
A Study Of Individual Learning Styles And Educational Multimedia Preferences

An Experiment using Self-Directed Online Learning Resources

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Abstract

This paper details an experimental investigation into relationships between Individual Learning Styles and Online Multimedia learning resources. The specific conditions of the experiment placed the online educational multimedia into an online learning environment called WebCT. The experiment's sample group used the online resource in a self-directed and self-paced way. Learning styles were identified using a VARK questionnaire and an Index of Learning Styles (ILS) questionnaire.

The methods used for the process-included design, production and sourcing of suitable course material, which was then integrated into the WebCT structure. Data was collected pre and post treatment utilising online and paper questionnaires, performance assessment tests and WebCT system logs. The software application Statistical Analysis for Social Sciences (SPSS) was used to log, transform and analyse the qualitative data.

Analysis of the data determined that students will prefer learning with some types of online multimedia better than others, depending on their individual learning style as identified by the VARK questionnaire but not the ILS questionnaire. These probabilities were tested to a significance level of 95%.

One: Research Hypotheses

This research project is aimed at testing the following two hypotheses:

Firstly,

Students will prefer learning with some types of online multimedia better than others, depending on their individual learning style.

This hypothesis is of interest, as its acceptance would provide an invaluable reference for lecturers in the Institute when designing web-based learning support resources for their apprentice students. The multimedia for a given subject could be designed in a variety of formats which the students could use the format of their own preference.

Secondly,

Group performance scores on abstract concept tests will have a smaller variance when these concepts are learned with self-direction via online learning support resources.

The acceptance of this hypothesis may indicate that if all the learners in a given group are enabled to review subject focused material in their own time and at their own pace, in addition to normal timetabled lectures then, the performance gap between those whose learning benefits greatly from traditional lectures and those who do not, would decrease. This would give grounds for lecturers to encourage student self-directed learning through web-based learning support resources, which are specifically designed and developed for abstract conceptual comprehension.

Two: Definition of Context

2.1 Apprentice Students

The Irish Electrical Apprenticeship is a Standards Based Apprenticeship. Each learner must achieve a given standard of competence on completion of each phase to continue to the next. There are seven phases to be completed in sequence. Only when an Apprentice has achieved the required competency level for all phases s/he is awarded with a National Craft Certificate. (<http://www.fas.ie> 2002).

Apprentice Electricians attend the Institute for two of the seven Phases (4 and 6) as short courses during their National Apprenticeship Program. Each of these courses is of 11-weeks duration. This research project considers the first of these courses, which is called Phase 4. High attendance at such an

intensely timetabled course leaves students little time for extra self-directed learning of the course subjects.

2.2 Self Directed Learning

However, Kearney (1997) points out that it takes time for students to get used to learning via technology, and until they overcome the preliminary trepidations that come with using unfamiliar technologies learning is likely to be somewhat inhibited; students must embrace the idea of playing an active role in learning rather than assuming the role of a passive recipient of information. Learning how to use the technology as well as learning with the technology is a challenge for many students (Bennet, 1999).

2.3 Multimedia

Computer delivered multimedia can utilise various combinations of several communication formats including text, video, audio, images, graphics and animation. These individual forms of media can be produced using a huge variety of software applications, which are readily available today .

To combine multimedia elements in one framework specialist authoring tools such as Flash, Director and Hyperstudio can be used. These authoring software applications typically include the ability to create, edit and import specific types of data and provide a structured method or language for responding to user input (Vaughan, 1998).

Three: Individual Learning Styles

Learning styles specifically deal with characteristic styles of learning, that is, how one learns. Kirby (1979) explains that cognitive style is a natural ability over which we have no influence whereas learning style is preference, which develop and change over time. This idea supports the concept that a persons learning style is affected by individual traits such as personality, cognitive styles, temperaments, sensory processes and age (Kolb, 1984; Kiersey, 2000; Fleming, 2001; Honey, 2002).

There are many interpretations and definitions of Learning styles. The definition offered by Della-Dora and Blanchard (1979, p22) of “a personally preferred way of dealing with information and experiences for learning that crosses content areas” puts emphasis on information processing. While the definition,“ the students consistent way of responding and using stimuli in the context of learning” stated by Claxton and Rolston (1978, p1) is focused more on the sensory perception.

