Student Behaviors in the Context of Computer Aided Learning in Design and Technology Teacher Training

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Introduction

This article discusses the relationship among an individual's cognitive style, attitude to learning, and his or her achievement in the context of computer aided learning (CAL). The results of a small-scale study involving 32 students (18 male and 14 female) studying their first electronics module during an Initial Teacher Training (ITT) Design and Technology degree program at a university in England are reported. Data concerning cognitive style, gender, attitude to CAL, appropriate prior knowledge, and the test results from a unit of work that used a CAL package as the main teaching strategy are analyzed and the relationship between selected variables are discussed. Conclusions pertinent to the students in this study are then drawn.

Background

In all sectors of higher education (HE), there has been an increasing professional concern with the processes of teaching, learning, and assessment and their management, at a time when economic and technological changes have had a major impact (Dillon, 1998; Somekh, 1998). With the rapid growth in the power and functionality of modern computing and network systems, HE has been encouraged both at a national level and by locally driven initiatives to embrace technology-assisted teaching and learning strategies (Boucher, 1998). In the context of this article, the technological changes referred to by Dillon (1998) are centered on the developing use of CAL packages to meet both lecturer and student needs within electronics modules in an ITT Design and Technology degree program.

The broad objectives for developing technology-assisted teaching and learning were first set out in 1996 after the Higher Education Funding Council for England (HEFCE) commissioned a six-month research study of information technology-assisted teaching and learning (ITATL) in HE. Primarily these objectives were to make teaching and learning more productive and efficient, to enhance the learning experience of students, and to widen access to HE through its delivery in new and different locations (Tearle, Davis, & Birbeck, 1998).

During recent years, a great variety of educational software has been designed that would support students' learning. Pedagogical advantages and disadvantages of such materials have been well researched (Alexander, 1995; Boucher, Davis, Dillon, Hobbs, & Tearle, 1997; Dillon, 1998; Ford, 1999; Lee, 1999; National Council for Education Technology [NCET], 2000; Pillay, 1998; Steurer, 1992). Benefits have been reported in terms of individualized learning that can be self-paced, self-accessed, asynchronous, synchronous, provide nonsequential based delivery, include positive motivational interactive features, while affording access to more accurate appraisal and documentation of learners' progress. Research has indicated that the hierarchical linking arrangements that facilitate browsing can also act as an aid to learning. The merging of formally separate media in a manner that allowed associations or links between the various elements (Ebersole, 1997) and under certain circumstances the modification of the form of the material being presented, by the learner themselves, have also been cited as positive features of CAL resources (Pillay, 1998; Steuer, 1992). At a time of considerable expansion in HE, the hope that Information and Communication Technology (ICT) could deliver a more cost effective teaching and learning environment has also played a significant role in its development (Somekh, 1998). However, there have been expectations without due regard to the difficulties that are an inevitable part of any technological innovation in education. Disadvantages have been cited (Ferris, 1999; Mak, 1995) in terms of the teachers' deficiency in understanding the differences between the pedagogy and philosophy underpinning the use of CAL and traditional learning materials in a university environment (Jones, 2001). There is also the lack of training for lecturers to exploit its potential (Oliver, 1994), and the need for appropriate technical support. In the context of the CAL materials themselves, many of the interfaces employed at present have been confusing and opaque to many users. For example, the absence of personal contact and clarity of message due to the nonexistence of physical presence, voice intonation, gesture, and other tacit cues (Harasim, 1989; Moore, 1992), together with the difficulty in conveying humor, irony, and subtle nuances of meaning (Feenburg, 1989), have all been shown to be disadvantageous for certain types of learners. It has also been shown that the nonlinear organization of information highlighted by many as an advantage has proved to be a distinct disadvantage for other users (Edwards & Hardman, 1989). Gygi (1990) referred to a lack of "discourse cues," whereas Shum (1990) talked of the need to reduce cognitive overload for the user by designing better cognitive maps that would aid the user's navigation through the CAL materials.

Ebersole (1997) described designing effective interactive media as a daunting proposition. He explained that in addition to the collection and organization of useful content the designer of CAL materials must create a user interface that facilitates access to the content. He and others (Lord, 1998; Pillary, 1998; Recker, 1995) all believed that learning materials should be crafted with careful attention to the mental processes and learning style that the user was likely to employ. Learners have been seen to waste valuable time navigating an erratic course through the complex structure of the materials provided for them often because they have been unable to acquire the original author's structure and map it on to their own learning style (Alexander, 1995; Shum, 1990). It would therefore seem important that all learning materials, whether they are for traditional or CAL environments, should be cognitively well designed.

