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Recognition, Recall and Application of Information Learned about the Human Brain from Two Varying Computer Based Instruction Tasks

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ABSTRACT

The research entailed a student learning task involving either a 'static-plus-text' or an 'interrelated' computer-based instructional (CBI) activity about the human brain. Eighty-four Year 8 students from Brisbane participated, working in either of two instruction formats, static-plus-text (n = 44) or interrelated (n = 40) with relatively equal number of girls (51%) and boys (49%). A test of learning, in the form of recognition, recall and application sub-tests, was administered to students following participation in the CBI activity. The test of learning results showed a noteworthy difference between the two instructional formats. When the sub-tests were analysed by instructional format a MANOVA calculation showed a significant difference between the three sub-tests, and the sub-tests by group. Overall, there were major differences between the two instructional formats for the recognition and application sub-tests but not for the recall sub-test. Students in the interrelated instructional group were better at recognising material and at applying the information learned. This research has implications for the design of computer based instructional materials.

Introduction

In an attempt to provide research that applies an integration of technological, psychological and pedagogically foundations, as Park & Hannafin (1993) challenge, the current study will analyse the recognition, recall and application of material learned in a CBI task about the human brain from two different instructional formats – static-plus text and interrelated.

The use of multimedia presents new challenges, beyond those of text book learning, by allowing teachers and students to utilize and construct diagrams, use layers to progressively build images, and develop graphical simulation to test conceptual ideas. Previous studies have considered instructional material in textbooks and have argued that learning from an illustration is easier than from text. For example, Ainsworth and ThLoizou (2003) argue that it is easier to learn diagrammatic than textual information. Levie and Lentz (1982) outlined numerous studies comparing learning from illustrated text versus learning from text alone. In their paper they analysed 46 studies, from 1953 to 1981, and the majority (98%) found learning was better from illustrated text than text alone. While there have been many studies conducted to understand the use of diagrams in instruction, these studies were concerned with mainly fixed 2D print-based diagrams in text books.

In CBI the design of learning tasks can go beyond a fixed 2D image, there is capacity to incorporate interactive based tasks that can include the incorporation of text and pictures.

According to Gyselinck, Ehrlich, Cornold, de Beni and Dubois (2000) the issue of text and picture presented via multimedia systems has not been investigated sufficiently. Mayer and Moreno (2002) applied cognitive load theory to multimedia learning and argued that a combination of simultaneously presented words and pictures is the best presentation format to minimize cognitive load. There is emerging evidence that information presented in text and diagram must not only be easy to connect cognitively but must also support each other structurally (Dubois & Vial, 2000; Gyselinck, et al. 2000). In their paper involving six experiments Mousavi, Low and Sweller (1995) argue that heavy cognitive load may be reduced, by mixing auditory and visual presentation models. There is still debate about whether and how illustrations and text should be presented in CBI. Rieber and Hannafin (1988) argued that for younger learners (4th and 5th graders), in CBI, input of information is better in visual than textual ways. Najjar (1998) contends that in multimedia learning “for recalling and reconizing items, pictures are better than text” (p 312).

In keeping with the challenge of Park and Hannafin (1993) an analysis of the outcomes of learning, in terms of memory, from an instructional task provides research that applies an integration of technology, psychology and pedagogy. Memory can be tested in the form of recognition or recall of events or of information (Clariana & Lee, 2001).

Jonassen and Tessmer (1996) describe recognition as a declarative knowledge outcome. Recognition is theorised as a single process, which does not require generation of a full response, only a decision concerning the accuracy of response (Ellis & Hunt, 1989). Recognition tasks could include matching items where alternatives are presented and the correct response is selected (Clariana & Lee, 2001). Recall has been theorised as a two-process retrieval, where a cue is first recognised, without prompting or the original stimuli present, and can then be recalled (Clariana & Lee, 2001). It may be cued (specific external cue given) or free (prompted by a general request only). Cued recall tasks could include constructed response or fill-in-responses questions (Clariana & Lee 2001).

Recall and recognition are considered to be separate memory tasks. A study by Clariana and Lee (2001) on 133 graduate students utilised a computer-based vocabulary lesson and found support for the argument that “recognition and recall are separate and distinct activities that are weakly related” (p35). In comparing recall and recognition, Nobel and Shiffrin (2001) found that recognition tests have better retrieval than recall tests.

