been answered and clarify our findings. We have also shown how we have incorporated the seven-stage mixed method data analysis process of (Onwuegbuzie and Teddlie, 2003). Finally we end this chapter with some recommendations.

6.2 Objectives of research

The objectives of our research were to investigate the influence of interfaces on the understanding of mathematics in secondary schools in Afghanistan. The essential question that was which aspects of the interface and e-learning can be improved to support the process of learning and teaching for students and teachers in Afghanistan secondary schools. In order to investigate this question we created two set theory lessons. One used Flash to implement the lesson and the other used the Visual Basic.net programming language.

6.3 Research findings

We incorporated the seven-stage mixed method data analysis process of (Onwuegbuzie and Teddlie, 2003) to analyse the data:
Data reduction It was not necessary to delete any of the respondents responses or comments as it was found to be honest responses; *Data display* Some of the data was displayed as in the form of charts; *Data transformation* We used the statistical package SAS (SAS, 1976) to transform the quantitative data

into a format that can be understood in terms of the research questions—see Appendix B; *Data correlation* We used the statistical package SAS to create cross tabulations to correlate the data—see Appendix B; *Consolidation* The responses to the open ended questions were consolidated into approximately 15 comments that were discussed in Section 5.5; *Data comparison* The quantitative and qualitative data were compared to see if they concur; *Data integration* All the data, qualitative and quantitative, were integrated to determine the outcome of the research questions.

We evaluated two created prototypes in the form of lessons on set theory and let 20 adult university students in the ANGeL centre at the Kabul University do these lessons. The lessons were followed up by a survey to determine the preferences of the university students toward certain aspects of the lessons. The reactions of the university students guided us in setting up the questionnaire for our real study where we assessed the perceptions of school children.

The same lessons were presented to 120 school children consisting of 60 boys and 60 girls in their ninth grade at two selected Kabul schools. The feedback of students was based on their observations, recognition and comprehension from two prototypes. The most important components and elements of two prototypes were: colours of figures, buttons, backgrounds including homepages, letters and other parts of prototypes, sizes of figures including Venn diagrams, buttons and letters of prototypes.

Besides the above-mentioned variables, the general shape of prototypes, readability, clarity and ease of usage of each lesson were determined from feedback given by the school learners. The learners gave various answers and opinions about the characteristics of components and elements of prototypes such as colours, buttons, sizes and general shapes of prototypes. These answers were reflected by feedback of students in a framework of closed questions, and some open-ended questions. Students also imparted their opinions and ideas about the prototypes by the very open-ended question: "any other comments".

The data collected from students, with respect to the first lesson, the Flash prototype, were as follows: a small majority, 52.50%, preferred the colour Blue for the background and the rest preferred other colours. Most of students, 89.17%, chose the medium size for buttons and a few students

opted for small and large sizes. Most students, 84.17%, preferred Black for the lettering. Most students, 94.17%, said that it is easy to move between pages. Most students, 89.17%, confirmed that they always know where they are in the lesson, and 78.33% said that it is simple to exit the program. Most students, 81.67%, liked the homepage of the lesson.

The collected data from the students for the second lesson, i.e. the Visual Basic.net prototype, were as follows: From the colours Green, Blue, Red, and White, more students, 35.83%, preferred the colour White for the background than any other colour. Most students, 81.67%, chose Black for the lettering and the rest of them chose the Blue or Green colours for the lettering. Most students, 88.33%, said that it is easy to move between the pages and other students rejected this. Also most students, 89.17%, said they always know that where they are in the lesson. Most students, 90%, believed that it is simple to exit the programme.

Most students, 81.67%, liked the introduction to Lesson 1, but a few less, 65%, liked the introduction of Lesson 2. Most students, 97.48%, liked the interactive part of the lesson that shows set operations such as union of two sets, intersection of two sets and difference of two sets by using animated examples. Only, 2.52%, did not like it.

There was only one question where girls responded significantly differently from the boys. See Table 5.1 on Page 42. The χ^2 test for the null hypothesis gives a value of 11.74 with a probability of 0.0028. Boys differed from girls in every choice of colour-the girls preferred Blue and Yellow and the boys preferred Grey. None of the other tables show any significant differences between the preferences of girls and boys.

Question 31 shows a marginally significant difference for persons with more experience to those of less experience. Those of more experience preferred the 'feel of' Lesson 1 and those of less experience preferred the 'feel of' Lesson 2. The χ^2 (Chi-squared) test gives a value of 4.5184 with a probability of 0.0335. None of the other questions showed a significant difference based on our measurement of experience.

Comparing the first and second lesson we found that most students, 58.82%, preferred the feel of Lesson 1 and the rest of them preferred the feel of Lesson 2, also more students, 66.67%, preferred the buttons of Lesson 1 and

Table 6.1: Experience cross tabulated against lesson preference yields $\chi^2 = 4.5184$ with a probability of 0.0335

	Less experience		More experience		Total
Lesson 1	29	49.15%	41	68.33%	70
Lesson 2	30	50.85%	19	31.67%	49
Total	59		60		119

the rest of them preferred the buttons of Lesson 2. More students, 76.67%, preferred the colours of Lesson 1 and the rest of them preferred the colours of Lesson 2. More students, 61.67%, said the lesson that best explains how to solve problems in set operations is Lesson 2 and the rest of them said Lesson 1 is the best lesson to solve problems in set operations. Finally, over all, 53.33%, preferred Lesson 1 and ,46.67%, preferred Lesson 2. So Lesson 1 is marginally better than Lesson 2. Most of the comments in the open-ended responses were favourable and even reflected their enjoyment of the lessons. Given the lack of significant differences on attitudes toward the lessons we can safely conclude that gender or experience plays only a minor role in the attitude toward interfaces in these school-going children.

On the other hand, most students gave the impression that they preferred teaching via a computer to normal teaching without computers. They suggested that teaching via computers must be come into Afghanistan education and should be broadly applied. Students suggested verbally and also via the open-ended-any-other-comments questions of the questionnaire that lessons such as these should become more generally available in other domains and subjects in Afghanistan schools.

Aforementioned paragraphs are the summary of ideas, beliefs, recognitions and impressions that they thought about the lessons. According to the views of students about the lessons, our main findings are:

1. Most students preferred teaching via computer than the normal teaching without computer.

2. Most of them preferred the elements and components of the first lesson than the second lesson.

They preferred the colours, buttons, letters, homepage, background, figures and arrangement of the first lesson to that of the second lesson. In general students approved of the interactive part of the second lesson. Overall students liked and preferred the first lesson to the second lesson. In our view, the main reason that students preferred the first lesson than the second lesson this is that the first lesson 'looks better' and 'is more colourful' than the other lesson. The student liked the colours. This fact is reflected by their responses in the open-ended questions. On the other hand, most students only liked interactive part of the second lesson, because of solving examples of set operations. In the second lesson, background, homepage, buttons had only one colour. In general the second lesson did not have an attractive shape and was not as colourful as the first lesson in the view of students. The main reason that some students chose the second lesson was because of its interactivity.