> Just as an ergonomically designed chair is well adapted to the physical requirements of its user, so a cognitively ergonomic learning resource is well adapted to the learning requirements of its user. (Ford, 1999, p. 188)

The terms *cognitive style* and *learning style* have been widely used by educational theorists for the past 60 years. Terminology has varied from writer to writer (Curry, 1983; Dunn & Dunn, 1993; Riding & Cheema, 1991). On some occasions the terms have been used interchangeably, while at other times they have been afforded separate and distinct definitions (Cassidy, 2003). However, many (Biggs & Moore, 1993; Goldstein & Blackman, 1978; Riding & Pearson, 1994; Tennant, 1988; Witkin, Oltman, Raskin, & Karp, 1971) have agreed that cognitive style is a distinct and consistent way for an individual to encode, store, and perform, and one that is mainly independent of intelligence, whereas learning style "is adopted to reflect a concern with the application of cognitive style in a learning situation" (Cassidy, 2003, p. 81).

As the relevant research base on cognitive style has grown, so has the number of terms used to describe cognitive style groupings. Riding and Rayner's (1998) analysis of the multiplicity of constructs concluded that the terms could all be grouped into two principal cognitive styles and a number of learning strategies. They referred to these cognitive style dimensions as a "Wholist-Analytic Cognitive Style Family" and a "Verbalizer-Imager Cognitive Style Family." The Wholist-Analytic style they defined as the tendency for individuals to process information in wholes or in parts, whereas the Verbalizer-Imager style they defined as the tendency for individuals to represent information during thinking verbally or pictorially. They believed that these dimensions were totally independent of one another.

Many notable investigations have been carried out concerning the relationship between cognitive style and ability. Witkin et al. (1977) differentiated between cognitive style and ability by emphasizing the bi-polar nature of cognitive styles, unlike intelligence and other abilities. They suggested that each pole of cognitive style had adaptive value under specified circumstances, whereas having more of an attribute such as intelligence was better than having less of it. This difference was well defined by Riding (1996). He explained that the basic distinction between cognitive style and ability was that performance on all tasks would improve as ability increased, whereas the effect of style on performance for an individual would either be positive or negative depending upon the nature of the task and the way in which it was presented to the learner.

In traditional teacher-led, paper-based environments, learning in matched conditions (instructional style matched to the student's preferred learning style) has been demonstrated to be significantly more effective than learning in mismatched conditions in many instances (Ford, 1999; Pask & Scott, 1972). Research findings using a sample of school children indicated that this was especially the case for young pupils and those of low ability. Conversely, more able pupils, who were given the opportunity to use mismatched learning materials at times, were shown to develop learning strategies that coped with a wider range of materials and experiences on future occasions (Riding & Rayner, 1999).

In the context of CAL environments, Ford (1999) suggested that it would be tempting to think that the potential navigational freedom inherent in such systems meant that mismatched education was a thing of the past, although he believed that the potential for navigational freedom was frequently not recognized by the learner nor were they always able, or willing, to use such freedom optimally, or even effectively, in relation to their preferred style of information processing.

Traditionally, learning materials in a university environment have been presented mainly in a text format. However, with the shift from an elite to a mass higher education system (Rumble, 1998) it has become increasingly important that materials are provided in a variety of forms that are able to match individual student learning style preferences. CAL packages, if designed to do so, have the potential to provide materials that can meet this need and be more sensitive to style differences.

The CAL package "units of learning" under consideration in this article were part of a suite of mixed media, blended learning materials developed over the past 25 years by LJ Technical Systems (www.ljgroup.com). These materials have been successfully and extensively used in schools and further education colleges across much of the world, particularly in America, the Middle East, and the United Kingdom (UK), although this was the first time a university in the UK had used these materials as part of one of its degree programs. The CAL package used in this instance had four primary objectives:

- Understanding electrical quantities and the use of instrumentation for their measurement.
- Identification of individual components and measurement of their characteristics.
- Synthesis of simple circuit building blocks based on components investigated.
- Location and identification of computer inserted "faults" within the investigated circuits.

