Engineering Students at the Vaal University of Technology: Analysing Learning Style Preferences

C. van Aardt, North-West University (Vaal Triangle Campus), Vanderbijlpark, South Africa,
vanaardtc@vut.ac.za

R. Goede, North-West University (Potchestroom Campus), Potchefstroom, South Africa,
roelien.goede@nwu.ac.za

E. Taylor, North-West University (Potchestroom Campus), Potchefstroom, South Africa,
estelle.taylor@nwu.ac.za

J.H. Kroeze, North-West University (Vaal Triangle Campus), Vanderbijlpark, South Africa,
jan.kroeze@gmail.com

P.D. Pretorius, North-West University (Vaal Triangle Campus), Vanderbijlpark, South Africa,
philip.pretorius@nwu.ac.za

Abstract

What are the different learning style preferences of students at the Vaal University of Technology, and how is it possible to address all the learning styles simultaneously? Each individual has a distinctive preference towards combinations of certain learning styles. If the information received during an instruction session does not match the learner's preferred learning style, his/her cognitive ability to retain this information will not hold and will thus cause him/her to under-perform. An empirical assessment of the preferred learning styles of 102 undergraduate Network Systems III students from the Engineering Faculty at the Vaal University of Technology was done through a modified questionnaire of Felder and Soloman's Index of Learning Styles. This paper analyses the results of the questionnaire to determine the learning style preferences of students at the Vaal University of Technology and suggests ways to improve learning interactions.

Keywords

Learning styles, e-learning, comparative analysis, learning style index.

Introduction

Effective teaching means to deal with learner diversity when transferring new complicated information to students, who in turn interpret and evaluate this information in a manner that makes it possible for them to retain and communicate this information to others.

It is important that teachers need to know what the most preferred learning styles of students are in order to reach more students and give them the opportunity to learn more effectively.

The problem statement is discussed in the next section. The research objective is discussed thereafter with a literature study about learning and learners' success. The methodology used for this research is discussed after the literature study and the questionnaires are discussed and analysed by pointing out how findings in this research relate to similarities in the Index of Learning Styles (ILS) of Felder and Soloman with appropriate action that may be implemented to improve academic success. An overview of learning style preferences is given in the section on learning style preferences. The implications for teaching effectiveness are given and the last section concludes the paper with recommendations for further research.

Problem statement

The research was motivated by a concern over weaknesses in student learning and understanding of the specific module content in the engineering qualification. Students enrolled for the module Network Systems III at the Vaal University of Technology (VUT) seem to find it difficult to understand the principles of subnetting. Lecturers reported that most of the students who had failed the module had done poorly in the section about subnetting. Mismatches between teaching and learning styles may be reduced by introducing alternatives to traditional teaching styles. The main

mode of teaching at the Vaal University of Technology (VUT) is still very traditional, by lecturing in classes with printed study material.

Learning style preferences of the Network Systems III students at the Vaal University of Technology will be investigated as well as methods to address a wide variety of learning styles for the diverse learning style preferences of these learners. The research objective indicates how the investigation will be done.

Research objective

This article aims to investigate, firstly, the different learning style preferences of third-year VUT engineering students and, secondly, to look at possibilities to address as many learning styles as possible. An adapted version of the Index of Learning Styles (ILS) questionnaire of Felder and Solomon (Felder and Soloman, 2009:1) will be used. The ILS is based on a model of learning styles that Felder and Silverman developed in 1988 specifically for engineering students (Felder and Silverman, 2009:1). According to Felder and Spurlin (2005:109), the ILS model is a very reliable research instrument.

In order to understand the influence of learning and teaching styles on learners, a literature study will be done.

Literature study

Learner success is very important in any tertiary study programme, and Felder (2009:1) believes that student dropouts are the result of disparities between learning and teaching styles and students' inability to understand the method of tuition. Seymour and Hewitt (2000:26) agree with Felder, indicating that learners who are unsuccessful in the engineering study field and leave have the same conceptual abilities as the ones who remain in this field of study, although it may be argued that any justification for students to terminate their studies has to do with the failure to match learning and teaching styles. Kommers (2004:214) believes that there is a correlation between teaching and learning styles which may have a considerable effect on learning success.

Fry *et al.* (2003:79) describes learning as an active process in which many effective teaching methods can be used to give learners a diversity of different approaches to improve understanding. However, Sternberg (1999:17) argues that teachers often disregard the fact that students bring many different thinking and learning styles to the classroom.