6.4 Review of research questions

We now deal with each of research questions stated in Section 1.5 on Page 3 one-by-one:

1. What factors of the interface and e-learning system are perceived as important to make it more accessible for the secondary school learners of mathematics in Afghanistan?

   The data seems to indicate that other than colour or experience of the user the only important factor is that the respondents wanted computers for delivery of e-learning. Our finding is that the perception of students is that computers are preferable to teachers.

2. How do these factors differ between groups when divided based on gender?

   We found that the perception of colour was the only factor that depended on gender difference.

3. How do these factors differ between groups when divided based on previous use experience?

Our findings are that experience and inexperienced users hardly differ in their perceptions of what is suitable. We found that the only statistically significant difference between preferences was on the choice of the better interface. The more experienced respondents sensed that the Flash interface of Lesson 1 was better. As the designers of these interfaces we would agree that it was indeed slicker than the Visual Basic.net interface of Lesson 2 whose graphics are not as good as that of Lesson 1 but it had the attraction and novelty of being more interactive which seems to be preferable for an inexperienced users.

6.5 Future work

More software for running on computers for presenting school mathematics will always be well received by school goers who seem to feel that the computers release them from the hold of the teacher. The view of students about the interface such as their answers to the questions about the size of buttons, colour of Venn diagrams, colours of other parts of the interface, and the position of menus should be heeded when presenting computer lessons. Such lessons should allow students to alter the colours while running the lesson to suit their preferences. Making the interface as interactive as possible is another goal that should be striven to. The interactivity increases the valency of lessons for school goers by removing the dullness of page-turning software.

6.6 Conclusion

We focused on our objectives and research findings. All our findings based on two variables previous computer experience and gender differences in considering of the title of research discussed and clarified. The chapter ended with my future plan and recommendation.

Appendix A

The questionnaires

A.1 The pilot questionnaire

The pilot questionnaire asked questions such as:
Which parts of the interface are easy for you to read and which parts are not?
Which colour(s) used in the Venn diagrams do you find helpful and easy to understand?
Which icons and pictures of interfaces were smaller or larger than you would have preferred?
Which other changes would you suggest to make this application easier to use?

The survey will also contained questions that collect data about the students themselves. It asked questions such as:
What is your gender? [Male, Female]
How often have you used a computer before?:
[Many times, Several times, Few times, Never]

How often have you written e-mails?:
[Many times, Several times, Few times, Never]

How often have you read information on web pages?:
[Many times, Several times, Few times, Never]

What computer programs have you used?:
[Microsoft Windows or any other operating system,
Microsoft Word or any other word processor,
Internet Explorer or any other web browser,
Microsoft Excel or any other spreadsheet,
any computer game]

A.2 The main questionnaire

University of the Western Cape

Department of Computer Science

Data collection questionnaire for a master's project

Dear Student,

Thank you for completing this questionnaire. It was will be used as input to a research project. Your responses will be treated with the utmost of confidence.

Please answer the questionnaire by circling the selected answers on the questionnaire.

Section A Background / demographic

1. Are you a boy (male) or a girl (female)?

Boy/Male	A
Girl/Female	B

2. How old are you?

13 or younger	A
14-15	B
16 or older	C

3. Do you have a computer at home?

Yes	A
No	B

4. Do you own a cell phone?

Yes	A
No	B

5. What was your mathematics mark for your last test?

80%–100%	A
70%–79%	B
60%–69%	C
50%–59%	D
Less than 50%	E

6. Did you learn about computers at school or at a technology centre?

Yes	A
No	B

7. My home language is:

Dari	A
Pashto	B
Another language	C

If you circled C—"Another language", PLEASE fill in your home language in the space provided below

.....

8. How often do you use a computer? :

Often	A
Sometimes	B
Seldom	C

9. My first contact with computers was at:

Pre-school	A
Primary school	B
Secondary school	C

10. I use e-mails (to write to friends or family):

Often	A
Sometimes	B
Seldom	C

11. I browse the internet to get information:

Often	A
Sometimes	B
Seldom	C

12. I enjoy playing computer games:

Often	A
Sometimes	B
Seldom	C

Which of the following programmes have you used before?

	Yes	No	I use another but similar programme
13. Microsoft Windows	A	B	C
14. Microsoft Word	A	B	C
15. Microsoft Excel	A	B	C
16. A browser such as Internet Explorer	A	B	C

Section B Lesson 1 (Flash))
Colours

17. A good colour for the background is:

Blue	A
Gray	B
Yellow	C

18. Buttons should be

Small	A
Medium	B
Big	C

19. For the lettering I prefer

Black	A
Blue	B
Green	C

Movement

20. It is easy to move between pages

Yes	A
No	B

21. I can go to each part of lesson easily.

Yes	A
No	B

22. It is simple to exit the programme

Yes	A
No	B

23. I like the introduction

Yes	A
No	B

Section C Lesson2 (Visual Basic)

Colours

24. For the background I would prefer

Green	A
Blue	B
Red	C
White	C
Grey	C

25. For the lettering I prefer

Black	C
Blue	B
Green	A

Movement

26. It is easy to move between pages

Yes	A
No	B

27. I always know where I am in the lesson

Yes	A
No	B

28. It is simple to exit the programme

Yes	A
No	B

29. I like the introduction

Yes	A
No	B

30. I like the interactive part of the lesson that shows set operations (union of two set, intersection of two set and difference of two sets) by examples.

Yes	A
No	B

Section D Compare Lesson 1 and 2

	Lesson 1	Lesson 2
31. I preferred the feel of	A	B
32. I preferred the buttons of	A	B
33. I preferred the colours of	A	B
34. The lesson that best explains how to solve problems in set operations is	A	B
35. I preferred	A	B

Section E Open ended questions

36. Which part of lesson 1 did you like more than lesson 2?

37. Which part of lesson 2 did you like more than lesson 1?

ANY OTHER USEFUL COMMENTS?

Thank you for your cooperation.

Regards

A. Rahman

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Appendix B

Quantitative analysis

B.1 Descriptive statistics

The statistics we derived from the data in the questionnaies consisted of determining the frequencies of the responses to each question. Cross-tabulations were calculated to determine the influence of gender and computer experience on the questions. The χ^2 test was computed to determine which questions showed significant differences ibased on gender or computer experience.

B.1.1 Frequencies of responses to the questions

The results below give simple frequency counts for each question.