The software was linked to a dedicated electronics base unit, and various subcircuit modules were connected to this for the investigations. All connections were by removable wires and link pins, so no circuit construction skills were required. The tasks were presented in the form of an "on screen" manual but copies of this could be printed and retained by the students as a log-book of activities. The answers were entered in a separate window and took a variety of forms. These were predominately multiple choice, or yes/no question formats, but in some instances numeric answers were required. In the case of calculations, the system required the exact value for a mark to be awarded, but when entering measured quantities, any value within a certain range would be accepted because of component and instrumentation tolerances. Within a particular group of questions, the student was free to go back and alter an answer as often as necessary. However, students were unable to proceed to the next group until that section was submitted and marks allocated. Failure to achieve a certain minimum score would also prevent progression to the next stage and tutor intervention was then required.

The educational theorist would hope that the fundamental purpose of assessment is to give feedback to learners and thereby enrich their learning experience. In the past the culture and traditions of universities have been deeply rooted in enriching learning. However, recently there have been indications that the purpose of assessment in HE has changed. Factors such as government interventions, the massive increase in the numbers of students entering higher education, the change in the character and needs of the student population, the worsening staff-student ratios, the requirement for accountability, and clarity in the relationship between learning objectives, learning outcomes, and assessment criteria have all led to the development of a predominantly categorizing assessment culture within many universities.

Most of the investigations into the advantages of assessing students using ICT have assumed the educational theorists' point of view, yet the use of CAL in university environments has brought the tensions between enriching learning and the need to categorize students into sharp focus. By their very nature, CAL-based systems are designed to facilitate the maximum number of positive outcomes for a cohort of students—be this by allowing repeated attempts until the correct outcome is achieved, by offering unlimited time for grappling with the issues in hand before offering a response, or even by allowing group discussion of a problem before arriving at a consensus viewpoint. However, the very process of accommodating these differing learning strategies in this manner can generate relatively undifferentiated results for a cohort of students, with all of them achieving fairly high mark levels.

With the rapid growth in the use of CAL within university environments, and the research evidence to suggest that various factors could affect learning and achievement within that context, it seemed pertinent to the authors of this article to design a small-scale research project that could examine the relationship among attitude, cognitive style, learning, and achievement in the context of a CAL package that was being used to teach electronics.

Methods and Procedures

Sample and Components

The purposive nonprobability sample referred to in this article comprised the total 32 students (18 male and 14 female) studying their first electronics module during an ITT Design and Technology degree program at a university in England.

The following components were used:

1. **Cognitive Style**. A well-established cognitive styles analysis (CSA; Riding, 1991), which was computer presented and self-administered, was used. This indicated a student's position on both the Wholist-Analytic (WA) and the Verbal-Imagery (VI) dimensions of cognitive style (Riding & Rayner, 1998) by means of an independent ratio for each. Every member of the sample carried out the CSA in the manner prescribed in the CSA administration documentation.
2. **Attitude to CAL**. The attitude of individual members of the sample to working with and using computers as a tool for learning was tested by means of a 58-item summated rating scale. Each of the items on the scale was subjected to a measurement of its discriminative power (DP). The 35 items with the highest DP

indices were selected to establish an attitude score for each student.

3. **Achievement**. One set of test results was used in this study. The test used was designed by LJ Systems and embedded in the CAL material. The overall mark for the module was calculated using the marks awarded for each task as described earlier in the article, together with a posttest which provided alternative scenarios that once again tested the learning that had taken place. As explained earlier, all the tests were computer generated and marked although they also required practical skills in creating the physical circuits and cognitive skills in linking the literature to the associated schematic diagrams, interpretation of instrumentation data, and the development of deductive reasoning to identify faults. The results were automatically summated and stored directly onto the computer managed learning (CML) system database. In line with university quality assurance requirements, all assignments were then both internally and externally cross-moderated to assess validity and reliability of both the marks and the materials being used. The students completed the module test before any of the other data for the study were collected.
4. **Prior Knowledge of Computing and Electronics**. A questionnaire that requested information regarding the previous computing and electronics experience of each student was used. Questions concerning computing and electronics were asked separately and involved examinations taken in computing and electronics prior to starting the degree program and any school or work experience in industry utilizing computing or electronics skills prior to starting the degree program. The answers were separated for scoring purposes into those that concerned previous experience in electronics and those that concerned previous experience in computing. A student who had studied an examination and had school or industrial experience in electronics or computing was given a score of 2, whereas a student who had only experienced one of those situations was given a score of 1. A student with no experience of either situation was given a score of 0.