It is essential to establish a good student-teacher relationship before trying to determine the learning style preferences of students. The authors Goh and Khine (2002:204) and Tauber and Mester (2007:7) describe a good student-teacher relationship as an essential factor to encourage a positive attitude towards learning.

The authors Hill and Howlett (2004:13) feel so strongly about learning styles and learning preferences that they say, "If a learning preference is not working for you, change it." Van Blerkom (2008:9), Rothwell (2008:93) and Greenhalgh (1994:235) agree with this opinion and state that academic success depends on the learning styles of students and the way in which information is presented to them.

Hativah (2000:56), during his research on learning styles, came to the conclusion that it is important to combine different learning styles to get an effective combination that will work for learners and teachers (Hativah, 2000:56).

A major advantage for lecturers is that they have the technology and mechanisms to address many learning styles at the same time through e-learning (Donnelly and McSweeney, 2008:112; Ryan and Cooper, 2008:72). The advantage of e-learning is that it enables the teacher to produce the same learning material in various learning style forms. E-learning enables students to choose the type of learning material with which they can identify (Holmes and Gardner, 2006:05).

Methodology

A literature study was undertaken on the most appropriate learning styles applicable to this particular tertiary environment and the best method to match teacher and learner styles. There are many different learning styles, such as the learning style inventory (LSI) of Dunn, the LSI of Kolb and the study process questionnaire (SPQ) of Biggs, to name only a few. Felder and Soloman (2009:1) took the research a bit further and developed the Index of Learning Styles questionnaire specifically for engineering students (Kalman, 2008:6).

For this study, an interpretive questionnaire similar to Felder and Soloman's Index of Learning Styles, was compiled and handed to the Networking Systems students (Felder, 2009:1). Although the questionnaire was related to Felder and Soloman's Index of Learning Styles, it was slightly adapted to make provision for closed and open-ended questions to address specific conditions at the VUT. The questionnaire enabled the researcher to collect both qualitative and quantitative data through closed and open-ended questions. The data was sorted per column and the frequencies calculated by using Microsoft Excel 2007.

The participants were 106 senior students enrolled for the module Network Systems III in the 2007 academic year at the Vaal University of Technology. The questionnaire was handed to the students enrolled for this module, and there was a 96% (102/106) return rate.

Quantitative answers were rounded off to two decimal places. The percentages (Appendix A, Table 1), calculated as a ratio of the varying student responses to the questions posed in the questionnaire to the total number of student responses received, were rounded off to two decimal places. In cases where more than one option was selected, the percentages differ from the normal ratio of calculation methods.

The answers obtained in the qualitative section of the questions (Appendix A, Table 2) were decoded, and the themes detected during the coding process are presented and discussed in the section on the analysis and discussion of the questionnaire results.

There were three types of questions. The type of question is indicated in the question heading. The three different types of questions are: 1) select one option (type one), 2) select one option with a comment (type two), and 3) select more that one option with a comment (type three).

Analysis of the data is presented in the next section.

Analysis and discussion of the questionnaire results

In this analysis and discussion, the sequence of the questions in the questionnaire is followed. The results are analysed and discussed in the context of the student percentages. Each question will be analysed individually; therefore, there may be contradictions with the analyses of some of the other questions. The main purpose of this study is to determine the most preferred learning styles. Contradictions between individual questions will not be discussed, as it is not part of this research.

Questions 1 to 6 and 10 to 24 have a quantitative approach, and questions 4 to 12 have a quantitative and qualitative approach. Questions 7 to 9 allow participants to select more than one option; therefore, their percentages will not add up to 100%.

During the discussions of the questionnaires, the quantitative section of the question will be discussed first and then the qualitative section.

All the questions will be analysed on a basis where the outcome will be related to the four learning style dimensions of Felder and Silverman's learning style model (Felder and Silverman, 2009:1). The first dimension determines active or reflective learning. The second dimension determines sensing or intuitive learning. The third dimension determines visual or verbal learning. The fourth and last dimension determines sequential or global learning.

Active learners need to interact with other learners to exchange knowledge, while reflective learners prefer a quiet learning environment and to process information on their own. Sensing learners prefer to learn facts, while intuitive learners prefer to learn theories. The difference between visual and verbal learners is obvious, but it is important to note that a written text is also seen as verbal learning. Sequential learners have to learn information in a clear order from beginning to end, while global learners have to see the bigger picture first and then the connections between the different parts in order to learn.

A brief discussion of the important e-learning guidelines is given for the result of each question to indicate possible ways to adapt e-learning material to various learning style combinations.