Frequency counts for all Questions 13:09 Tuesday, November 23, 2010 288

The FREQ Procedure

gender

q1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	60	50.00	60	50.00
2	60	50.00	120	100.00

age

q2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	2.50	3	2.50
2	50	41.67	53	44.17
3	67	55.83	120	100.00

computer@home

q3	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	98	81.67	98	81.67
2	22	18.33	120	100.00

cell phone

q4	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	105	87.50	105	87.50
2	15	12.50	120	100.00

math mark

q5	Frequency	Percent	Cumulative Frequency	Cumulative Percent

1	41	34.17	41	34.17
2	23	19.17	64	53.33
3	15	12.50	79	65.83
4	15	12.50	94	78.33
5	26	21.67	120	100.00

learn@school

q6	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	104	86.67	104	86.67
2	16	13.33	120	100.00

language

q7	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	101	84.17	101	84.17
2	17	14.17	118	98.33
3	2	1.67	120	100.00

comp use

q8	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	60	50.00	60	50.00
2	48	40.00	108	90.00
3	12	10.00	120	100.00

1st contact

q9	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	18	15.00	18	15.00
2	45	37.50	63	52.50
3	57	47.50	120	100.00

The FREQ Procedure

Use email

q10	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	19	15.83	19	15.83
2	43	35.83	62	51.67
3	58	48.33	120	100.00

browse internet

q11	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	36	30.00	36	30.00
2	42	35.00	78	65.00
3	42	35.00	120	100.00

games

q12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	28	23.53	28	23.53
2	72	60.50	100	84.03
3	19	15.97	119	100.00

Frequency Missing = 1

Windows

q13	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	119	99.17	119	99.17
2	1	0.83	120	100.00

Word

q14	Frequency	Percent	Cumulative Frequency	Cumulative Percent

1	93	78.15	93	78.15
2	26	21.85	119	100.00

Frequency Missing = 1

Exce

q15	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	61	51.26	61	51.26
2	56	47.06	117	98.32
3	2	1.68	119	100.00

Frequency Missing = 1

browser

q16	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	48	40.00	48	40.00
2	64	53.33	112	93.33
3	8	6.67	120	100.00

backgrnd colour

q17	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	63	52.50	63	52.50
2	36	30.00	99	82.50
3	21	17.50	120	100.00

buttons

q18	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	3	2.50	3	2.50
2	107	89.17	110	91.67
3	10	8.33	120	100.00

letter colour

q19	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	101	84.17	101	84.17
2	9	7.50	110	91.67
3	10	8.33	120	100.00

move pages

q20	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	113	94.17	113	94.17
2	7	5.83	120	100.00

move parts

q21	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	107	89.17	107	89.17
2	13	10.83	120	100.00

easy exit

q22	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	94	78.33	94	78.33
2	26	21.67	120	100.00

like intro

q23	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	98	81.67	98	81.67
2	22	18.33	120	100.00

backgrnd colour2

q24	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	26	21.67	26	21.67
2	21	17.50	47	39.17
3	8	6.67	55	45.83
4	43	35.83	98	81.67
5	22	18.33	120	100.00

letter colour2

q25	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	98	81.67	98	81.67
2	8	6.67	106	88.33
3	14	11.67	120	100.00

move pages2

q26	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	106	88.33	106	88.33
2	14	11.67	120	100.00

where I am

q27	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	107	89.17	107	89.17
2	13	10.83	120	100.00

easy exit2

q28	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	108	90.00	108	90.00
2	12	10.00	120	100.00

like intro2

q29	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	78	65.00	78	65.00
2	42	35.00	120	100.00

Like intro2

q30	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	116	97.48	116	97.48
2	3	2.52	119	100.00

Frequency Missing = 1

Feel of

q31	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	70	58.82	70	58.82
2	49	41.18	119	100.00

Frequency Missing = 1

button pref

q32	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	80	66.67	80	66.67
2	40	33.33	120	100.00

colour pref

q33	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	92	76.67	92	76.67
2	28	23.33	120	100.00

explanation pref

q34	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	46	38.33	46	38.33
2	74	61.67	120	100.00

Overall pref

q35	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	64	53.33	64	53.33
	56	46.67	120	100.00

B.1.2 Cross-tabulations based on gender

The cross-tabulations compare gender with each question and the χ^2 test was was done for the tables of gender versus Questions 17–35.

CrossTabulations

Gender differences for questions (related to preference) Tuesday, November 23, 2010 292

The FREQ Procedure

Table of q1 by q17

q1(gender) q17(backgrnd colour)

Frequency| Row Pct	1	2	3	Total
Male	28	26	6	60
	46.67	43.33	10.00	
Female	35	10	15	60
	58.33	16.67	25.00	
Total	63	36	21	120

Table of q1 by q18

q1(gender) q18(buttons)

Frequency| Row Pct	1	2	3	Total
Male	3	52	5	60
	5.00	86.67	8.33	
Female	0	55	5	60
	0.00	91.67	8.33	
Total	3	107	10	120

Table of q1 by q19

q1(gender) q19(letter colour)

Frequency| Row Pct	1	2	3	Total
Male	49	6	5	60
	81.67	10.00	8.33	
Female	52	3	5	60
	86.67	5.00	8.33	
Total	101	9	10	120

Table of q1 by q20

q1(gender) q20(move pages)

Frequency| Row Pct	1	2	Total

Male	57	3	60
	95.00	5.00	
Female	56	4	60
	93.33	6.67	
Total	113	7	120

Table of q1 by q21

q1(gender) q21(move parts)

Frequency| Row Pct	1	2	Total
Male	53	7	60
	88.33	11.67	
Female	54	6	60
	90.00	10.00	
Total	107	13	120

Table of q1 by q22

q1(gender) q22(easy exit)

Frequency| Row Pct	1	2	Total
Male	43	17	60
	71.67	28.33	
Female	51	9	60
	85.00	15.00	
Total	94	26	120

Table of q1 by q23

q1(gender) q23(like intro)

Frequency| Row Pct	1	2	Total
Male	47	13	60
	78.33	21.67	
Female	51	9	60
	85.00	15.00	
Total	98	22	120

Table of q1 by q24

q1(gender) q24(backgrnd colour2)

Frequency| Row Pct	1	2	3	4	5	Total
Male	17	7	5	22	9	60
	28.33	11.67	8.33	36.67	15.00	
Female	9	14	3	21	13	60
	15.00	23.33	5.00	35.00	21.67	
Total	26	21	8	43	22	120

Table of q1 by q25

q1(gender) q25(letter colour2)

Frequency| Row Pct	1	2	3	Total
Male	52	2	6	60
	86.67	3.33	10.00	
Female	46	6	8	60
	76.67	10.00	13.33	
Total	98	8	14	120

Table of q1 by q26

q1(gender) q26(move pages2)