   A student's perception of the newness of electronics and computing skills required to complete the module successfully was established through a second part of the questionnaire. This provided students with two statements, one regarding the newness of the electronics skills required in the module being studied and one about the newness of using computers for learning. These both needed a summated scale response. These were scored between 0 and 2. A score of 0 was given to those who indicated that all the materials were new to them, and also to those who said that they had not used a computer for learning before. A score of 1 was given to those who indicated that most of the materials were new to them, and also to those who said that they had sometimes used a computer for learning before. A score of 2 was given to those who indicated that little of the materials were new to them, and also to those who said that they had often used a computer for learning before.
5. **End of Module Feedback**. In line with all university modules, anonymous written feedback was collected from students using an optically read questionnaire. This feedback is primarily used to monitor the educational health of the module. However, it also provides the module leader with data on aspects of the module that students perceived as particularly helpful and areas of the module in which they believed their learning could have been enhanced if things had been approached differently.

Results and Discussion

Cognitive Style

Recent debate into the stability and internal consistency of many cognitive/learning style models (Coffield, Mosely, Ecclestone, & Hall, 2003; Peterson, Deary, & Austin, 2003; Riding, 2003) was taken into consideration when methods of analyzing the collected data were designed. Initially, the data were analyzed using the raw CSA ratios as suggested by Peterson et al. (2003). However, no linear correlation with any of the variables under discussion was found, so it was decided to group the sample by the well used cognitive style categories defined in the CSA administration documentation, as these labels seemed appropriate to this research project. The WA ratios of the total sample ranged from 0.700 to 2.910 with a mean of 1.412 (SD = 0.463). The male and female means were, respectively, 1.392 (SD = 0.475) and 1.436 (SD = 0.459). The gender difference was not significant (p = 0.7408). The VI ratios ranged from 0.750 to 1.430 with a mean of 1.094 (SD = 0.148). The male and female means were, respectively, 1.096 (SD = 0.143) and 1.091 (SD = 0.157). The gender difference was not significant (p = 0.9104). The correlation between the two cognitive style dimensions was -0.153, attesting to the orthogonality of the two dimensions (cf. Riding & Cheema, 1991; Riding & Douglas, 1993). In comparison to the CSA standardization sample (N = 999) referred to by Riding (2000), the sample reported in this study had very similar mean scores on each dimension, both as a total sample and when divided by gender. However, the sample in this study did not have subjects at the extremes of either dimension. This was particularly noticeable at the Wholist end of the WA dimension and the Imager end of the VI dimension.

This later result was initially very surprising, as it had been expected that many of the sample would have been "strong" imagers because these students were training to become design and technology teachers where the need to be able to manipulate images in the mind during design activity was recognized as a valuable skill. However, as prospective teachers, the need to be able to work equally competently with both text and diagrams and be able to communicate with pupils at the extremes of a dimension would suggest that being at the center of a dimension could be an advantage. In this study, the categories on the VI dimension were fairly evenly divided into 9 Verbalizers towards one end of the dimension, 13 Bimodals around the center, and 10 Imagers towards the other end of the dimension.

With regard to the WA dimension, in both the task of being a successful teacher and a successful design technologist, the authors would suggest that being strongly Analytic or Wholist could be an advantage at certain times and a disadvantage at others. Data from this study indicated that the sample on the WA dimension was unevenly balanced. It was predominantly Analytic (n = 20) with only 7 Intermediates around the center of the dimension and 5 Wholists at the other end of the dimension. It was therefore recognized by the researchers that this skewed distribution could affect results and needed to be borne in mind during data analysis.

Attitude to Using CAL

The data concerning student attitude to CAL was scrutinized using descriptive statistics. The maximum score that could have been achieved was 165 and the minimum was 35. The actual maximum score achieved was 153 and the minimum score was 69. The distribution was negatively skewed (skewness = - 0.251) with an overall mean score of 117.281 and a standard deviation of 22.036.

When individual student scores for attitude were placed in rank order and split into equal sized quartiles (top, 2nd, 3rd, bottom) there was the expected significant difference between the mean attitude scores for each quartile.

There were no significant differences between the attitudes of male and female students to using computers for learning.

