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Effects of Practice in a Linear and Non-linear Web-based Learning Environment

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ABSTRACT

Instructional elements remain the foundation of current instructional design practice. Practice is the instructional element provided after learners have been given information required to master an objective and Navigation is the non-instructional element guides the learner on the sequence of instruction. Linear Navigation can be referred to as program control where the learners do not have control over sequence and Non-Linear Navigation can be referred to as Learner control over sequence of instruction. The purpose of this study was to investigate the effect of practice with feedback, navigation type on achievement, attitude, and time when students use a web-based instructional program and the interaction between practice and navigation type. 240 students from a large south western university participated in four different web based environments. Significant differences were found for practice main effect, but not for navigation main effect. There was no interaction between practice and navigation. There were significant differences for attitude items, I learned a lot from this program and the program gave me enough opportunity to practice between the treatments who received practice and those who did not. This study reinforces on the importance of practice and has implications for the design and development of web-based, multimedia instruction.

Keywords

Practice, Navigation, Web-based instruction, Linear and non-linear, Instructional elements

Introduction

Instructional elements

Forty years ago, Robert Gagné published the first edition of his book *The Conditions of Learning* (1965) in which he proposed nine events of instruction that provide a sequence for organizing a lesson. These events remain the foundation of current instructional design practice (Reiser, 2002; Richey, 2000). They represent desirable conditions in an instructional program and increase the probability of successful learner achievement (Gagné, 1965, 1985, 1988; Gagné, Briggs & Wager, 1992). Other authors cite similar elements of instruction that promote student learning from an instructional program (Dick, Carey, & Carey, 2005; Sullivan & Higgins, 1983).

According to Forcier & Descy (2002), "every learning environment has an implied method of information presentation" (p. 104). Information is necessary to perform the task stated in an objective and is presented in a straightforward manner (Sullivan & Higgins, 1983). Apart from the information which is the basic instructional element that is needed in any instructional program, other instructional elements such as objectives, examples, practice with feedback and review are provided in addition. Some of the instructional elements that have been suggested by Gagne (1985) and Dick et al. (2005) to promote learning are objectives, practice with feedback, examples and review.

According to Clark & Mayer (2007) instructional methods are "the elements included in instruction for the purpose of supporting the achievement of the learning objective . . . instructional methods are intended to encourage learners to use appropriate cognitive processing during instruction" (p. 314). These authors indicate that multimedia will promote learning to the extent that it supports human cognitive processes. Each of these instructional elements is described in the following paragraphs.

An instructional *objective* is a statement that describes an intended outcome of instruction (Dick et al., 2005; Mager, 1997). Objectives facilitate cognitive processing by focusing student attention, directing selective perception of specific lesson content, communicating expectations, and organizing new information into an existing structure (Foshay, Silber, & Stelnicki, 2003; Gagné, 1985; Gagné, Wager, Golas, & Keller, 2005, Smith & Ragan, 2005). According to Reiser & Dick (1996), "At a fairly early stage, learners should be informed of what it is that they are going to be able to do when they finish the instructional process. By knowing what will be expected of them, learners may be better able to guide themselves through that process" (p.48). Morrison, Ross, & Kemp (2006), indicate that

although the general trend continues to be the use of objectives as a pre-instructional strategy, research results suggest providing learners with objectives is not as effective as once thought.

Practice involves eliciting performance from learners (Gagné, 1985; Gagné et al., 2005). It is often provided after learners have been given information required to master an objective. Practice provides an opportunity for learners to strengthen new knowledge by internalizing it so they can recall and use it (Foshay et al., 2003). It helps to confirm correct understanding and repeated practice increases the likelihood of retention (Klein, Spector, Grabowski & de la Teja, 2004; Kruse & Kevin, 1999). Practice is effective when it is aligned with assessment and with the skills, knowledge and attitudes reflected in the objectives (Merrill, 2002; Reiser & Dick, 1996).

Feedback can be defined as "knowledge of one's performance provided" (Delgado & Prieto, 2003, p. 73). Practice provides an opportunity for feedback that confirms the student's answer as being correct or indicates that it is incorrect. Feedback strengthens the probability of correct responses and reduces the probability of subsequent incorrect responses (Philips, Hannafin & Tripp, 1988). Kulhavy & Stock (1989) define feedback as information consisting of two components: verification and elaboration. Verification is the simple, dichotomous judgment that an initial response was right or wrong. Elaboration consists of all substantive information contained in a feedback message.