Number of students using a computer (Question 1 - type one)

According to Morley (2008:5), computers are an integral part of our lives. It is very clear from the results that most of the students (69.6%) were using computers. It can be assumed that when learning material is presented on a computer, it does not put additional restraints on the participants.

The fact that more than 98% of the participants used computers at least a few times per week is very important information. This may indicate that it could be feasible to incorporate e-learning material into the learning environment, and there is very good reason to believe that the participants will use it, since they prefer reflective learning styles.

Interaction with computers (Question 2 - type one)

A percentage of 72.5% of the participating students indicated that they were using computers to play games on. Only 9.8% of the participants indicated that they used their computers at least 5 hours or more on average per week to play games. A percentage of 17.9% of students indicated that they used their computers between 1 and 5 hours per week to play games.

Students are not permitted to play games on the computers in the student centre, although they might have if they had the opportunity to do so. It is also possible that only a small percentage of students own their own computers. The results to this question are somewhat different from what was expected. It indicates that only a small percentage of participants (27.4%) were used to the typical games-user interface and played computer games approximately 5 hours per week.

Data on movies watched on computer (Question 3 - type one)

A percentage of 54.9% of the participants indicated that they sometimes watched a movie on a computer, while a total of 90.2% of the participants watched at least one movie on a computer during their lifetime. This indicates that at least 90.2% of the participating students had already interacted with computers and may be familiar with the video-user interface, and that they might be ready to use computers for tuition as well.

Animation and sound in computer games (Question 4 - type two)

Although results of previous questions indicted that computers were not often used to play games or watch movies, it is indicated that 46.94% of the students liked the animation and sound of computer games, which is one of the qualities of visual learners. Computer games teach the player to interact with the computer in various ways.

From the three comments in this question, two of the participants could be categorised as reflective participants, as they prefer to interact with a computer on a one-to-one basis.

Type of lecturing method preferred (Question 5 - type two)

This question was asked with the purpose of determining whether or not the participants were receptive to e-learning. The majority of participants (74.23%) preferred normal lecturing classes and only 1.0% preferred other teaching methods. It is clear that 74.23% of the participants are auditory

learners as well as active learners, because they prefer to go to lecturing classes and like to participate in class discussions. It is worth mentioning here that none of the participants' other subjects or modules exposed them to e-learning material.

There were a total of five comments on question 5. The theme detected was that there was a definite preference to use a computer for self-study; therefore, they may be categorised as reflective learners.

Use of multimedia to improve learning skills (Question 6 - type two)

The results of this question are very important, because 85.15% of the students said that if the multimedia had been available to them, they would have used it. This high percentage is an indication of visual learning. Only 14.85% prefer a verbal learning style. There is a similarity between the qualitative and quantitative dimensions of the learning style index of Felder and Silverman's questionnaires when considering the quantitative and qualitative part of this question. Most of the participants indicated that they were active participants who preferred a visual and verbal style environment.

The comments in question six were analysed and the majority of participants (91%) indicated that they preferred a visual (56%), verbal (18%) and active (22%) learning approach, and indicated that they would make use of multimedia to improve their learning skills.

Preferred situation when receiving new information (Question 7 - type three)

Participants were allowed to choose more than one option. The majority (81.37%) indicated a preference to attend a lecture when receiving new information. It is assumed that they preferred lecturing because they had not had much experience with multimedia teaching. Thirty-eight percent (38.24%) of the students preferred to have the lecture on video and to watch it repeatedly. More than fifty-five percent (55.88%) of the participants preferred to study a textbook when receiving new information. There is a strong indication that participants preferred variation in learning when learning new concepts, although attending a lecture was still their dominant learning style preference.

Participants made twenty-one (21) comments to question 7. Most of the participants' comments indicate that they prefer an active learning style (44%), while only 35% indicate that they prefer a visual learning style.

From the analysis, an interesting challenge arose in that students like to interact with others when receiving new information. In an e-learning environment, this challenge can be met with chat groups on a web interface.

How to react when confronted with new information (Question 8 - type three)

Participants were allowed to choose more than one option. Although 55.88% of the participants wanted to discuss new information in class, 58.82% of the participants preferred to look at pictures and read more about the topic.

The comments were analysed, and most of the participants (80%) indicated that they preferred an active learning style.

Best method of learning (Question 9 - type three)

Participants were allowed to choose more than one option. Most of the participants (70.59%) indicated that they learnt best by doing many exercises, while the second most (61.77%) said that they preferred to read their textbooks over and over. Felder and Silverman's reflective learning style surfaces very clearly here in that 66.18% of the participants indicated that they preferred to process information on their own, either by reading the textbook repeatedly or by doing many exercises.