3.1 Learning Style Perspectives

A number of perspectives have been taken by researchers in an effort to identify, analyse and label a person's learning style. Categorising the plethora of learning style models into groups helps one to understand the main differences in approaches to identifying individual learning styles. Claxton and Murrell (1987) offer four categories, which arrange learning style models from those focusing on external conditions to those based on personality theory. These four groups are:

(i) Instructional and Environmental Preference

This approach is to categorise learning style from a perspective that considers one's preferences in terms of *Sensory Perception* (auditory, aural, visual, tactile etc). Dunn and Dunn (1981), Fleming (1987), and Celli Sarasin (1999) also advocate the usefulness of this approach to learning style identification.

(ii) Social Interaction

According to Swanson (1995), Reichmann references learning styles "as a particular set of behaviours and attitudes related to the learning context". These include a learner's epistemic attitude as well as social and environmental attitudes.

(iii) Information Processing

Kolb (1984) considers *Physiological* traits as being the decider of individuality in learning styles. Honey and Mumford (1986), McCarthy (1990) and Felder (1993) support Kolb's theories with their own diversifications and all categorise learners in a four-quadrant model.

Yet another model is the idea of *Multiple Intelligence* pronounced by Gardner as a natural or trained level of talents and abilities. Gregoric Mind Styles (1985) also fits into this general category.

(iv) Personality Levels

Myers and Briggs (1956) advocate consideration of the *Psychological* types of people and their resultant cognitive processing. Building on this Kiersey (1978), concludes that personality traits mean that *Temperament* is a deciding factor.

Two of these four groups are of particular interest in the context of this project. Firstly, the *Instructional Preferences* approach directly facilitates efforts to identify the students' perception of multimedia as sensory stimuli. Secondly, the *Information Processing* approach allows a more complex identification of the students preferred use of the multimedia within the online learning environment.

3.2 Learning Style Models

There is a vast catalogue of Learning Style Models even each main perspectives category. Identifying ones learning style is not an easy task as scholars and researchers have concentrated their works on a very broad range of factors and personal characteristics, which they believe affects a person's ability to learn.

“ Learning style contains many elements, and they are not usually ‘either-or’ extremes”, (Kirby 1979). As a result of this, many learning style models offer identification options as combinations of traits, strongest trait or Multimodal learning styles. Most also offer suggestions for learning and study strategies based on identified preferences. Kolb (1984) concedes, “individual styles of learning are complex and not easily reducible into simple topologies – a point to bear in mind as we attempt to describe general patterns of individuality in learning”. The following two Learning Style Models were used in this research.

3.2.1 Instructional and Environmental Preference Models

These models are based on a person’s preference for particular external events to stimulate their senses to help them learn.

Neil Fleming: VARK- Visual, Aural, Read/Write and Kinesthetic

Fleming (1987) developed this model and complimentary identification instrument. It classifies learners by their preferred mode of interaction with others based on input stimulus and output performance. This model facilitates Multimodal-learning styles for those learners with more than one preference. Fleming accompanies the model with Study Strategies for each style and for Multimodal combinations.

VARK divides Learning Styles into four main categories:

- (i) **Visual** – pictures, diagrams, video, animation, flowcharts, colours, symbols, lecturers gestures and graphs.
- (ii) **Aural** – lecturers voices, discussions, verbal explanations, tape recordings, stories and jokes, recall to other people.
- (iii) **Read/Write** – lists, headings, dictionaries, glossaries, textbooks, and lecture notes.
- (iv) **Kinesthetic** – real experiences, concrete examples, case studies, field trips, laboratory experiments.

3.2.2 Information Processing Models

This category contains a vast array of models most of which have their academic bases in cognitive style theories (Claxton and Murrell, 1987).

Richard M. Felder and Silverman: Index of Learning Styles

Felder and Silverman have synthesized findings from a number of studies to formulate a learning style model with dimensions that should be particularly relevant to science education (Felder, 1993).

This model uses eight types of Learning Style on four scales:

- (i) **Active & Reflective** Learners. – Active → doing. Reflective → thinking.
- (ii) **Sensing & Intuitive** Learners. Sensing → learning facts. Intuitive → discovering (possibilities and relationships).
- (iii) **Visual and Verbal** Learners. Visual → pictures etc. Verb → words (spoken or written)

- (iv) **Sequential & Global Learners.** Sequential → logical steps to solution. Global → big picture, novel approaches.