Frequency| Row Pct	1	2	Total

```
---------+--------+--------+
Male     |     52 |      8 |     60
         |  86.67 |  13.33 |
---------+--------+--------+
Female   |     54 |      6 |     60
         |  90.00 |  10.00 |
---------+--------+--------+
Total         106       14      120


Table of q1 by q27

q1(gender)     q27(where I am)

Frequency|
Row Pct  |       1|       2|  Total
---------+--------+--------+
Male     |     54 |      6 |     60
         |  90.00 |  10.00 |
---------+--------+--------+
Female   |     53 |      7 |     60
         |  88.33 |  11.67 |
---------+--------+--------+
Total         107       13      120


Table of q1 by q28

q1(gender)     q28(easy exit2)

Frequency|
Row Pct  |       1|       2|  Total
---------+--------+--------+
Male     |     55 |      5 |     60
         |  91.67 |   8.33 |
---------+--------+--------+
Female   |     53 |      7 |     60
         |  88.33 |  11.67 |
---------+--------+--------+
Total         108       12      120


Table of q1 by q29

q1(gender)     q29(like intro2)

Frequency|
Row Pct  |       1|       2|  Total
---------+--------+--------+
Male     |     36 |     24 |     60
         |  60.00 |  40.00 |
---------+--------+--------+
Female   |     42 |     18 |     60
         |  70.00 |  30.00 |
---------+--------+--------+
Total          78       42      120


Table of q1 by q30

q1(gender)     q30(Like intro2)

Frequency|
Row Pct  |       1|       2|  Total
---------+--------+--------+
Male     |     57 |      2 |     59
         |  96.61 |   3.39 |
---------+--------+--------+
Female   |     59 |      1 |     60
         |  98.33 |   1.67 |
---------+--------+--------+
Total         116        3      119

Frequency Missing = 1


Table of q1 by q31

q1(gender)     q31(Feel of)

Frequency|
Row Pct  |       1|       2|  Total
---------+--------+--------+
Male     |     38 |     21 |     59
         |  64.41 |  35.59 |
---------+--------+--------+
Female   |     32 |     28 |     60
         |  53.33 |  46.67 |
---------+--------+--------+
Total          70       49      119

Frequency Missing = 1


Table of q1 by q32
```

q1(gender) q32(button pref)

Frequency|			
Row Pct	1	2	Total
Male	44	16	60
	73.33	26.67	
Female	36	24	60
	60.00	40.00	
Total	80	40	120

Table of q1 by q33

q1(gender) q33(colour pref)

Frequency|			
Row Pct	1	2	Total
Male	45	15	60
	75.00	25.00	
Female	47	13	60
	78.33	21.67	
Total	92	28	120

Table of q1 by q34

q1(gender)
q34(explanation pref)

Frequency|			
Row Pct	1	2	Total
Male	25	35	60
	41.67	58.33	
Female	21	39	60
	35.00	65.00	
Total	46	74	120

Table of q1 by q35

q1(gender) q35(Overall pref)

Frequency|			
Row Pct	1	2	Total
Male	37	23	60
	61.67	38.33	
Female	27	33	60
	45.00	55.00	
Total	64	56	120

Gender differences for questions related to preference 13:09 Tuesday, November 23, 2010 296

Obs	Table	Statistic	DF	Value	Prob
1	Table q1 * q17	Chi-Square	2	11.7460	0.0028
7	Table q1 * q18	Chi-Square	2	3.0841	0.2139
13	Table q1 * q19	Chi-Square	2	1.0891	0.5801
19	Table q1 * q20	Chi-Square	1	0.1517	0.6969
26	Table q1 * q21	Chi-Square	1	0.0863	0.7690
33	Table q1 * q22	Chi-Square	1	3.1424	0.0763
40	Table q1 * q23	Chi-Square	1	0.8905	0.3453
47	Table q1 * q24	Chi-Square	4	6.0454	0.1958
53	Table q1 * q25	Chi-Square	2	2.6531	0.2654
59	Table q1 * q26	Chi-Square	1	0.3235	0.5695
66	Table q1 * q27	Chi-Square	1	0.0863	0.7690
73	Table q1 * q28	Chi-Square	1	0.3704	0.5428
80	Table q1 * q29	Chi-Square	1	1.3187	0.2508
87	Table q1 * q30	Chi-Square	1	0.3594	0.5488
94	Table q1 * q31	Chi-Square	1	1.5060	0.2198
101	Table q1 * q32	Chi-Square	1	2.4000	0.1213
108	Table q1 * q33	Chi-Square	1	0.1863	0.6660
115	Table q1 * q34	Chi-Square	1	0.5640	0.4526
	Table q1 * q35	Chi-Square	1	3.3482	0.0673

B.1.3 Cross-tabulations based on computer experience

A score for computer experience was calculated and found to have a median of 10 which then determined the cut-off point for less and more computer experienced learners. The following listing shows the cross-tabulations of computer experience with Questions 17–35, followed by their χ^2 tests.

```
Computer experience differences for questions (related to preference)
---------------------------------------------------------------------

A scoring system was used to try to quantify computer experience.
A statement in parentheses is a logic statement and, if true, takes on the value '1' and takes the value '0' otherwise.
experience=2*(q3=1)+1*(q8=1)+(4-q9)+ (3-q10)+3*(q11=1)+2*(q11=2)+(3-q12)+1*(q14=1) +1*(q15=1)+1*(q16=1);

more_experienced =(experience>9);

The first output below gives the frequency distribution of the calculated experience scores.
The median value was 10, which led to the decision to define 'more experienced' students to be those with a
score over 9 (10 or higher).Next you will find two-way tables showing experience (more or less) with the preference questions.
At the end are results of chi-squared tests to see if the proportions preferring a given option differ by experience level.
The smallest p-value is 0.0142 for Q32 and this result would be considered significant.  Given the number of tests being done2,
the value of 0.0335 for Q31 would only be considered marginally significant.
(I looked at experience as an ordinal variable (not dichotomized) as well and tested for differences relative to chosen preferences.
There were no significant differences.  Results not shown here to save space.)


Distribution of Experience Scores 11:50 Wednesday, November 24, 2010  66
------------------------------------------------------------------------

The FREQ Procedure

                                          Cumulative    Cumulative
experience    Frequency     Percent      Frequency      Percent
-------------------------------------------------------------------
         1           4        3.36              4         3.36
         2           3        2.52              7         5.88
         3           3        2.52             10         8.40
         4          13       10.92             23        19.33
         5           5        4.20             28        23.53
         6           7        5.88             35        29.41
         7           8        6.72             43        36.13
         8           6        5.04             49        41.18
         9           9        7.56             58        48.74
        10          10        8.40             68        57.14
        11          16       13.45             84        70.59
        12          13       10.92             97        81.51
        13          12       10.08            109        91.60
        14           7        5.88            116        97.48
        15           3        2.52            119       100.00

Frequency Missing = 1


Distribution of Experience Scores 11:50 Wednesday, November 24, 2010  67
------------------------------------------------------------------------

The UNIVARIATE Procedure
Variable:  experience

                          Moments

N                         119    Sum Weights               119
Mean                8.85714286    Sum Observations         1054
Std Deviation       3.77387477    Variance            14.2421308
Skewness             -0.389438    Kurtosis            -0.9395527
Uncorrected SS           11016    Corrected SS        1680.57143
Coeff Variation     42.6082635    Std Error Mean      0.34595053


             Basic Statistical Measures

    Location                     Variability

Mean      8.85714     Std Deviation            3.77387
Median   10.00000     Variance                14.24213
Mode     11.00000     Range                   14.00000
                      Interquartile Range      6.00000


           Tests for Location: Mu0=0

Test           -Statistic-    -----p Value------
```

Student's t	t	25.60234	Pr > |t|	<.0001
Sign	M	59.5	Pr >= |M|	<.0001
Signed Rank	S	3570	Pr >= |S|	<.0001

Quantiles (Definition 5)