The comments of twelve participants were used to categorise them as active (39%), reflective (42%), verbal (14%) and 5% visual learners. Most of the participants indicated that they liked to learn by

doing many exercises and participating in discussions. This indicates that they are reflective and active learners who prefer to work on their own most of the time and sometimes go to a class.

Reaction during active class sessions (Question 10 - type two)

More than half of the students (88.37%) chose to take part in class activities, while 2.33% found active class activities boring. This question indicates that the participants prefer synchronous learning. They are active learners as well as visual/verbal learners, which is a combination of two dimensions of Felder and Soloman's Index of Learning Styles.

The qualitative section of this question indicates that 45% preferred an active learning style. The other 36% indicated that they preferred a verbal learning style.

Preferred method of study (Question 11 - type two)

Two participants did not complete this question. Twelve participants selected more than one option, and these were rendered void. Most of the participants (59.1%) start from the beginning and work through the textbook. Only 3.4% of the participants do not study - they only listen to the lecture. Many of the participants preferred a sequential learning style that allowed them to start from the beginning and continue to the end, which is a dimension of Felder and Soloman's Index of Learning Styles. Learners who study in sequence can be addressed easily through e-learning material.

The number of comments in this question is too small to make an assumption about the outcome. However, it is clear that the participants were equally eager to use both an active and reflective learning style when they studied.

Improve current marks (Question 12 - type two)

All the participants completed the question, but three selected more than one option; thus, these were rendered void. Most of the students chose a reflective learning style (70.7%), and agreed that in order to improve their marks they needed to find more effective study methods. The majority of participants indicated that the traditional way of learning was no longer sufficient, and in order to improve their current marks, they needed to apply a multidimensional collaborative learning process.

The comments of the participants in this question make it very clear that the preferred learning styles of the participants are reflective (75%) and active (25%). This is very much in line with e-learning material, because it allows the participants to study individually at their own place and at their own pace.

Other methods of learning (Question 13 - type one)

All the participants completed the question, but ten selected more than the permitted number of options and were rendered void. While 38% of students would rather use video recordings if they were available, 28.3% of the students preferred to use multimedia aids on a computer if they were available. There were 33.7% of the participants who preferred a verbal learning style while a total of 66.3% preferred a visual learning style. Written text, according to Felder and Soloman, is also considered to be verbal. As indicated by the lecturers, students were not yet familiar with a choice of various multimedia methods in their immediate subject surroundings.

Effective ways of understanding (Question 14 - type one)

All the participants answered the question, but eleven selected more than the permitted number of options and were rendered void. There were 70.31% of the students who indicated that they understood something more effectively when they did it on their own. Only 6.59% of the students drew pictures about the topic in order to understand it. Most of the participants preferred a reflective learning style, which is part of the first dimension of Felder and Soloman's learning style index.

Ways of recalling previous information (Question 15 - type one)

All the participants answered the question, but three selected more than one option, and these were rendered void. Only 6.59% of the students drew pictures about the topic in order to understand it. Most of the students (76.8%) indicated that they recalled what they had learned the previous day by visualizing it as a picture. Only 23.2% remembered the words during an explanation. There was a strong preference (76.8%) for visual learning when participants recalled what they had done the previous day. Visualisation is a very strong concept that is reflected in answers to this question, which is an indication that multimedia might be viewed as a favourite learning instrument.

Methods used to understand new information (Question 16 - type one)

All the participants answered the question and there were no void answers. Most of the students (53.92%) tended to understand the overall structure, but were concerned about the finer parts of the learning material. On the other hand, approximately 46.08% of the students understood the details of a subject, but they were concerned about the bigger picture. The participants indicated their preference for a global learning style in this question. The global learning style of participants can be addressed easily through multimedia concepts in e-learning material.

Methods of receiving new information (Question 17 - type one)

All the participants answered the question, but there were four void answers because participants selected more than one option. Many of the participants (63.26%) indicated that they preferred verbal explanations when they learnt new information. Only 36.74% liked to see pictures, diagrams, graphs or maps when they learnt new concepts. Most participants preferred a verbal approach to learning. Written texts are also considered to be a verbal learning style, and a multimedia approach for e-learning material makes it easy to include written texts with sound and pictures.