Examples are verbal or graphical information that provides additional clarification of rules or information presented to learners. Kruse & Kevin (1999) include examples, non-examples, graphical representation and analogies as guidance strategies that can be used to further clarify new content that is presented.

Review typically provides an outline of the key information that was presented to learners. It is intended to reinforce learning, at the end of the instruction, often just before students are tested. Reiser & Dick (1996) cite the value of reviews to bring closure to instruction and to help reinforce the skills and knowledge students should have acquired. Mattiske (2001) suggests that a review activity immediately after participants have learned something new reassures them that they are learning. Klein et al. (2004) suggest that learners should be given time to reflect and review after new information has been presented to them. Gagné et al., (2005) indicate that spaced reviews should be given to learners to help them retrieve and use newly acquired information.

Practice and Feedback

Researchers have found that practice has a significant effect on performance. Hannafin (1987) reported a significant difference between practiced and non-practiced items on the learning of cued and uncued information presented via computer-based instruction. Phillips et al. (1988) found a significant difference favoring practice over no practice in an interactive video in which practice items were embedded questions. Hannafin, Philips, Rieber & Garhart (1987) noted that practice effects were more pronounced for facts than for applications in computer-based instruction. Participants who received intellectual skills practice in a cooperative learning environment performed significantly better than those who received verbal information practice (Klein & Pridemore, 1994).

Practice provides an opportunity for feedback that confirms the student's answer as being correct or indicates that it is incorrect. This feedback strengthens the probability of correct responses and reduces the probability of subsequent incorrect responses. (Philips et al., 1988). Simple forms of feedback are effective when learners are able to answer items correctly. More elaborate forms such as providing and explaining the correct answer and explaining why a wrong answer is incorrect are helpful when learners answer incorrectly (Kulhavy, 1977). Simple forms of feedback are most effective for simple verbatim and verbal information types of learning (Kulhavy, White, Topp, Chan & Adams, 1985).

Non-Instructional elements

Apart from the instructional elements which Gagne (1985), Dick et al. (2005) have proposed and many researchers have researched on, there are the non-instructional elements such as usability, navigation type, learner control that also influence learning. Researchers have examined the effects of these non-instructional elements such as navigation

type (Su & Klein, 2006), personalization (Ku & Sullivan, 2002), animated agents (Atkinson, Mayer & Merrill, 2005) in student achievement and attitudes.

As Hannafin (1987) noted, some design strategies may have positive effects when used in isolation that are diminished or negated when these strategies are used in combination with more powerful techniques. The effects of these instructional elements could be enhanced or diminished when used in combination with other variables such as different navigation types, media types.

Linear and Non-Linear Navigation (Program Control versus Learner Control over the sequence of instruction)

Linear Navigation can be referred to as program control where the learners do not have control over sequence and Non-Linear Navigation can be referred to as Learner control over sequence of instruction. Hypertext has been defined as an approach to information management in which data is stored in a network of nodes connected by links. Shneiderman defines hypertext as "a database that has active cross-references and allows the reader to "jump" to other parts of the database as desired" (Shneiderman & Kearsley, 1989). Much of the previous research on the effects of navigation tools look at efficiency and effectiveness of hypertext environment (Boechler & Dawson, 2002; Dee-Lucas & Larkin, 1995; Dias & Sousa, 1997; McDonald & Stevenson, 1998). Efficiency measures are based on speed and the number of steps taken to complete an information search. Effectiveness measures focus on the user's search accuracy and the users understanding of the structure of the document (Boechler & Dawson, 2002). Different types of navigation structures are available – hypertext links, hypertext links with graphics, keyword index (Hammond & Allison, 1989). Studies were also conducted to test for the most effective navigation types such as content list and content map (Su & Klein, 2006).

Many of the instructional programs designed to test in computer based instruction were built with Hypercard and Tool book initially and now it is built with Director, Authorware, Dreamweaver and Flash. In general these programs have been linear in format (Freitag & Sullivan, 1995; Schankenberg, Sullivan, Leader & Jones, 1995; Martin, Klein & Sullivan, 2006). These programs do not allow learners to navigate to any screen of their choice except in a linear format. But with the advent of web and the hypermedia structure, programs are now built with the feature such that the users can trace the path they like to within these computer based programs.