Studies have applied recognition and recall as an outcome to CBI. A study by Flanagan and Black (1997) investigated 60 third grade (USA) students who were either taught to represent number on a wooden abacus or on a computer simulation of an abacus. One recognition test and two performance tests were used in assessing transfer of knowledge. They found no difference in working out numbers or recognising numbers on an abacus between the two groups, but did find a difference on production tests where the time spent and the proportion of correct responses favoured the wooden abacus group, as opposed to the computer simulation group. Even so, recall and recognition have not been directly applied in an investigation of varying instructional formats within CBI.

Kulik and Kulik (1991) argue that computer based instruction is an effective form of instruction because it produces high student outcomes of achievement in short periods of time. The current study will explore through an investigation of the outcomes of secondary school students measured by their memory of learned material from a task presented in either a static-plus-test or an interrelated instructional format.

Method

Research Design

The design adopted involved the participation of learners in either of two instructional formats followed by a common test of learning. The two instructional formats involved learning about the structure and functioning of the human brain. The instructional material was created by the authors, based on introductory Psychology text-books and encyclopaedia entries, including the Gale Encyclopaedia of Psychology (Oceano, 2000). The computer based instructional formats, created by the authors and a computer programmer, involved an annotated diagram presented in two formats with students assigned to either a static-plus-text or an interrelated instructional format group. A test of learning consisted of three sub-tests which assessed the student's recognition of information, their recall and application of material.

Subjects

A total of 84, Year 8 Brisbane secondary school students were involved in the project with relatively equal number of girls (51%) and boys (49%). Of the 84 students participating in the activity, 44 were presented with the static-plus-text instructional format and another 40 worked with the interrelated instructional format.

Procedures

The students worked in a classroom based computer lab at individual computers. They were randomly assigned to either the static-plus-text or the interrelated instructional formats. Students accessed the activity via a web page previously developed for the purpose of the research. In a 45 minute lesson the students were invited to study the instructional material presented to them and to complete the test of learning. There was a built in feature in the instructional design to prevent students going back to the instructional material, after they had pressed the linked to the assessment task.

Materials

Static-plus-text instructional format. The static-plus-text format of the instructional material contained a basic static diagram of the human brain with each lobe and 2 fissures of the brain labelled and colour coded, as shown in Figure 1. To the right of the diagram all information to be learned was written in text. A scroll bar was used to enable students to access all of the material to be learned. Once the students believed they had learned all of the instructional material they were asked to click on the "Quiz" icon.

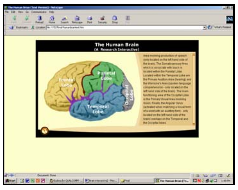

Figure 1: Static-plus-text instructional format

Interrelated instructional format. The interrelated format of the instructional material contained a semi-interactive diagram of the human brain with each lobe and the two fissures of the brain colour coded. The material included was the same as for the static-plus-text instructional. Basic instructions were given to the students: * Scroll your mouse over the human brain to see the various lobes [their colour lit up when scrolled over]. * Click on each lobe to look at the outline of functioning and specific functions [the names of lobes appeared in bubbles that pointed to the locations]. * Identify the two fissures which separate certain lobes [these appeared in red and with labels when scrolled over].

As a student scrolled their mouse over each lobe the colour became brighter and the name of the lobe or the fissure appeared in a bubble (see Figure 2). Once the student clicked on the lobe, two selection buttons appeared at the bottom right of the diagram—the “Outline of Functioning” or “Specific Function” for each of the lobes with information appearing in bubbles. Figure 3 gives an example of material shown in the “Outline of Functioning” section and Figure 4 gives an example of material found in the “Specific Function” section. Once the students believed they had learned all of the instructional material they were asked to click on the “Quiz” icon.