The dichotomous learning style dimensions of this model are continua and not either/or categories. With this model an individual can be identified as having four to eight learning style preferences

Four: Research Process

4.1 Overview Of Research Methods

A self-controlled method of experimentation was used with the sample group. Thirty-one students formed a non-random sample of the Phase 4 Electrical Apprentice population of 87 students in the third level educational Institute. Each student's Learning Style was identified using two online Learning Style Inventories. The author designed, managed and administered an Electrical Science course in the WebCT online learning environment, to which participants had access in addition to their normal lectures. Pre-treatment and post-treatment tests were administered. The data collected was mostly quantitative with some qualitative data also gathered during the process. Participants were each given a code to use on all their experimental work to ensure their anonymity and the integrity of the data logging process. The presentation and analysis of the data collected is undertaken in the next chapter.

4.2 Design

4.2.1 Self-Controls

Self-controlled survey design was used in this study. This design involves having just one sample group. Each participant in the group is subject to the same treatments and data collection techniques. This design is appropriate for this research study because it allows a group to serve as its own comparison and can provide data on change within the group (Fink, 1995). In this study the participants' responsiveness to a computer based multimedia approach to learning was compared to the same participants' identified individual learning style. In addition, self-control design also supports the comparison of pre-treatment and post-treatment performance measures of the participants, facilitating analysis of the learning benefits of the treatment.

4.2.2 Selection of Participants

The participants for this study were statistically not randomly selected. A quasi-experimental design was used as it best facilitated the logistics and constraints of the class timetables. In this circumstance it was most practical to use two intact classes. The classes were not pre-existing before the trials

started and were formed through the department's administration process of working from the top of the enrolment lists at the beginning of the course. This means that membership bias was not a factor effecting the study results.

4.2.3 The Sample Group

The convenience sample consisted of two classes, one with 16 students and the other with 15 students. Both classes were taught Electrical Science for 2 hours by the same lecturer. This lecturer (not the Author) used the same teaching methods and worked at a similar pace with both classes.

This sample of 31 students consisted of all male Apprentice Electricians, as there were no females enrolled on the course. The complete sample was treated as a self-controlled group with non-random assignment and all were exposed to the exact same experimental treatments.

4.3 Data Collection

4.3.1 Qualitative Data

A variety of methods and instruments were utilised to obtain relevant qualitative data. This data was collected using a variety of online and paper questionnaires and surveys.

The online instruments used were:

- Two Learning Style Inventory Questionnaires
- WebCT System Log Files

The 'pencil and paper' instruments used were:

- Computer Usage Questionnaire
- Performance Measure Tests
- Attitude Survey

4.3.2 Pilot Tests

Pilot tests were carried out during the development stages of the survey. A small number of non-sample group students completed the instruments before they were administered to the actual sample group. During these tests errors and ambiguities were found and rectified. The times taken to complete the instruments were also noted from the pilot tests. This aided in the logistical planning for the administration of each instrument.

4.3.3 Validity

Fink (1995) states about a research instrument "a valid one is accurate". Internal and external validity were considered factors of this research process. Internal validity of a survey design relates to how well a survey measures what it intended to measure. External validity of a design means that the results can be applied to the target population. Although extensive validity was not undertaken for this project design, Arlene Fink's "Internal Validity: Checklist of Risks to Avoid" (1995) was used as a guideline for validity of the research process.

4.4 Experimental Treatments

The overall experimental treatment given to the group was divided into four parts. Each part consisted of a variety of learning resources available to the participants within the structure of the WebCT Online Learning Environment. The four parts presented to the students in WebCT make up most of the syllabus for AC Theory for Phase 4. The learning materials used were a combination of World Wide Web resources and computer-generated multimedia designed and developed by the author.

4.4.1 Selection of Multimedia Elements

The use of multimedia elements for the treatments was affected by a number of factors. These include, the learning styles being targeted, the structure of WebCT, the level of technical expertise of the author and multimedia already available online via the Internet.

The learning styles targeted were those as defined by the ILS and the VARK identifiers. The structure of the WebCT environment facilitated a variety of communication and information exchange methods. Synchronous communication using a chat room and Asynchronous communication using a discussion forum and email was encouraged. Information was presented utilising a variety of multimedia element combinations.