Quantile	Estimate
100% Max	15
99%	15
95%	14
90%	13
75% Q3	12
50% Median	10
25% Q1	6
10%	4
5%	2
1%	1
0% Min	1

Extreme Observations

----Lowest----		----Highest---	
Value	Obs	Value	Obs
1	105	14	58
1	104	14	98
1	94	15	52
1	84	15	72
2	120	15	90

Missing Values

-----Percent Of-----			
Missing Value	Count	All Obs	Missing Obs
.	1	0.83	100.00

```
   Stem Leaf                     #  Boxplot                    Normal Probability Plot
     15 000                      3     |          15.5+                                ++ * *  *
     14 0000000                  7     |              |                                ******
     13 000000000000            12     |              |                          *****
     12 0000000000000           13  +-----+          |                     *****
     11 00000000000000000       16  |     |          |                  *******
     10 0000000000              10  *-----*          |                *** ++
      9 000000000                9  |     |          |              ******
      8 000000                   6  |  +  |       8.5+                ****
      7 00000000                 8  |     |          |              ***
      6 0000000                  7  +-----+          |            ***
      5 00000                    5     |             |          ++++
      4 0000000000000           13     |             |        *****
      3 000                      3     |             |      ***
      2 000                      3     |             |    ***
      1 0000                     4     |          1.5+*  * **
        ----+----+----+----+                          +----+----+----+----+----+----+----+----+----+----+
                                                     -2        -1         0        +1        +2
```

Experience differences for questions related to preference 11:50 Wednesday, November 24, 2010 68

The FREQ Procedure

Table of more_experienced by q17

more_experienced q17(backgrnd colour)

Frequency / Row Pct	1	2	3	Total
Less Experienced	33 55.93	15 25.42	11 18.64	59
More Experience	30 49.18	21 34.43	10 16.39	61
Total	63	36	21	120

Table of more_experienced by q18

more_experienced q18(buttons)

Frequency / Row Pct	1	2	3	Total
Less Experienced	1 1.69	55 93.22	3 5.08	59

More Experience	2	52	7	61
	3.28	85.25	11.48	
Total	3	107	10	120

Table of more_experienced by q19

more_experienced q19(letter colour)

Frequency / Row Pct	1	2	3	Total
Less Experienced	51	2	6	59
	86.44	3.39	10.17	
More Experience	50	7	4	61
	81.97	11.48	6.56	
Total	101	9	10	120

Table of more_experienced by q20

more_experienced q20(move pages)

Frequency / Row Pct	1	2	Total
Less Experienced	54	5	59
	91.53	8.47	
More Experience	59	2	61
	96.72	3.28	
Total	113	7	120

Table of more_experienced by q21

more_experienced q21(move parts)

Frequency / Row Pct	1	2	Total
Less Experienced	50	9	59
	84.75	15.25	
More Experience	57	4	61
	93.44	6.56	
Total	107	13	120

Table of more_experienced by q22

more_experienced q22(easy exit)

Frequency / Row Pct	1	2	Total
Less Experienced	44	15	59
	74.58	25.42	
More Experience	50	11	61
	81.97	18.03	
Total	94	26	120

Experience differences for questions related to preference 11:50 Wednesday, November 24, 2010 69

The FREQ Procedure

Table of more_experienced by q23

more_experienced q23(like intro)

Frequency / Row Pct	1	2	Total
Less Experienced	50	9	59
	84.75	15.25	
More Experience	48	13	61
	78.69	21.31	
Total	98	22	120

Table of more_experienced by q24

more_experienced q24(backgrnd colour2)

Frequency / Row Pct	1	2	3	4	5	Total
Less Experienced	10 16.95	13 22.03	5 8.47	22 37.29	9 15.25	59
More Experience	16 26.23	8 13.11	3 4.92	21 34.43	13 21.31	61
Total	26	21	8	43	22	120

Table of more_experienced by q25

more_experienced q25(letter colour2)

Frequency / Row Pct	1	2	3	Total
Less Experienced	46 77.97	5 8.47	8 13.56	59
More Experience	52 85.25	3 4.92	6 9.84	61
Total	98	8	14	120

Table of more_experienced by q26

more_experienced q26(move pages2)

Frequency / Row Pct	1	2	Total
Less Experienced	51 86.44	8 13.56	59
More Experience	55 90.16	6 9.84	61
Total	106	14	120

Table of more_experienced by q27

more_experienced q27(where I am)

Frequency / Row Pct	1	2	Total
Less Experienced	53 89.83	6 10.17	59
More Experience	54 88.52	7 11.48	61
Total	107	13	120

Table of more_experienced by q28

more_experienced q28(easy exit2)

Frequency / Row Pct	1	2	Total
Less Experienced	51 86.44	8 13.56	59
More Experience	57 93.44	4 6.56	61
Total	108	12	120

The FREQ Procedure

Table of more_experienced by q29

more_experienced q29(like intro2)

Frequency / Row Pct	1	2	Total
Less Experienced	39 66.10	20 33.90	59
More Experience	39 63.93	22 36.07	61
Total	78	42	120

Table of more_experienced by q30

more_experienced q30(Like intro2)

Frequency / Row Pct	1	2	Total
Less Experienced	57 98.28	1 1.72	58
More Experience	59 96.72	2 3.28	61
Total	116	3	119

Frequency Missing = 1

Table of more_experienced by q31

more_experienced q31(Feel of)

Frequency / Row Pct	1	2	Total
Less Experienced	29 49.15	30 50.85	59
More Experience	41 68.33	19 31.67	60
Total	70	49	119

Frequency Missing = 1

Table of more_experienced by q32

more_experienced q32(button pref)

Frequency / Row Pct	1	2	Total
Less Experienced	33 55.93	26 44.07	59
More Experience	47 77.05	14 22.95	61
Total	80	40	120

Table of more_experienced by q33

more_experienced q33(colour pref)

Frequency / Row Pct	1	2	Total
Less Experienced	43 72.88	16 27.12	59
More Experience	49 80.33	12 19.67	61
Total	92	28	120

Experience differences for questions related to preference 11:50 Wednesday, November 24, 2010 71

The FREQ Procedure

Table of more_experienced by q34

more_experienced q34(explanation pref)

Frequency / Row Pct	1	2	Total
Less Experienced	20 33.90	39 66.10	59
More Experience	26 42.62	35 57.38	61
Total	46	74	120

Table of more_experienced by q35

more_experienced q35(Overall pref)

Frequency / Row Pct	1	2	Total

Less Experienced	29	30	59
	49.15	50.85	
More Experience	35	26	61
	57.38	42.62	
Total	64	56	120

Experience differences for questions related to preference 11:50 Wednesday, November 24, 2010 72