Learner control generally increases effectiveness, efficiency, and motivates learners. There are no disadvantages against using learner control as long as the control option does not confuse the learners. There are only arguments for and against the degree of learner control. Depover & Quintin (1992) mention that the degree of learner control depends on variables like age, previous knowledge, learning progress, complexity of material and familiarity with the subject. Some of the other variables that influence the degree of learner control are prior knowledge, student strategy and ability, learning progress, complexity of material and familiarity with the subject (Depover & Quintin, 1992; Hannafin, 1984; Milheim & Martin, 1991; Steinberg, 1989).

In computer based instruction, some of the control options learners have are, control over choice and sequencing of instruction, control over strategy and control over content. There has been research on learner control relating to choice of strategy such as level of difficulty of examples and practice items (Merrill, 1980; Kopcha, 2005). Chung & Reigeluth (1992) break down learner control into control over content, sequence, speed of learning, display or strategy, the internal process, and the advisory strategy. In this current study, the students had control over the sequence of instruction where the learners could choose the instructional elements in any sequence of their choice in the web based hypertext environment. Navigation option was provided as a menu bar at the top of the screen.

Purpose of Current Study

In the previous studies conducted by the author (Martin, Klein & Sullivan, 2007; Martin & Klein, 2008), the learners did not have control on the sequence of the instruction in the program and had only linear navigation (program control). Hence in order to answer the questions of the effects of the instructional element practice with feedback when learners had control (non-linear navigation) and learners had no control (linear navigation), this study was

proposed. The IPSO instructional program with the same instructional content but with the changes to the navigation links was used in this study.

The purpose of this study was to investigate if a) the presence or absence of practice in a web based lesson had significant effect on student achievement, attitude and time b) if the navigation types which provided control over sequence of the instructional element (Linear, Non-Linear) had a significant effect on student achievement, attitude and time and c) if there was any interaction between practice and navigation type. The elements investigated in the study, practice with feedback, and linear and non-linear navigation type were combined into four different versions of web based programs in a manner that permitted investigation of the effectiveness of the program when practice was present and absent for both linear and non-linear navigation types.

The primary research questions for this study are listed below.

1. What is the effect of practice with feedback on achievement, attitude, and time when students use a web-based learning environment?
2. What is the effect of navigation type (linear and non-linear navigation) on achievement, attitude, and time when students use a web-based learning environment?
3. Does practice and navigation type (linear and non-linear navigation) interact to influence achievement, attitude and time?

The researchers anticipated that the combination of practice and linear navigation would have higher student achievement while practice with non-linear navigation would have higher student attitude.

Method

Participants

Participants were 240 freshman and sophomore undergraduate students enrolled in a computer literacy course at a large Southwestern University. 60 students participated in each treatment. The students enrolled in this course had varied background knowledge on computers and were from different majors including education, communication, journalism and others. Students participated in this study as part of the course requirement and the score in the post test was part of their course grade.

To avoid the variation in treatments with in the class (practice, no practice, linear navigation, and non-linear navigation), the students from were assigned to the treatments by classes and not by individual. The classes were randomly assigned to one of the four treatments based on the pretest average scores. It was a quasi-experimental study due to this nature of assignment to the treatments. This was one of the limitations to the study but helped to avoid differences in content, attitude or time spent on the program between the students enrolled in the same class.

Materials

Four different versions of a web-based lesson on the topic *Input, Processing, Storage and Output of a Computer (IPSO)* were developed using Dreamweaver. IPSO explains the primary operations of the computer which are Input, Processing, Storage and Output. An introduction section was included before the primary operations were explained in detail. This section introduced what a computer is and classified it based on size, power and generation. It also explained the IPSO cycle. The next four sections described the concepts of the Input, Processing, Storage and Output operations in a computer and explained the function of the different components associated with that operation. The content used in this study was part of the required content for the course. The web-based lesson was pilot tested with five students before it was used in the study.

The four different versions of instructional program were as follows:

1. Program with Practice and using Linear Navigation (Program control)
2. Program with Practice and using Non-Linear Navigation (Learner Control over Sequence)
3. Program without Practice and using Linear Navigation (Program Control)
4. Program without Practice and using Non-Linear Navigation (Learner Control over Sequence)

In Linear navigation, the users go through the module in a linear path, page after page and this process can also be referred to as program control. Figure1 shows the linear or structure navigation approach that was used in the instructional material.