4.4.2 WebCT Course

The WebCT course was developed as four treatments. The treatments were made accessible to the students at first over a two-week period. Access to all four treatments simultaneously was then available for a further six weeks. So the total time that the WebCt course was available to the students was eight weeks. The questions in the premeasure and postmeasure tests were designed to directly relate to the concepts that were covered in the online course resources. The Attitude Survey was designed to only ask about elements easily identifiable within the online course.

The multimedia elements used in the complete course were animation, video, graphics, text, audio, interactive laboratories and quizzes. Also included were asynchronous and synchronous computer mediated communication facilities. These elements were combined together in a variety of ways to instruct, tutor and encourage active learner participation.

4.4.3 Limitations and Constraints

The main constraint of the implementation of the treatments was the fact that the author designed them to be accessed outside of the normal class times in the context of self-directed learning. This meant that the author had no control over the extent of the exposure of each participant to the treatment intervention.

A record of each individual participants usage of the course was obtained from the Student Tracking facility of the WebCT application.

Five: Statistical Findings

A combination of methods was used during the research process to collect meaningful quantitative data from and about the participants. All data collected was organised using numerical scoring systems devised by the author. The data was then logged, transformed and analysed using the software application SPSS Version 10.1.

5.1 Hypothesis One

Students will prefer learning with some types of online multimedia better than others, depending on their individual learning style.

Each student's strongest learning style preference was logged from the results of two learning style inventory questionnaires. The first identifier is called Index of Learning Styles (ILS) and the second is called VARK. In both sets of data a category labelled "more than one" was added to indicate students who show equally strong preference for more than one learning style but not for all styles equally.

The students' preferences of online educational multimedia elements in the WebCT course were transformed and bracketed to produce four categories, Images, Computer Mediated Communication, Interactivity and Words. An additional category called "all equal" indicates that a student weighted all categories the exact same.

5.1.1 Tests To Determine An Association Between Learning Styles And Multimedia Preferences.

The following three Pearson Chi-square tests were carried out to test the significance of correlations at 95%.

1. Association between strong VARK measures and strong Multimedia measures.

Of the students identified as strongly Kinesthetic 47.05% choose Interactivity as their favourite multimedia. While 47.05% of the same learning style group liked to use more than one form of multimedia to help them learn. Oddly, no student with a Read/write preference favoured the Words category of multimedia. Only one student had a strong Visual learning style and that student rated the multimedia categories as 'all-equal' to each other.

The Pearson Chi-square statistical test resulted in a probability measure of .038. Therefore a 95% level of significance is reached and so the hypothesis can be accepted for the VARK identified learning styles.

2. Association between strong ILS measures and strong Multimedia measures

60% of the Sensing students choose Interactivity as their favourite multimedia. Any student with a singular strong learning style did not favour the Words category of multimedia. Only one student had a strong Active learning style and that student rated Interactivity in multimedia as their favourite way to learn online.

The Pearson Chi-square statistical test results in a probability measure of .328. Therefore a 95% level of significance is not reached and so the hypothesis cannot be accepted for ILS identified learning styles.

3. Association between strong ILS measures and Interactivity measures

The Pearson Chi-square statistical test results in a probability measure of .063. Although this reaches a 94.7% level of association the hypothesis cannot be accepted under a 95% level of significance.

5.1.2 Results for Hypothesis One

Hypothesis One can be accepted when the VARK inventory is used to identify learning styles however this hypothesis cannot be accepted when the learning styles have been identified by the ILS inventory.

5.2 Hypothesis Two

Group performance scores on abstract concept tests will have a smaller variance when these concepts are learned with self-direction via online learning support resources.

The premeasure test scores indicate the comprehension level of the students for Electrical Science abstract concepts prior to the experimental intervention. The objective of the experimental treatment was to give a variety of learning methods to the sample group via multimedia thus enabling those who do not benefit greatly from lectures to increase their learning outside of the lecture. The post measure test scores indicate the comprehension level of the students for Electrical Science abstract concepts after to the experimental intervention. The questions in the performance tests vary slightly as the postmeasure test incorporates questions aimed at assessing comprehension of concepts learned in Phase 4. If the variance of the scores on the postmeasure test is smaller than that of the premeasure test then this may indicate that everyone in the sample group had more equal opportunity to learn in a preferred way.

Those who learn well in a lecture still had the benefit of the lecture and those who don't rather than being disadvantaged, had a different perspective provided by the online multimedia course.