Effective ways of remembering new information (Question 18 - type one)

All the participants answered the question, but one participant selected more than one option, and that answer was rendered void. There is only a 1% difference between the preferences for learning material. Although the global learning style has a 1% advantage over sequential learning, it is clear that the material developed should cater for both styles. The global learning approach can be implemented by using a picture that shows the whole layout of the study material. Smaller pictures of the whole can be applied to explain smaller parts of the section. Multimedia and the computer are perfectly positioned to indicate parts individually or globally, to allow the participant to enjoy any of these approaches as a preferred learning style.

Choosing between pictures and charts (Question 19 - type one)

All the participants answered the question, but one selected more than one option, and this answer was rendered void. When the information of this question was analysed, it was found that 56.44% of the participants preferred to look at pictures and charts rather than focus on the written text. The results of question 17 were about the learning of new information, while question 19 specifically addresses the feelings of the participant when looking at pictures and charts. Most of the participants preferred visual learning, but the percentage difference between visual learning and verbal learning is only 13%. Therefore, the needs of both learning styles should be satisfied.

Receiving information from teachers (Question 20 - type one)

All the participants answered the question, but three selected more than one option, and these answers were rendered void. The majority of participants (74.7%) indicated that they preferred a lecturer who explained the topic thoroughly before moving on to the next topic. Only 25.3% preferred diagrams, which is an indication that the participants preferred a verbal learning style rather than a visual learning style.

Steps when doing homework (Question 21 - type one)

All the participants answered this question, so there were no void answers. The response to this question relates to a dimension of the learning styles model of Felder and Silverman not addressed by the rest of this questionnaire. This dimension describes how students react to given material. Some students will react more intuitively, while others would react more sensitively. It is not clear at this stage how the structure of the material will be influenced by this dimension.

It is not easy to address the sensing/intuition learning style dimension in an e-learning environment. The most appropriate option was to give the student the opportunity of selecting the e-learning material most preferable and acceptable to him or her. However, in this blended e-learning environment, it will be possible to address the dimension in the traditional lecturing environment. The response to this question should be brought under the attention of the lecturers.

The majority of participants (88.24%) preferred to understand a problem first before they started doing their homework, while only about 11.76% started doing their homework immediately, even before they really understand the problem. These results indicate a preference for a sensing learning style.

From the analysis of this question it is clear that the specific context of new topics should be carefully discussed. Students need to understand the necessity of the new topic in terms of problems addressed by the new material before studying the detail of such material.

Methods of instruction (Question 22 - type one)

All the participants answered the question, but two selected more than one option and were considered void answers. There is not much difference between the two sets of data. It is clear that 51% of the students were more practical and wished that the instructor would use methods to relate the learning material to things that they were more familiar with rather than explain the material from beginning to end (49%). The difference between the two selections is too small to make a clear decision, and both should be catered for.

Recalling information from a diagram or sketch (Question 23 - type one)

All the participants answered the question, but two participants selected more than one answer, and their answers were rendered void.

Once again the response to this question should be understood within the relevant context. From the overwhelming response, it is clear that all new material should be associated with lectures, and as written text also addresses the verbal style, care should be taken to provide enough written explanations on the e-learning material.

A total of 78% of the participants indicated that they would remember what the instructor had said about the lesson when they had studied pictures or diagrams used in previous lectures in class. An overwhelming number of participants selected a verbal learning style and preferred to have synchronous learning. E-learning material should have good explanations aiding the diagrams given.

Different ways of entertainment (Question 24 - type one)

All the participants answered the questions, but four selected more than one option, and their answers were rendered void. There were 69.39% of the participants who preferred to watch television for entertainment. Only 30.61% indicated that they would read a book rather than watch television. This is encouraging, because it shows that the participants enjoyed the multiple-sense stimulation of a television rather than the visually limited presentation of a book.

Learning style preferences will be discussed in the next section with specific references to the outcome of the analysis of the questions in the questionnaire.

Learning style preferences

There is a growing realisation that learning style awareness contributes to the effectiveness of learning and teaching. This investigation gave a clear indication of the new trend in teaching styles of lecturers in engineering at the VUT to help meet the learning needs of students.

The information in Table 1 is a summary of the findings from the analysis of the learning style preferences that were structured according to the guidelines of Felder and Soloman's Index of Learning Styles. The analysis of the preferred learning styles was done as follow:

The percentages of each question were grouped into three categories, namely a low percentage of less than 20%, a moderate percentage and a high percentage. A factor of 0.2, 0.5 or 1 was allocated to each percentage, with 1 being the factor for the highest percentage and 0.5 for the moderate percentage. All the values were added together and the percentage for each learning style was calculated. This was done for the qualitative and quantitative sections of each question.