Achievement

The pass mark for the test was set high at 60% in order to try to overcome the problem highlighted earlier in this article concerning CAL's ability to facilitate the maximum number of positive outcomes and the need to differentiate between students' achievement within the electronics module. All students in the sample took the test and achieved a mean score of 73.938 with a standard deviation of 17.212. Six students failed and 10 students achieved scores of 90% or over. There was no significant difference between male and female students, although in both attitude to using computers as a learning strategy and in the test results, females achieved lower mean scores than their male counterparts.

Previous Experience

All members of the sample provided their answers to the questionnaire regarding previous experience and newness of computing and electronics as described in the methods section of this article. In analyzing the data regarding previous computing activity, everyone in the sample had some previous experience of using computers although only six of the students had studied for an examination and used computers in an industrial context. It was therefore not surprising that 16 of the sample did not believe that they had had to learn any new computing skills in order to use a computer as a learning tool in this instance, whereas nine suggested that they had had to learn some new skills and seven had found that learning using a computer was very new to them.

With regard to previous electronics experience, a significant 28 students had no previous experience of electronics prior to starting their degree program, two had taken an examination or had industrial experience, and only two students had taken an examination and had industrial experience of electronics. It was therefore not surprising that a significant number of the sample believed that the electronics material was either entirely new to them or mostly new to them. Only four students believed there was little new material to learn.

The Relationship Between Variables

It was the intention of the authors to discuss the relationship between and among all the variables in the study. However, during analysis it became apparent that in certain combinations of the variables the cell size became too small for meaningful analysis to be carried out. The relationship between cognitive style and attitude to CAL; cognitive style and achievement; attitude, prior experience, and achievement were found to be statistically feasible. These are discussed in the following paragraphs. Issues associated with gender have also been included whenever the cell size permitted.

Cognitive Style and Attitude to CAL

When the two separate cognitive style dimensions were scrutinized in relation to attitude to CAL, there was found to be a significant difference between the mean scores for the three categories on the two dimensions ($p = < 0.0001$ in both instances). On the VI dimension, the largest difference was between Imagers and Verbalizers. Imagers were the most positive and Verbalizers the least positive. On the WA dimension, Wholists were the least positive and Intermediates, at the center of the dimension, the most positive. When comparing the two dimensions, it could be seen that Wholists were even less positive than Verbalizers in their attitude to CAL while Imagers were more positive than Intermediates.

This result would suggest that poor attitude to CAL may be influenced more by the segmented nature of the CAL materials than whether those materials were biased towards the use of images or text. However, it must be remembered that the skewed distribution of the sample on the WA dimension may or may not have influenced this result.

Cognitive Style and Achievement

When the two cognitive style dimensions were scrutinized separately in relation to test scores, there was found to be a significant difference between each category on both dimensions ($p = < .0001$ in both instances). Intermediates achieved a high mean score, while Wholists achieved a much lower mean score. On the other dimension, Verbalizers achieved the highest mean score and Bimodals, at the center of the dimension, the lowest. When the rank order for both attitude and achievement in the test were compared, it could be seen that on the WA dimension there was a positive relationship between the two variables. However, on the VI dimension Verbalizers were ranked lowest in attitude to CAL while they managed to achieve the highest mean score in the test.

Some explanation for the unexpected inverse relationship between Verbalizers' attitude and achievement was sought. An analysis of the CAL materials indicated that the balance between the pictorial and text based material remained relatively constant throughout and it was felt that neither had a preponderance of sufficient significance to skew the outcomes. The explanation was thought to lie not so much in the way that the tasks were presented but more in the way that the content was organized. Quite complex text based instructions were designed to become much clearer when linked to their corresponding diagrams. The Verbalizer, in avoiding use of image and remaining focused on text, may have needed to read and re-read the material before gaining sufficient understanding to proceed. Such difficult and time consuming tasks may perhaps explain the resulting low CAL attitude scores, but this very investment of time in a task that they perceived as difficult may have led to a deeper understanding of the requirements and therefore the higher level of achievement.

Further examination of the VI data led the researchers to examine the possible reasons for the low mean score of Imagers in the context of their high attitude score. Such individuals could have been expected to have higher levels of satisfaction resulting from their focus on diagrams and the relative ease with which they were able to correctly build circuits from the visual information. Such activity one expected could have engendered the more positive attitude to CAL. However, the assessments required careful reading of accompanying text, which explained settings required before measurements could be taken and answers given. Those Imagers who were not as thorough in their attention to reading the text could therefore expect significantly lower scores as a result.