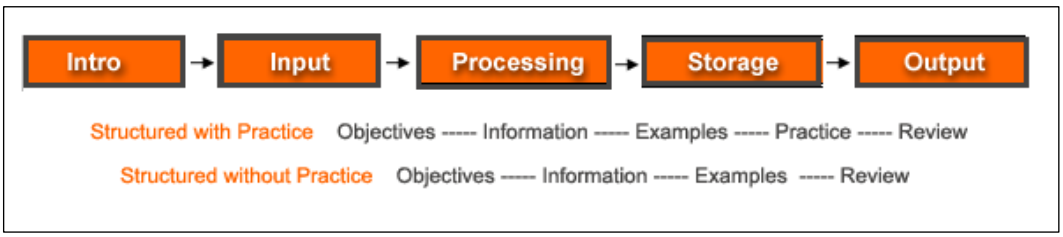

Figure 1. Linear Navigation or Program Control

And in Non-Linear navigation, users can navigate from one page to another in any particular order, both forward and backward and to any screen within the instructional program. This navigation type is also called as learner control over sequence. The instructional program in this study was built with Dreamweaver and the navigation type was hypertext links. Figure 2 shows the non-linear navigation or the unstructured navigation approach that used in the instructional material.

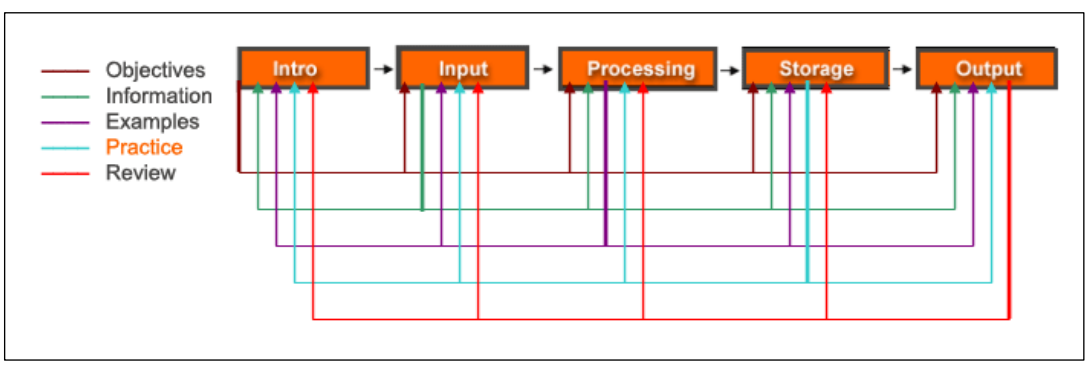

Figure 2. Non-Linear Navigation or Learner Control

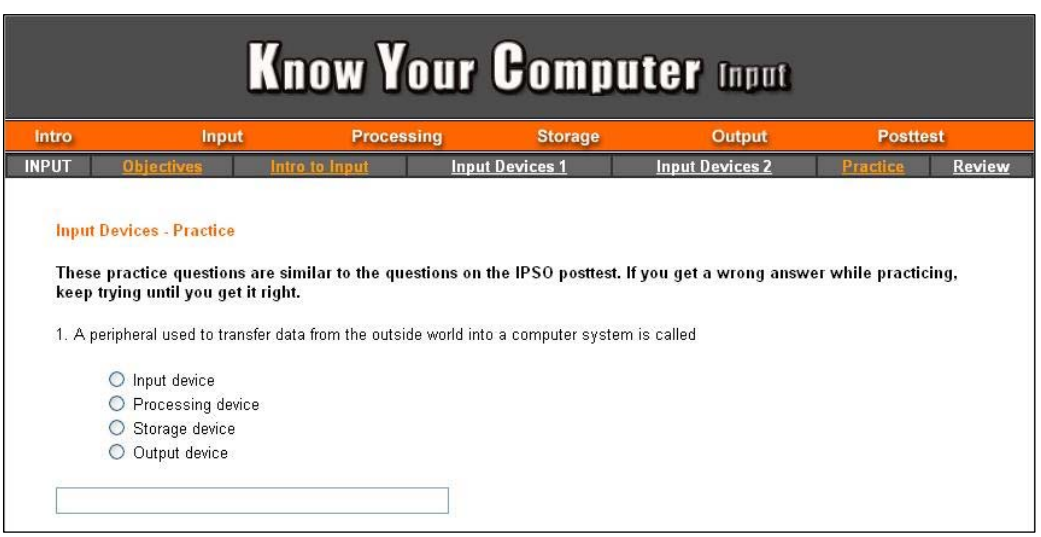

Figure 3. Practice screen in the non-linear navigation program

Practice Screens

The first two programs had practice screens in the program and it provided students with an opportunity to practice the content they were learning. There were a total of five practice screens, each of which contained five four-choice