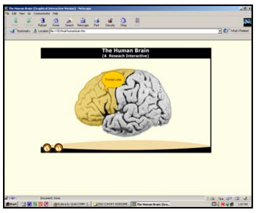

Figure 2: Interrelated format

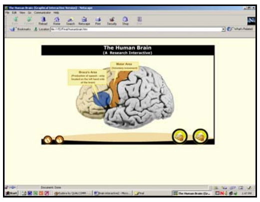

Figure 3: Outline of function

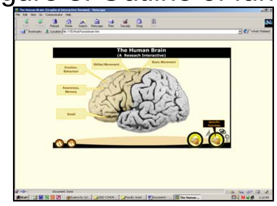

Figure 4: Specific function

Assessment Tasks. The assessment section included a test of learning in three sub-tests: 1. recognition of material, 2. recall and 3. application of material. These are expanded below.

Sub-test 1 – Recognition test. Students were invited to complete a word recognition and matching activity by interacting with information presented on the computer screen (see Figure 5). The test included a static diagram of the human brain and on one side of the diagram was a list of numbers corresponding to numbers on the static diagram. Students were required to click and drag the names listed below the diagram to the appropriate number. The correct names had to be matched and the correct score was recorded for each student, without feedback of performance.

Figure 5: Recognition test of learning

Sub-test 2 – Recall test. This involved providing written answers to five questions involving giving details, naming, explaining and identification, with a total possible score of 33. Question 1 had sub-sections making up 21 points of the assessment score.

Sub-test 3 - Application test. Two questions related to the application of material learned were asked in the written task.

Results

Test of learning by instructional format

A test of learning score was determined by combining results from the three sub-tests; the recognition, recall and application tests. The difference between the means of the two instructional format groups was statistically significant at the .05 level using Analysis of Variance computations F (1, 82) = 5.18, p < .05, with the interrelated group having the highest mean, see Table 1. A MANOVA computation revealed a significant difference between the three sub-tests; recognition, recall and application F (2, 160) = 88.56, p < .05. A significant interaction was found for the sub-tests by instructional format F (2, 160) = 3.27, p < .05.

Sub-test 1- Recognition test The recognition test, involving a word recognition and matching task, showed a significant difference between the static-plus-text (u = 5.5) and the interrelated (u = 6.4) format groups F (1, 80) = 3.947, p < .05.

Sub-test 2 – Recall test In an ANOVA computation, the recall test, that had five questions involving giving details, naming, explaining and identification, did not show a significant difference between the two instructional formats F (1,80) = .00, p =ns.

Question 1 – Recall of information learned. Categorical data gathered for question 1 (requiring students to recall the information learned), [N.B. for the total test of learning scores and the recall test results the students received points for each category they mentioned] involved an analysis of percentage. Results showed that recalling one or more of the lobe names was the easiest information to recall, 52.4% of students recalled this information. For the students involved in the interrelated format more students could recall the functions than the names of lobes, as per Table 2, and more students recalled that the lobes have functions as opposed to the brain having four lobes. These results were opposite for students in the static-plus-text group, see Table 2.

Table 1: Mean and standard deviation results for the test of learning and the sub-tests by static-plus-text and interactive format groups.

Test	All	Group	
		Static-text	Inter-related
Test of Learning	13.15 (4.8)	12.0 (4.4)	14.4* (4.9)
Sub-Test 1: Recognition /9	5.9 (2.1)	5.5 (2.1)	6.4 * (2.1)
Sub-Test 2: Recall /33	4.7 (2.5)	4.7 (2.1)	4.8 (2.8)
Sub-Test 3: Application /6	2.5 (1.7)	1.9 (1.3)	3.2 * (1.8)

Questions 2 through 5. No differences were found between the format groups for questions 2 (naming the main structural lobes) (F (1, 82) = 1.65, ns, u = 3.09 & 2.73 respectively), 3 (explaining how the main lobes work) (F (1, 82) = .841, ns, u = 1.16 & 1.48), 4 (identifying the area that represent heat, cold, touch, pain and the sense of body movement) (F (1, 82) = 1.457, ns, u = .07 & .15) and 5 (identifying which functions are only located on the left hand side of the brain) (F (1, 82) = .169, ns, u = .34 & .40).

Sub-test 3 – Application test ANOVA showed the two questions related to the application of material learned revealed a significant difference between the two instructional formats F (1,80) = 15.26, p <.05, static-plus-text u = 1.9, interrelated u = 3.2.