Attitude to CAL, Prior Experience and Newness of the Materials, and Achievement

When data concerning attitude to computing and previous experience and newness of electronics were combined, a positive relationship was found. Students who believed that there was little new electronic materials to learn had the most positive attitude to using computers in their quest for knowledge, while students who believed that all the material they had to learn was new to them were the least positive. The difference in attitude between the top and bottom groups was found to be significant ($\chi^2 = 61.350$, $p = <0.0001$). The anonymous "End of Module Feedback" supported a possible explanation for this outcome. Although the whole sample indicated that they recognized the advantages that independent learning using CAL could offer, there was still a general feeling of resentment that the lecturer had not been "on call" for support when needed. Those with more experience of electronics naturally had a more secure mental "scaffolding" to support the leaps of intuition needed for progress beyond an impasse and such success seemed by its nature to have led to a degree of comfort in working with information technology (IT). Conversely, those with little electronics experience had no background to draw from to help maintain progress. Being unable to converse with the computer for the help needed led to an inevitable frustration with IT and the poorest attitude score.

When the test results were scrutinized with the student perception of the level of new electronic materials present in the CAL program as a second variable, it was found that the mean scores for those who found the materials new to them followed the expected pattern; they achieved the lowest mean marks. However, the mean marks for the other two groups were not as expected. Those who believed that there was little new material did not achieve as high a mean mark as those for whom the electronic materials were mainly new knowledge. Observation of the students while they were using the CAL materials suggested a reason for this. Many of the students who had not studied electronics before recognized their deficiencies and were prepared to invest the substantial amount of time needed to become cognizant. Their newly learned knowledge and understanding then led to success in the tests. Whereas many of those who believed that they already knew much of the electronics needed were seen to bypass the supporting materials available on the computer, moving directly to the tests. The weaker score for this group indicated that this confidence was generally misplaced.

When data from the questionnaire concerning students' personal level of computing experience prior to taking the electronics modules were analyzed in conjunction with attitude to CAL, the result once again indicated a significant positive linear correlation between the two variables (Fisher's r to z; $p = .0032$). Those with previous computing experience were the most positive and those with little computing experience were the least positive about having to use CAL to gain their electronic knowledge and understanding.

A further scrutiny of the data also indicated that there was a positive linear relationship between test results and the level of previous computing skills. Those with the most previous computing experience achieved the highest test results and those with little previous computing experience achieved the lowest result. In fact, when compared to the achievement data split by levels of prior electronic knowledge, it could be seen that levels of computing skills prior to the start of the module had a more marked effect upon achievement than the amount of electronics knowledge known before studying the module.

Conclusion

The evidence for this study was collected using a small purposive nonprobability sample. Consequently, it was not statistically possible to generalize to a larger population. However, the data gathered provided a useful picture of the relationship that existed between CAL materials, appropriate prior knowledge, cognitive style, and attitude to using computers as a learning tool, as well as ability to achieve when using such materials, for this specific cohort of students.

The data indicated that those students who had no previous electronics experience were significantly less positive in their attitude to using computers as a learning strategy in comparison to those who had prior skills in electronics. It was also found that there was a linear correlation between previous computer experience and attitude to using computers as a learning tool and previous computer experience and levels of achievement in the electronics test. The data from this study also indicated that computing skills were possibly more important for achieving high marks within the CAL situation under consideration than the level of previous electronics knowledge.

With regard to gender differences, there was found to be no significant difference between male and female students in either their attitude to computing or in their levels of achievement when using the CAL materials under scrutiny, although in both instances males achieved a higher mean score than females.

With regard to the relationship between attitude, achievement, and cognitive style, it was unfortunate that the sample was not evenly distributed between the three categories on one of the two cognitive style dimensions. However, the results on the VI dimension, where the distribution of the sample was evenly spread, provided evidence to suggest that there was a different relationship between students' attitudes to using a computer as a learning strategy and their ability to achieve using such materials depending upon their cognitive style. The authors of this article suggest that CAL packages designed to present materials in a different manner to learners with different learning style preferences may well help those learners to achieve their full potential in terms of learning and achievement in comparison to software that does not have this facility.

The results of this research have also provided the stimulus for the authors of this article to continue collecting data from subsequent groups of students to see if these findings are replicated with a larger sample size that can add credence to the conclusions drawn from this initial small-scale study.

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