multiple-choice questions. The student received immediate feedback after each response to a practice item. Students had the option to practice until they got the right answer. One practice screen was presented after each information screen. One example from the five items on a practice screen is shown in Figure 1 and Figure 2.

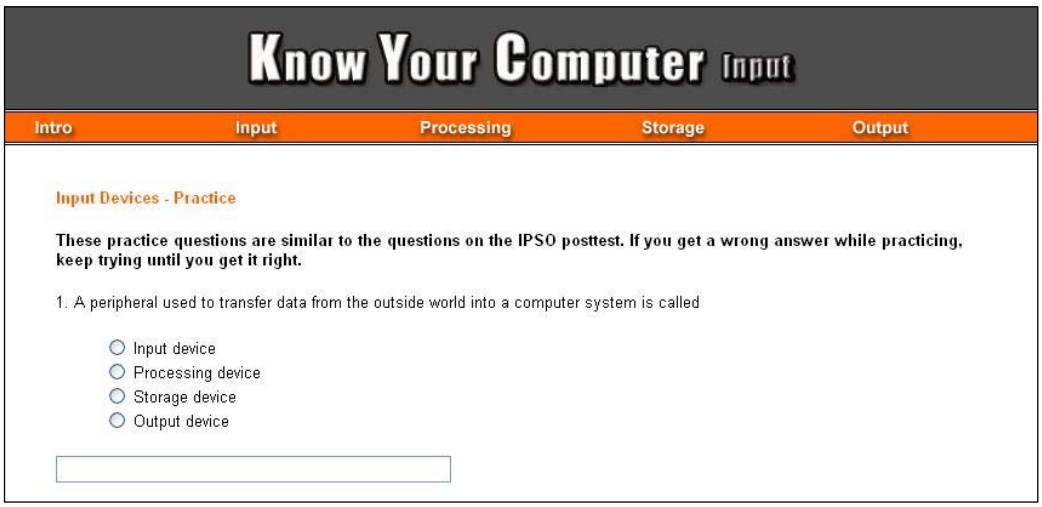

Figure 4. Practice screen in the linear navigation program

Procedures

Eighteen sections of students (n = 240) enrolled in the computer literacy course were blocked by classes and randomly assigned to the four treatment groups. The pretest, which took approximately 15 minutes to complete, was administered a week prior to the study. The classes were blocked into four groups based on their mean pretest scores, and one class within each block was assigned to each of the four treatments.

The participants used the web-based IPSO lesson during the sixth week of the semester. Participants met in a regular computer lab for instruction and were directed by the instructor to the web address for the instructional program. Each class was routed directly to its treatment version of the program. Students worked through the program at their own pace, averaging approximately one hour. Then they took the posttest and the attitude survey online. All six treatment groups followed the same procedure. Thus, the experimental differences in treatments occurred exclusively in the materials themselves and not in the procedure.

Criterion Measures

The criterion measures consisted of a posttest and a student attitude survey. In addition, a pretest was used to assess subjects' knowledge of the content prior to the instruction.

Pretest. The pretest consisted of 20 multiple-choice questions covering the content with four response choice questions. A sample question that appeared on both the pretest and posttest is shown below.

What is the purpose of a program counter?

a. *Executes instruction*
b. *Fetches instruction from the main memory*
c. *Keeps track of successive instruction*
d. *Temporary memory location*

The overall mean score on the pretest was 8.38 or 42%, indicating that participants were not very knowledgeable about the content prior to instruction.

Posttest. The posttest consisted of the same 20 multiple-choice questions that were on the pretest. The reliability of the posttest was .65. The item analysis done on the posttest revealed that question 17 was the most difficult with a difficulty level of .42, question 3 was at .60, followed by question 1 and 2 at .62 and .63. The rest of the questions difficulty level varied between .70 and .99.