5.2.1 Tests to Determine Reduction of Variance in Sample Group's Performance Measures.

A paired t-test was carried out between the sample groups' Pre Test Scores and the same groups' Post Test scores.

Score attainable per individual per test was minimum 0% and maximum score attainable 100%.

There was a difference of 2.62 between the Means. The Mean of the post-test scores was less than that of the pre test scores. The standard deviation from the mean for the pre test was 17.28604 revealing a broad range of scores within the group. However, the standard deviation of the post-test of 13.38908 indicates that the scores are 'closer together' after the experimental intervention. This may imply a more 'level playing field' is achieved as a result of the multimedia course

A perfect fit correlation is given a statistical measure of 1 and no correlation existing is given the statistical measure 0. The Correlation between the Pre Test and Post Test scores was .151 demonstrates little or no relationship between the two sets of Test scores.

The t value shows a very small difference between the pre-test and post-test means. This t value was not significant as the result of the significance test at .467 is greater than .05, which is 95% ($t = .722, p < 0.05$).

5.2.2 Results for Hypothesis Two

Hypothesis Two cannot be accepted as the variances of the postmeasure test scores is not smaller as a 95% significance level.

Six: Discussion of Results

The research question investigated in this study is two tiered. The first part of the research aimed to determine if a relationship exists between an individuals learning style and their preferential use of online multimedia learning resources. The second part examined the self-directed use of the multimedia WebCT course by students to gain comprehension of abstract concepts to find out if the variance in performance scores decreased.

6.1 Overview Of Results

The main findings determined that a significant relationship exists between learning style and multimedia preferences when those learning styles are

identified using the VARK questionnaire. If however, the learning styles are identified using the Index of Learning Styles (ILS) questionnaire a significant relationship does not exist between learning style and multimedia preferences.

When the premeasure test and postmeasure test percentage scores were statistically analysed no significant change occurred in the standard deviations although a small reduction in variance was observed in the groups postmeasure scores.

6.2 Online Multimedia And Learning Styles

6.2.1 Individual Learning Styles

When the sample group were tested for evidence of their strongest learning style using the VARK model 35.48% were identified as having a kinesthetic learning type. 16.12% were strongly Aural and a further 16.25% were strong in more than one style in the VARK classifications. 9.65% of the students were Read/write types while just 3.22% were strong Visual types. The Kinesthetic type learner, as identified by the VARK learning style model prefers learning by doing. Berryman (2002) cites Jordan (1987) as having identified the mastering of tasks, skills acquisition and bodily performance as characteristics of traditional apprenticeship learning. This supports the general perception that apprenticeship learning has much greater emphasis on physical skills rather than cognitive skills. So the relatively high proportion of Kinesthetic learning style types in the sample group of apprentices may be indicative of the intake of applicants and their expectations of the apprenticeship program.

The second learning style model used was the Index of Learning Styles (ILS). The modal classification identified for the sample group were Sensing at 32.25%. According to the ILS model a Sensing type learner prefers to learn concrete facts rather than abstractions. The online course was focused to enable learning of abstract concepts so the factual information presented was not for reiteration but rather to add to the process of learning. If this didn't suit the learners' style then their comprehension of the abstract science concepts may not improve. The pre and post performance measures indicate no significant improvement to the groups mean score. No student was identified as having an Intuitive learning style, which the ILS describes as 'comfortable with abstractions and mathematical formulations'.

6.2.2 Online Multimedia Preferences

To use computer delivered interactive multimedia one must 'do' tasks on the computer. The relationship between VARK learning styles (35.48% Kinesthetic) and multimedia may exist in this case because of the high proportion of students (35.48%) selecting Interactivity as their preferred multimedia learning experience. Interactivity simulates practical tasks and concrete experience such as working in a virtual laboratory.

A modal 32.25% of the sample group said they benefited from 'more than one' multimedia category. This may be due to the fact that only each student's strongest learning style was used for the data analysis when some students had a second strongest learning style rating very close to their strongest type.

6.2.3 VARK versus ILS

The VARK model is based on principles of sensory perception so the instructional methods must be a stimulus for the student to gain any understanding of the subject. The VARK questionnaire may have targeted this well and in the context of this study the main concern was the sensory impact of the multimedia on the student. The students expressed preferences for different types of multimedia but did not show any significant improvement in learning the subject matter.