The quantitative and qualitative results appear in the respective columns as indicated in Table 1. The learning style with the highest percentage is the most preferred learning style and the one with the lowest percentage the least preferred learning style.

Table 1: Learning Style Preferences

Styles	Quantitative results	Qualitative results	Average percentage	Percentage	Importance
Visual	30%	13.3%	21.7%	21.7%	3
Active	13%	38.5%	25.8%	25.8%	2
Reflective	15%	37.8%	26.5%	26.5%	1
Verbal	16%	9.1%	12.6%	12.6%	4
Global	9%	0.0%		9.0%	5
Sequential	11%	1.4%	6.1%	6.1%	6
Sensing	5%	0.0%		5.0%	7
Intuitive	1%	0.0%		1.0%	8

The reflective learning style was indicated as the most preferred learning style, which can be traced to their previous traditional learning experiences. The second most preferred learning style is an active learning style, which indicates that students prefer to study in a lecture room situation and interact with others.

The information obtained from this research is very positive in that it shows that a reflective learning style is very high on the list of most preferred learning styles, which means that students will be receptive to e-learning material.

Visual learning is the third most preferred style and is mostly satisfied with lectures, pictures, graphs and many more. The verbal learning style is also associated with written texts and is very much in line with the more preferred learning style (reflective), because text material can also be studied on their own at home. There is a strong similarity between global and sequential learning in the sense that students want to see the bigger picture before they begin to study the information in clear sequential steps.

The implications of the outcome of the learning style analysis are discussed in the next section.

Implications for teaching effectiveness

The results obtained from analysing the questionnaires will be applied when compiling future learning material for students.

The next section discusses the outcome of the questionnaire analysis and makes recommendations for future research on this topic.

Conclusion and recommendations

The learning style preferences of the Networks Systems III students at the VUT were identified using the ILS of Felder and Soloman as a guideline. Learning styles are important but have to be implemented in collaboration with teachers who will support this approach to satisfy a large percentage of learning style preferences.

The analyses of both the quantitative and qualitative questions clearly indicate that the participants preferred a variety of learning style combinations. One of the most prominent e-learning guidelines, as indicated in the e-learning guideline column in Tables 1 and 2, was multimedia technology. Multimedia technology enables the teacher to address multiple learning styles at the same time in many different ways. In this study, it will be used specifically via the Internet and in collaboration with lecturers to help learners with immediate problems. The e-learning material should be structured and presented in the same sequence as the lecture. Times have changed and teachers must discover students' existing conceptions and interests to design effective methods of instruction (Weimer, 2002:11).

Multimedia technology, combined with traditional learning methods, is seen as blended learning where the lecturer gives the presentation and the participant has the option to collect additional information and refresh his/her memory through the multimedia presentations of e-learning material on the Internet. All the prominent learning styles that surfaced through the analyses of all the questions in the questionnaires can be accommodated in a blended e-learning environment.

In order to use multimedia technology for study purposes, it has to be visual and the participant has to interact with the study material in order to cater for active learning style preferences. Therefore, the learning material will have to be comprised of text with links to pictures, videos, voice recordings, text examples, discussion forums and e-mail facilities. The participant must be enabled to work sequentially through learning material and also have the opportunity to look at the bigger picture to see how the whole fits together and then work through the smaller parts.

The data obtained from this analysis will assist lecturers in the planning and designing of more effective learning material which, in turn, may improve the academic success of students. There is a strong probability that the results of this research will have an affect on learning material for future use.

Future research that might arise from this study:

- Consider the effect of other possible determinants of learning style preferences, such as the effect of educational background and learning abilities on learning success.
- Concentrate on ways to narrow down the variety of styles by using more effective combinations to refine the learning material and to implement the findings of this research in other modules.
- Implement the findings of this research in the Network Systems III module by using e-learning material and evaluating the learning efficiency and effectiveness of the system.