Obs	Table	Statistic	DF	Value	Prob
1	Table more_experienced * q17	Chi-Square	2	1.1575	0.5606
7	Table more_experienced * q18	Chi-Square	2	1.9847	0.3707
13	Table more_experienced * q19	Chi-Square	2	3.1552	0.2065
19	Table more_experienced * q20	Chi-Square	1	1.4740	0.2247
26	Table more_experienced * q21	Chi-Square	1	2.3483	0.1254
33	Table more_experienced * q22	Chi-Square	1	0.9653	0.3259
40	Table more_experienced * q23	Chi-Square	1	0.7350	0.3913
47	Table more_experienced * q24	Chi-Square	4	3.7933	0.4347
53	Table more_experienced * q25	Chi-Square	2	1.1200	0.5712
59	Table more_experienced * q26	Chi-Square	1	0.4034	0.5253
66	Table more_experienced * q27	Chi-Square	1	0.0530	0.8180
73	Table more_experienced * q28	Chi-Square	1	1.6338	0.2012
80	Table more_experienced * q29	Chi-Square	1	0.0619	0.8035
87	Table more_experienced * q30	Chi-Square	1	0.2924	0.5887
94	Table more_experienced * q31	Chi-Square	1	4.5184	0.0335
101	Table more_experienced * q32	Chi-Square	1	6.0183	0.0142
108	Table more_experienced * q33	Chi-Square	1	0.9297	0.3350
115	Table more_experienced * q34	Chi-Square	1	0.9658	0.3257
122	Table more_experienced * q35	Chi-Square	1	0.8151	0.3666

Appendix C

Qualitative data

C.1 Pilot questionnaire

Question 35
I liked the colours and design of the first lesson, more than the second lesson. Especially background and buttons.
I liked the background and buttons, I liked the pictures more in the first lesson than in the second lesson.
I liked the beautiful environment and graphical part of the first lesson.
In general, several parts of the first lesson were better than the second lesson. For example: colours, background colour, font and shapes.
I liked the union and intersection and difference of sets in the second lesson.
I liked subsets and properties of sets more so in the first lesson than in the second lesson.
The first programme has beautiful shapes of the lesson are better for learning.
In the first lesson the colours was better than in the second lesson. Also designing of buttons was better.
In the first lesson the graphical part was beautiful.
The first lesson has a beautiful home page.
I liked the examples, lessons and the colours of the first lesson.
In the first lesson I liked background.
I liked the colours, buttons and keys of the first lesson.
I liked the background, colours and designs of the first lesson.
In the first lesson, using varies colours to attraction attention of students.
Graph of the first lesson was better than the second lesson. And also showing the dynamic shapes.
the colours and design of the first lesson, was better than the second lesson.
I liked the buttons in the first lesson and also it is easy navigating through the programme.
I like the home page and also the union and intersection of two sets.
I liked the icons and showing of sets than the second lessons.

Question 36
The examples of the second lesson was better, also navigating through programme was good.
In the second lesson the examples was very good.
In general the second lesson was easy and better.
In the second part only the examples of it is better than the first lesson.
I liked the examples in the second lesson.
In the second lesson, the compliment of a set was better than the second lesson.

I liked the examples in the second lesson.
The examples of the second lesson were better than the first lesson.
In the second lesson, only examples were good. It will be better if you add examples to the first lesson.
In the second lesson the examples and the buttons of the home page was beautiful.
I liked the home page and the examples of the second lesson.
In the second lesson the interactive part was good. And not boring for user.
The examples of the second lesson were excellent.
I liked the home page, previous page, and font colour and font size.
The second part has several examples which are better for learning.
In the second lesson, entering the home page is easy.
The examples of the second lesson were better than the first lesson.
The examples of the second lesson were better than the first lesson.
I liked the examples in the second lesson.
I liked the examples in the second lesson.

ANY OTHER COMMENTS?
It will be better that the design of the second lesson improve.
The first part of second lesson must have God on the top.
It will be better if there is some restriction had in these lessons. For example: password for the user.
In my view, if a programme start it must have cover / splash screen containing programmer name, and the name of God on it.
It will be better that the first page, contains the name of God.
This programme is very good for students, but only difficulty of this programme there is no name of God on it.
It will be better if examples are added in the first lesson. It will be better if the name of God is on the home page.
I preferred visual basic programme than the flash programme. Start of programme must include name of GOD
If these lessons are used to teach in school and universities it will be better.
Name of God on the home page.
It will be better if the second lesson has a title bar for each heading.
Name of God on the home page.
It will be better that the visual basic programme has a big heading before starting. And have a list of topics.
If possible, the positive aspects of the two programmes must merge and create one programme.
Both lessons have positive and negative aspects. The first lesson has good colours; the second lesson has good examples.
In the first lesson, design and examples were better. And in the second lesson there wasn't previous button.
It will be better if you add more examples to the lessons and also place the name of god on them.
It will be better if the design of the second lesson improve. Also in the second lesson in the examples, create a button to delete user input.
The first page must use the name of God.
It will be better many more examples are added it to the first lesson. In my view the first lesson was better then the second lesson in terms of design.

C.2 Schools questionniare

Question 36

I liked the buttons and colours of the first lesson.
I liked the whole of the first lesson.
In the first lesson, the pictures in the examples were better and understandable.
I like the colours of the buttons.
I liked icons and colours.
I liked the style, sizes and colours of the first lesson than the second lesson.
I liked the design and the colour of the first lesson.
I liked the home page of the first lesson.
I liked the background of the first lesson.
I liked the pictures of the first lesson.
The first lesson has beautiful buttons.
I liked the buttons of the first lesson.
I liked the design of the first lesson.
In the first lesson, it is easy to navigate through the pages.
I like the colours of the first lesson.
I liked the animations of the first lessons.
I liked the buttons of the first lesson more than the second lesson.
I liked the colour of the first lesson.
I liked the first lesson more than the second lesson.
I liked the buttons of the first lesson.
I think learning of the first lesson is better than the second lesson.
I liked the union of two sets in the first lesson.
I liked the examples of the first lesson more than the second lesson.
I liked entering the programme in the first lesson.
I like the part of entering the program.
I liked the headings and examples of the first lesson.
I liked the examples of the first lesson.
I liked the first lesson had better design than the second lesson.
I liked the background and the size of the buttons in the first lesson.
Flash program was designed better and the buttons are good.
The first lesson was better than the second lesson because it had good colours and wonderful background.
The first programme was better then the second programme. And it had better colours.
I like the union of two sets in the first lesson.
The first lesson had good colours and good buttons than the second lesson.
First lesson had good colours.
I like the colour first lesson more than the second lesson.
I liked the second lesson more than the first lesson.
I liked entering and exiting from one part to the other part of the lesson.
The first lesson has good buttons and it's understandable.
The first lesson had good buttons.
I like the colour of the background, of the previous, next page as well as the font.
Buttons and colour of buttons of the first lesson is more beautiful than the second lesson.
The second lesson had beautiful colours and good examples and also good menus.
The buttons and the background was better than the second lesson.
The first lesson is better than the second lesson.