Questions 1 through 2. ANOVA computations showed a significant difference between the two groups to each of the questions relating to applying the material learned (q 1: F (1, 82) = 10.84, p < .01 and q2: F (1, 82) = 12.03, p < .01). The average of students in the interrelated group for questions 1 (u = 1.63) and 2 (u = 1.60) was higher than for students in the static-plus-text group for questions 1 (u = .93) and 2 (u = .95).

Table 2: Percent of students recalling information by type of information recalled.

Recalled	All	Group	
		Static -text	Inter-related*
Lobe/s named	52.4%	56.8%*	47.5%*
Functions mentioned	50.0%	45.5%*	55.0%*
There are 4 lobes	29.8%	36.4%*	22.5%
Lobes have functions	21.4%	18.2%	25.0%*
Fissures mentioned	15.5%	15.9%	15.0%
Specific function area/s mentioned	6.0%	4.5%	7.5%

Discussion

In furthering Levie and Lentz's (1982) finding that learning from a text book with an illustration and text was better than text alone, the current study discovered the best format in CBI was interrelated illustration and text. The analysis of total test scores showed, for secondary school students, a significant difference between instructional formats, suggesting that the interrelated instructional format provides better memory outcomes than the static-diagram-plus-text instructional format, for CBI. The interaction presumably directs learner's attention to more specific learning tasks. The current research supports Rieber and Hannafin (1988) that students learned better in visual than textual ways in CBI. Najjar's (1998) conclusions that pictures are better than text for recalling and recognizing in multimedia were somewhat sustained in the current findings, in that an interrelated integration of the two is the preferred format. This outcome supports Mayer and Moreno (2002) that the best format to minimize cognitive load is simultaneously presented words and pictures. This is particularly relevant for the interrelated format of the current study because the words within the interactive brain diagram appeared simultaneously for each lobe, thus enabling the students to automatically link a word with a particular part of a picture. This indicates that students in the static group may have experienced more cognitive load difficulties in the form of a split-attention effect (Mousavi et al. 1995).

In terms of the memory outcome of the CBI activity there were differences found between the instructional formats for recognition and application but not for recall, although the main 'type of information' recalled differed by instructional group. The current study showed that recognition tests have better retrieval than recall tests (Nobel & Shiffrin, 2001) and application tests. It was found that students from the interrelated instructional group had a significantly higher recognition outcome. This could be due to the interrelated nature of the recognition test being similar to the interrelated group instruction. Alternatively, this finding may be due to the students in the interrelated group being able to focus their attention and readily make connections between the image and label near the areas of the diagram, due to the minimization of cognitive load (Mayer & Moreno, 2002). On the other hand those in the static-plus-text group had to read the information and move their vision and attention back and forth from the text to the diagram, thus not being able to minimizing cognitive load (Mayer & Moreno, 2002). This may also be an indication of the split-attention effect (Mousavi et al., 1995) for students in the static group. In addition, the interrelated instruction group also performed better on the application test. Gyselinck et al. (2000) argue that comprehension is improved with the use of illustrations which also encourages deeper learning. Students of the current study in the interrelated instructional format were able to engage in deeper learning of the material and were able to recognize and apply the information learned.

Although no significant differences were found between the two instructional formats for any of the recall questions, one interesting outcome was discovered. The type of information recalled for students in the interrelated group focused, in order, on <u>naming the lobes, functions mentioned and that there are four lobes</u>, students from the static-plus-text group focused, in order, on <u>functions mentioned, naming the lobes and that lobes have functions</u>. These recall outcomes could be indicative of the input formats with the interrelated focusing on visual links (i.e. viewing the four lobes, looking closer in a link at the functions). Whereas, students in the static-plus-text format focused mainly on the written text (i.e. the fact that the functions are performed by certain lobes). Students in the static-plus-text group seem to have learned about the linked between the 'structure and functioning' of the human brain from the reading text.

In conclusion, the study has shown that the design and the element of interaction is an important factor in CBI. A static-plus-text presentation of material within a CBI design was found to be not as productive for students' deep attention and learning as an interrelated presentation of material. It is suggested, as per Mayer and Moreno's (2002), that simultaneously presented words with diagrams in an interactive format is the most appropriate for CBI.

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