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Appendix A

Table 1: Questionnaire Analysis

Question	Answer n = 102	Relate to Felder	E-learning guidelines
Question 1			
How often do you use a computer?			
Daily	69.60%	Reflective	Important to have a typical look and feel interface
Few times per week	28.40%	Reflective	
Sometimes	2.00%	Non specific	
Never	0.00%	Non specific	None
Question 2			
How often do you play computer games?			
Never	27.50%	Non specific	None
Less than 4 hours per month on average	45.10%	Non specific	
Between 1 and 5 hours per week on average	17.60%	Non specific	One could base material on a typical games interface
More than 5 hours per week on average	9.80%	Non specific	
Question 3			
How often do you watch a movie on your computer?			
More than once per week	15.70%	Visual	Include movies, video's
Once per week	19.60%	Visual	
Sometimes	54.90%	Non specific	
Never	9.80%	Non specific	None
Question 4			
Do you like animation and sound in computer games?			
I don't play games	26.57%	Non specific	Non specific
Enjoy it very much	46.94%	Visual	Include animation and sound
Never notice it	19.39%	Non specific	Draw specific attention to important aspects of information
Other	7.10%	Non specific	Non specific
Question 5			
What type of lecturing method do you prefer?			
Going to normal lecturing classes	74.23%	Active	Material should be associable to lectures
Use a computer with sound and video to learn new concepts	20.64%	Visual	Include sound and video to e-material
Doing self-study	4.13%	Reflective	e-material should be very comprehensive and detailed
Other	1.00%	Non specific	None

Question	Answer n = 102	Relate to Felder	E-learning guidelines
Question 6			
If available would you make use of multimedia to improve your skills?			
Yes	85.15%	Visual	E-material should contain voice, animation and video
No	14.85%	Verbal	E-learning material should be associable with lectures
Question 7			
Which of the following situations do you prefer when receiving new information? (may select more than one option)			
Attending a lecture	81.37%	Active	E-material must be associable with lectures
Studying a text book	55.88%	Reflective	Material should be comprehensive and detailed
Watching a video over and over	38.24%	Sequential	Material should allow multiple sessions
Question 8			
What do you do to understand difficult and new information? (may select more than one option)			
Use your imagination to form images in your mind	43.14%	Visual	E-material should contain graphs and pictures
Look at pictures and read more about the topic	58.82%	Visual	Include pictures or diagrams with text
Discuss the topic in class	55.88%	Active	Provide links to interact with pages
Question 9			
I learn best by: (may select more than one option)			
Reading my textbook over and over	61.77%	Reflective	Include text material on screen
Doing lots of exercises	70.59%	Reflective	Include on screen exercises
Asking other people to re-explain the work	55.88%	Active	Include e-mail connectivity
Question 10			
How do you react during an active class session?			
Take part in class activities	60.47%	Active	Include variation of screens with interaction
Look and listen at class activities	27.90%	Active	Include variation of screens and audio
Read through your text book	9.30%	Reflective	Include on screen text
I am generally bored	2.33%	Non specific	None
Other	0.00%	Non specific	
Question 11			
How do you prefer to study?			
Start from the beginning and work through the text book	59.10%	Sequential	Explain information in steps
Learn the most difficult parts first and then the easier parts	18.20%	Sequential	Allow selection of different pages
Learn the easier parts first and then the difficult parts	19.30%	Sequential	Allow selection of parts
Don't study at home, just listen in class	3.40%	Active	Include video and audio text
Other		Non specific	None

Question	Answer n = 102	Relate to Felder	E-learning guidelines
Question 12			
How would you improve your current marks?			
By using current methods more effectively	27.30%	Sensing	Material should be associable to lectures
To try and find new more effective methods to study	70.70%	Reflective	Introduce effective text explanations
Other methods	2.00%	Non specific	None
Question 13			
Which of the following would you use if they were available?			Include video and voice and all other forms of multimedia
Using multimedia aids on a computer	28.30%	Visual	
Listening and looking at video recordings	38.00%	Visual	Include video and voice
Collecting additional textual information	33.70%	Verbal	
Question 14			
I understand something more effectively when I:			E-material should be comprehensive and detailed
Do it myself	70.31%	Reflective	
Think about it before I do it	23.10%	Reflective	Allow time to think about solutions
Draw pictures about the topic	6.59%	Visual	Include pictures and diagrams
Question 15			
When I think about what I did yesterday, I am most likely to get			
A picture	76.80%	Visual	Include video, pictures and diagrams
Words	23.20%	Verbal	Include on screen text
Question 16			
I tend to:			
Understand details of a subject but may be fuzzy about its overall structure	46.08%	Global	Include sections of material that show smaller parts of the e-learning material
Understand the overall structure but may be fuzzy about details	53.92%	Global	Include a picture or diagram that gives an overall impression of the entirety
Question 17			
I prefer to get new information in:			Include multimedia, pictures and animation
Pictures, diagrams, graphs or maps	36.74%	Visual	
Written directions or verbal information	63.26%	Verbal	Include voice and text
Question 18			
Once I understand			
All the parts, I understand the whole thing	49.50%	Sequential	Include smaller parts of section in sequential order
The whole thing, I see how the parts fit	50.50%	Global	Include an overview of the whole in text or picture
Question 19			
In a book with lost of pictures and charts, I am likely to:			
Look over the pictures and charts carefully	56.44%	Visual	Include pictures and charts
Focus on the written text	43.56%	Verbal	Include text screens