The buttons on the second lesson were better than the first lesson. Also the colour of the page was better.
I like the part of first lesson which deals with the practical examples.
I like the colour, fonts and graphics of the first lesson.
Animation are beautiful.
I like the colour of background and the buttons.
I like the lessons on sets.
The part of buttons in the first lesson is better than the second lesson.
Homepage good in the first lesson.
Buttons and backgrounds and backgrounds of the first lesson were more beautiful than the second lesson.
I like the buttons of the first lesson.
In the first lesson the part of buttons were better than the second lesson.
I liked the first part of the first lesson because the buttons were blue.
I liked the first lesson.
The first lesson is understandable, more so than the first lesson.
The background of the second lesson is good because all the buttons are situated on the home page.
The first part of the lesson has very useful and I learned a lot of things from them. Thank you for your guidance.
I liked the first part of the first lesson, because of the beautiful colours.
I liked the buttons of the first lesson more than the second lesson.
I liked the buttons on the home page, because they were arranged horizontally.
The buttons on the home page arranged horizontally thus I can move from one part to the other parts easily.
I liked the part of set elements in the first lesson, than in the second lesson.
I liked the buttons in the first lesson.
I liked the entire first lesson.
In the first lesson the practical part and the colours of them were beautiful.
The examples section, colours and the background of the first lesson were better than the second lesson.
The first lesson is better than the second lesson.
The first lesson was better than the second lesson due to good examples.
I liked the colours and buttons of the first lesson.
I liked the first lesson.
The buttons of the first lesson was better than the second lesson.
I liked the first lesson very much.
I liked the examples of both lessons.
I liked the home page of the first lesson.
I liked the colours and the buttons of the first lesson.
I liked the first lesson because it is much explanatory.
IN the first lesson I liked the colour more than the second lesson.
The colours and the size of the buttons in the first lesson were better than the second lesson.
I liked the difference of two sets in the second lesson more than the first lesson.
I liked the first part of the first lesson about sets, types of sets, size of buttons and colour of pages that was regular.
I liked the examples of the first lesson with their definitions.
I liked the examples of the first lesson with colours.
I liked the intersection and union of two sets, this was very clear and interactive.

I liked the colour of buttons and the practical part of sets.
I liked sets and properties of sets in the first lesson.
In the first lesson the intersection, union and the difference of two sets was excellent and understandable.
I like the whole part of the first and second lesson, it was good.
In the second lesson, the background colour and the font size was better than the second lesson.
I liked all first lesson.
I preferred the first lesson more than the second lesson. Because of good colours and appropriate size of buttons.
I liked the buttons of the first lesson more than the second lesson.
I liked the background of the first lesson more than the second lesson. And so I liked the colours and size of buttons that were horizontal.
I liked the buttons more in the first lesson than in the second lesson.
I like the colour more in the first lesson than the second lesson.
(NO COMMENT)
I liked the elements and types of elements in the first lesson.
I liked the colours and buttons of the first programme. And also I liked the animated circular images.
I like the first lesson not the second lesson. But I like the examples of the second lesson.
I liked the colours and the buttons of the first lesson.
I liked the buttons and the colours of the first lesson more than second lesson.
I liked the definition of sets and types of sets in the first lesson.
I liked the colours of the first lesson.
I liked the definition of set and types of sets. In the first lesson, it was very useful to us.
I liked the button of the second lesson more than the first lesson.
I liked the buttons and colours of the first lesson.
I liked the icons of the first lesson more than that of the second lesson.
In the first lesson, the colours were very beautiful and well organized.
I liked the colours of the first lesson.
I liked the colour of the first lesson more than the second lesson.
liked the colours of the first lesson.
I liked the home page of the set programme more than the second lesson.
I liked the circles of examples and the motion of them.
I liked the colours of the first lesson.
I liked the colours of the first lesson more than the second lesson.
I liked and preferred the first lesson because the first lesson was very beautiful and had very beautiful colours.
In the first lesson I liked the definition of sets and types of sets. This was useful for us.

Question 37
I liked the examples of the second lesson.
I liked the examples of the second lesson.
In the second lesson buttons were good.
I liked the examples of the second lesson than the first lesson.
I liked the examples of the second lesson.
I liked the interactive part of the second lesson.

I liked the examples of the second lesson.
I liked the examples of the second lesson more than the first lesson.
I liked the letters of the second lesson.
I liked the examples of the second lesson.
Exiting from the second lesson is easier than the first lesson.
I liked the examples of the second lesson.
I liked the examples of the second lesson.
In the second lesson I liked the intersection, union and difference of two sets.
I liked the interactive part and explanation of the second lesson.
I liked the examples of the second lesson.
I liked the background of the second lesson.
I liked the example of the second lesson.
I liked only the interactive part of the second lesson.
I liked the examples of the second lesson.
I liked the examples of the second lesson.
The first lesson was more understandable than the second lesson. I don't like the second lesson.
I liked the exiting of the program in the second lesson.
I liked exiting in the second lesson.
I liked the union of two sets.
I like the colours of the second lesson.
I like the union of two sets in the second lesson.
Interactive part of the second lesson was better than the first lesson but the size of the buttons are small and not good.
I liked the interactive part of the second lesson.
The colours of pictures and examples of the second lessons were good.
I liked the previous page, main page and the letters of the program.
I liked the main page and previous page in the second lesson.
I liked the intersection and difference of two sets in the second lesson.
The second lesson had good examples than the first example.
The second lesson had good examples.
I liked the examples of the second lesson more than the first lesson.
I like the interactive part of the second lesson.
Examples of the second lesson are interesting.
In the second lesson I liked the examples.
The second lesson had good examples.
I like the examples of the second lesson.
In the second lesson, the example of sets and interactive part is better than the first lesson.
In general, the first lesson was better.
In the second lesson, exiting the program was better than the first lesson.
I like the second lesson for having the interactive part.
The size of letters in the second lesson was better than the second lesson.
I like the part of the second lesson that show the examples (interactive).
I like the examples of the second lesson.
Solving examples in the second lesson is better than the first lesson.
I like the interactive part of the second lesson.
I liked the second lesson more than the first lesson.
The background of second lesson was better than first lesson.
The examples of the second lesson was better than the first lesson.

Generally the second programme was better than the first programme.
I liked the examples of the second lesson.
The interactive part of the second lesson was better than the first lesson.
I liked the second lesson because the home page was good.
The second part of the second lesson was better than the first lesson.
The part of solving problems is better in the second lesson.
The second lesson will be better if it has a good design.
In the second lesson the colours and background were beautiful.
I liked the second part of the second lesson, which solves the problems of sets. (examples)
I liked the algebraic operation in the second lesson more than the first lesson.
I liked the second lesson for having the interactive part.
By the second lesson we can solve the examples of sets.
I liked the algebraic part of the second lesson.
I liked the examples of the second lesson.
Both of the lessons were useful and explanatory.
in the second lesson. The examples were better than in the first lesson.
The second lesson was similar to the first lesson but the difference was in the colours and icons.
in the second lesson the properties of sets was better than the first lesson.
The second lesson was better than the first lesson because of the interactive parts.
I liked the examples of the second lesson.
I liked the second lesson.
I liked colours of second lesson.
I liked the interactive part of the second lesson.
I liked all of the parts of both lessons.
I liked the examples of the second lesson.
I liked the examples of the second lesson.
I liked the examples of the second lesson.
I liked the interactive part of the second lesson.
The examples of the second lesson were more useful than the first lesson.
The examples of the second lesson were better than the first lesson.
I liked the interactive part of the second lesson that was very regular.
I liked the pictures and geometrical shapes in the second lesson.
I liked the geometrical shapes and Venn Diagrams in the second lesson.
I liked the examples of the second lesson that perform numerical operation.
I liked the examples of the second lesson.
I liked the buttons and the colours of them.
In the second lesson the examples was excellent.
I liked the examples of the second lesson.
In the second lesson the solving of problems is better than the first lesson. But the font size are to small.
I liked examples of second lesson.
I liked the examples of the second lesson.
I liked the colours of the second lesson more than first lesson.
I liked the second lesson in view of navigating through the lesson, it was very easy.
I liked the second part of the second lesson.
I liked the examples of the second lesson more than the first lesson.
I liked the colour of the first lesson and also the examples of it.
I liked the examples of the second lesson.