The ILS model is based on the principle of how the learner processes information. It claims that one can customise the way one receives information to match one processing preferences. One type of multimedia could suit a number of learning types in ILS but it is the context it is in that will make the difference to the learner. For instance an online bulletin board provide information for constructivist learning or it can be used to ask a question to initiate problem-based learning.

6.3 Abstract Concepts And Multimedia

6.3.1 Self-Directed Participation

Completion of the research instruments was supervised and a 100% response rate achieved. The experimental intervention was however unsupervised and individual participation levels varied dramatically. The lowest participation rate by a student was 2 WebCT sessions while the highest was 96 sessions over the eight-week experiment period. In fact 50% of students lodged on to the online learning environment less than 20 times throughout the experiment.

Some comments received from the students when asked for reasons effecting their use of the course were "no time", "no interest in computers", "lack of access facilities" and "lecture notes enough" as recurring reasons for students not logging on the to the WebCt course during the experiment. When asked if they had any dislikes of the actual online course itself 32.25% said they had no dislikes.

6.3.2 Self-Directed Learning

There was no significant change in the cognitive comprehension of the sample group over the experimental period. The premeasure test scores and the post measure test scores revealed a mean difference of only -2.62 . Reasons for this lack of overall improvement could be a combination of the

inherent difficulty of cognitive comprehension about electrical science and the amount of self-direction the students undertook. If the students have epistemic experience of being passive in a teacher centred learning environment then the expected leap into self-direction may have been to difficult for them. A slightly smaller standard deviation for the Post Test variables could imply the scores are tending to become more even across the sample group after treatment.

No correlation between access to computer facilities and Internet plus previous experience of learning with computers and the self-directed use WebCT exists at a 95% significance level. Self-direction was necessary part of the experimental treatment for the learners. There are many factors involved in the motivation for an individual to self-direct any aspect of their life including their learning. The factors considered in this study were environmental (computer and internet access) and experiential (use of computers to learn). No consideration was made for mental, emotional, social or economic aspects of the individual's composition that could effect their motivation or ability to learn in a self-directed way. Consideration of some of these additional factors might have resulted in improved insight.

7. Conclusion

7.1 Summary Of Research Study

All students were very co-operative while responding to all the research instruments under supervision. To achieve the 100% response rate the Author scheduled extra time to administer the instruments to previously absent students. Pre experimental instruments administered were Computer Usage questionnaire, learning style questionnaires and premeasure performance test. Post experimental instruments used were postmeasure performance test, Multimedia User Survey and WebCT System Log.

The WebCt online learning environment was shown to the students at a specially scheduled practical computer laboratory session at the beginning of the eight-week experiment. They were shown how to navigate around WebCT, how to use the synchronous and a synchronous communication tools and how to select learning resources for their own use. Time was allowed for practice, questions and answers during this session. There after the students accessed and used the WebCT course at their own behest. The Author was involved in online communications with the group and held an open non-compulsory laboratory session in week four of the experiment to help users with any problems they were having using the WebCT application. The Author also spoke informally to the group throughout the experimental period to encourage participation and use of the online resources.

7.2 Limitations of Results

A relationship exists between a students' VARK learning styles and multimedia preferences but not between students' ILS learning styles and those same multimedia preferences. Also no significant reduction in the variance of performance measure scores occurred in the group after using the online multimedia course to learn abstract concepts.

When viewing these results the following points must be taken recognised:

- Inferences can only be made to the population of male Electrical Apprentice Students in the Institute.
- WebCT was chosen as the online learning environment so results may vary if another online learning environment is used.
- Some of the research instruments used were designed and produced by the Author. More refined instruments might have lead to more in-depth results.

7.3 Recommendations For Further Research

The following are recommendations for further study in this area which if undertaken in conjunction with each other could expand the possibility of drawing accurate inferences on the complete population of Irish male Electrical Apprentice students.

- Rationalise use of Learning Style identification instruments to those in one category, for instance only use those associated with Instructional and Environmental models.
- Elimination of the self –directed participation could be achieved by timetabling regular computer laboratory sessions for WebCT use.
- Use of official FAS Electrical Science examinations as premeasure tests and post measure tests.
- Repetition of research over three 11 week Phase 4 courses giving an accumulation of results.
- Use the same multimedia online course and learning style identifiers to repeat the experiment in a number of third level educational Institutes that offer the Phase 4 course.

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