Question	Answer n = 102	Relate to Felder	E-learning guidelines
Question 20			
I like teachers			
Who put a lot of diagrams on the board	25.30%	Visual	Include video and pictures
Who spend a lot of time explaining	74.70%	Verbal	Material should be associable to lectures
Question 21			
When I start a homework problem, I am more likely to:			
Start working on the solution immediately	11.76%	Intuition	Include the option to select certain learning material
Try to fully understand the problem first	88.24%	Sensing	Include select of text pages
Question 22			
It is more important to me than an instructor.			
Lay out the material in clear sequential steps	49%	Sequential	Allow sequential selection of learning material
Give me an overall picture and relate the material to other subjects	51%	Global	Include diagram or picture to explain the whole of the section
Question 23			
When I see a diagram or sketch in class, I am most likely to remember.			
The picture	22%	Visual	Include pictures, diagrams and video
What the instructor said about it	78%	Verbal	Material should be associable to lectures
Question 24			
For entertainment, I would rather:			
Watch television	69.39%	Visual	Include pictures, video
Read a book	30.61%	Verbal	E-material should be comprehensive and detailed

Table 2: Open-ended Question Results

Themes detected	Relate to Felder	Percentage	Guideline for e-learning
Question 4b			
Do you like animation and sound in computer games?			
Don't like animation and sound in computer games			
None	Non specific	50%	None
None			
Sometimes if cool (1) Sometimes enjoy sound (1)	Reflective	50%	Include functional sound clips
Question 5b **What type of lecturing method do you prefer?**			Make e-learning material available through the internet
Use computer for self study	Reflective	100%	
Question 6b			
If available would you make use of multi media to improve your learning skills?			
Listen to lecture in class (4)	Verbal	18%	Include voice recordings
Other class activities (5)	Active	22%	Include interactive activities
Prefer looking at text and pictures (13)	Visual	56%	Include Multimedia and text
Disturb concentration (1)	Non specific	4%	None
Question 7b			
Which of the following situations do you prefer when receiving new information?			Material should be associable with lectures, be comprehensive and detailed, include audio recordings of material with pictures and graphs and linked to other pages
Read textbook (5)	Verbal	11%	
Interaction in class (18)	Active	44%	
Use text for self study (4)	Reflective	10%	
Look at pictures, read attend lectures (14)	Visual	35%	
Question 8b			
What do you do to understand difficult and new information?			
Write and read text material (2)	Verbal	8%	Include readable text on screen Include interactive multimedia pages, e-mail communication and user forums accessible through internet
Discuss work with friends in class (21)	Active	80%	
Self study and work through problems at home, interact with others (3)	Reflective	12%	Access e-material and user forums through the internet

Themes detected	Relate to Felder	Percentage	Guideline for e-learning
Question 9b			
I learn best by:			
Compare answers (3)	Verbal	14%	Include e-mail and discussion forums
Interaction through communication with others in group relationship (8)	Active	39%	Include e-mail, discussion forums Combine class and internet actions
Do many exercises (10)	Reflective	42%	Include multimedia, visual text pages and on screen exercises to work independently at home
Do exercises and read (1)	Visual	5%	Update e-material constantly Include e-learning material
Question 10b			
How do you react during an active class session?			
Take notes, do exercises and do examples (4)	Verbal	36%	Make interactive text screens and exercises available through internet
Participate if understand (5)	Active	45%	Include interactive screens
Listen to explanations and record valuable information (2)	Visual	18%	Include text, video clips and animation
None	Non specific	1%	None
Question 11b			
How do prefer to study?			
Interact with students and text (2)	Active	28.58%	Include multimedia, text in sequence and hyperlinks to other pages and e-mails
Study on own (2)	Reflective	28.58%	Include readable text on screen
Study recent work first (1)	Sequential	14.29%	Include sequential text on screen
Non specific(2)	None	28.58%	None
Question 12b			
How would you improve your current marks?			
Interaction with other students (2)	Active	25%	Include multimedia, text with hyperlinks, e-mail and discussion forums Allow login through internet with text pages on screen
Self study more attractive (6)	Reflective	75%	E-material should be very comprehensive and detailed