I don't like the colours and buttons of the second lesson. But I liked the examples of the second lesson.
I liked the sizes and buttons of the second lesson. But I didn't like the colour of the second lesson.
I like the examples of the second lesson.
I liked the examples of the second lesson. In the second lesson it will be better that the font colour must be green.
In the second lesson, the examples were very good.
I liked examples of the second lesson.
I liked the examples of the second lesson.
I like the colour of first lesson more than the second lesson.
I liked the examples of the second lesson.
I liked the examples of the second lesson more than the first lesson.
In the second lesson, the examples were very good.
I liked the examples of the second lesson.
I liked the examples of the second lesson more.
I liked the examples of the second lesson.
I liked both of them.
I liked the examples of the second lesson.
I liked the second lesson, it was very easy.
I like the interactive part of the second lesson that has.
I liked the examples of the second lesson.
In the second lesson, the examples were all useful for us.

Any other comments?
I know well that two lessons are best for our schools or students.
If add some other examples that will be good.
There will better that we create buttons small and the colours of them bright.
There will be better that Icons are large and the main page buttons are bigger.
The first lesson was much better than the second lesson.
If this method is added in our lessons it will be better for our learning.
I hope you pay more attention in the graphical part and also in the buttons and their colours.
These two interfaces are very user friendly and helpful for our schools and students.
These programmes are better for our learning.
I think these lessons are very good for us.
These lesson will be useful for improving our learning.
I think the first lesson is good but the second is better then the first lesson.
I liked the first lesson, it's more interesting than the second lesson.
I like this method become generalized, can be used in other subjects.
I think interactive part of the second lesson is better than the first lesson but exiting the first programme is better than the second.
I think examples shown must be animated and the background colour needs improvement.
These two lessons are good for us.
I liked both of the lessons.
I would like this method applied to all my other subjects.
I think both of the lessons were good but there wasn't any examples in the first lesson. This program will be useful for students.
. I would like the computer use to other subjects.

I like this method of learning to be applied to other subjects as well.
I like the black colour for the letters and the blue colour background.
I like to change the black colour to the blue colour.
I like the first lesson more than the second lesson.
I think the second lesson was better than the first lesson because it had interactive content.
Thank You for creating this program.
I think the colours and sizes of the letters and buttons must become better.
Thank you for creating this programs.
This programme is useful for our students and school.
Thank you for creating programme.
I would like this method applied in physics and chemistry subjects.
Both of the lessons are good.
If these examples added to first lesson, it would become very interesting. However if both are interesting but I like PowerPoint program presentation.
Thank You for creating this program.
There will be better that people learn computers.
It will be better to add a help button in the programme. And I want your attention in design of the programme.
Second lesson didn't have good buttons.
These lessons are good for us.
Thank you for creating usable programme.
If the second lesson changes, for example: the colour and buttons of the second lesson. It will be better.
The second lesson must have beautiful colours and the intersection, union and difference of sets.

There will be good if you create such a programme for other subjects.
Teaching subject is better on computers.
The font size of 12 is better for the letters.
In my view, such programmes must be expanded.
If the first lesson added more examples it will be better.
I don't have any special comments, thank you.
The first lesson will be better than the second lesson if added some examples in the first lesson.
Visual basic if a useful programme for students.
You created a very best software - thank you.
Teaching of subjects by computer in school would be better.
In my view, you have done good work for us.
If will be better that the background of the first lesson have white or grey colour.
Thank you very much for your kindness.
It will be better that the home page have a bright colour.
(NO COMMENT)
You must create programmes like these.
In my view, the second lesson must have good background and good colour for attraction.
(NO COMMENT)
Thank You for creating this program.
Both of the lessons were excellent.
It will be better that all of my subjects are taught on computers.
The heading must have another colour to understand. On the other hand, we must

have the list of subheadings.
The first lesson is better than second lesson. This programme is excellent and useful for Afghanistan future. I liked the buttons of the second lesson.
In my view, the other subjects must be done on computers.
You must continue this work in other schools. Thank you.
In my view, the continuation of this work in other school.
In my view, this programme must improve and in look as well.
I understood both lessons.
Both lessons were good.
(NO COMMENT)
All of the parts of the lessons were good. Thank you very much.
It will be better all of our subjects are taught my computer.
(NO COMMENT)
Both of the lessons were good in light of buttons and colours.
I liked the colour of the home page of the first lesson. I didn't like the colour of the second lesson because it was grey.
These programmes are very good for us, it will be better the other people create similar programmes too.
These programmes were useful and helpful.
The solving of problems by computers are useful to students, because it's more practical.
Thank you.
The first lesson was very useful and had beautiful colours and was understandable. But in the second lesson I prefer to change the shapes and pictures.
Both lessons were good for us.
(NO COMMENT)

It will be better that the first lesson have examples like the second lesson.
Thank you very much for creating good programme.
It will be better that mathematics examples be solved by computers.
I liked the first and second lesson thank you.
Thank you.
The first lesson was better than the second lesson, in view of buttons and background colour but it didn't have enough examples.
Thank you very much.
Thank you very much.
I like teaching the subjects by computer.
Thank you very much.
These lessons are very useful for us.
Thank you.
Thank you very much for creating good programme. You'll be successful.
We are learning too much from these to programme.
Thank you very much for the best programme.
Learning mathematics is better by computer.
In my view, the first lessons had a better colour scheme than the second lesson. But in the second lesson the examples were good.
In my view, the colours of the first lesson were much better than the second lesson.
In the second lesson, the examples were very good and I liked them.
Thank you very much for creating prog.
It will be better that in the second lesson that you change the colours and icons. Also in the second lesson you must add examples.

It will be better if in the first lesson you add examples and in the second lesson must be changed - the font and font size.
This program is very useful and helpful for us, thank you very much.
This program is very good for us.
These programmes are excellent for us.
These programmes are excellent for students.
I hope this manner will be used in other subjects.
This program was useful to our learning.
It will be better that you use better colours for the lessons.
I want this programme must teach in our schools.
I want in all our school this programme must be used.
In my view it will be better that the background of the first lesson have a bright colour.

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