Attitude Survey. The attitude survey assessed student attitudes towards the instructional program and the presence or absence of the instructional events. The survey included 12 Likert-type questions that were rated strongly agree (scored as 4) to strongly disagree (scored as 0). The survey also included two open-ended questions that asked the participants what they liked best and least about the program. The survey was administered after the lesson and the posttest were completed. The reliability of the attitude survey was .83.

Data Analysis

A 2X2 analysis of variance (ANOVA) test was conducted on data obtained from the achievement posttest and on the total time spent on the program. The attitude survey results for the Likert type items (Items 1-6) was analyzed using a 2X2 ANOVA. All analyses revealed significant differences.

Results

Achievement

The first research question investigated the effects of practice and navigation type on student achievement. Table 1 shows the mean scores and standard deviations for achievement on the pretest and posttest by treatment. The average pretest score was 8.46 (SD = 2.26) and posttest score was 15.91 (SD = 2.92). Participants who received practice and linear navigation scored the highest on the posttest (M=17.14) and those who received no practice and had non-linear navigation scored the lowest (M=14.78) on the posttest.

A 2X2 ANOVA conducted on the pretest data revealed no significant difference for practice main effect, navigation main effect or interaction. 2X2 ANOVA conducted between the treatment groups on the posttest revealed a significant practice main effect, $F(1, 196) = 22.388$, $p < 0.01$. Thus, there was a significant difference between the groups that received practice and no practice. Those who had received practice (M=16.84) performed significantly higher on the posttest compared to those who did not receive practice (M=14.98). However, there was no significant difference for those who had control over the instruction using the Linear navigation (M= 15.66) and Non-Linear navigation (M=16.16). There was also no significant interaction between practice and navigation type.

Table 1. Means and Standard Deviations (SD) for Posttest scores by treatment

	Pretest			Posttest		
Treatment	Linear Navigation Mean (SD)	Non-Linear Navigation Mean (SD)	Total	Linear Navigation Mean (SD)	Non-Linear Navigation Mean (SD)	Total
Program with Practice	8.24 (2.75)	8.50 (2.32)	8.37 (2.53)	17.14 (1.92)	16.54 (3.42)	16.84 (2.77)
Program without Practice	8.62 (2.60)	8.48 (2.21)	8.55 (2.40)	15.18 (2.81)	14.78 (2.77)	14.98 (2.78)
Total	8.43 (2.66)	8.49 (2.25)	8.46 (2.26)	16.16 (2.59)	15.66 (3.22)	15.91 (2.92)

Attitude

The next research question dealt with the effects of practice and navigation type on student attitudes. Table 2 shows means for responses to the 6 Likert-type items on the attitude survey. The items were rated on a 5 point Likert scale from strongly agree (N= 4) to strongly disagree (N=0).

Table 2. Means for Attitude survey by treatment

Treatment	Program with Practice			Program without Practice		
Attitudes Items	Linear Navigation Mean (SD)	Non-Linear Navigation Mean (SD)	Total	Linear Navigation Mean (SD)	Non-Linear Navigation Mean (SD)	Total Mean (SD)
1. I learned a lot from this program.	3.32 (.587)	3.22 (.648)	3.27 (.617)	3..06 (.620)	3.12 (.659)	3.09 (.637)
2. The overall quality of the program was good	3.36 (.525)	3.26 (.600)	3.31 (.563)	3.26 (.600)	3.22 (.507)	3.24 (.553)
3. I would recommend this program to other students	3.22 (.648)	3.10 (.678)	3.16 (.662)	3.04 (.676)	2.94 (.586)	2.99 (.631)
4. I would enjoy using other computer programs like this one in future lessons	3.00 (.736)	3.04 (.755)	3.02 (.742)	2.96 (.735)	2.94 (.712)	2.95 (.720)
5. The program gave me enough opportunity to practice what I was learning	3.20 (.639)	3.26 (.694)	3.23 (.664)	2.56 (.760)	2.40 (.782)	2.48 (.772)
6. The program gave me enough control to move around the program.	3.22 (.616)	3.36 (.663)	3.29 (.640)	3.12 (.718)	3.30 (.544)	3.21 (.640)
Total	3.22	3.21	3.21	2.99	2.99	2.99

A MANOVA conducted on the overall attitude data revealed a significant difference on the 6 attitude questions, $F(18, 535.06) = 4.33$, $p < 0.01$. Follow-up 2x2 ANOVA conducted on the attitude data indicated significant differences for items 1(I learned a lot from this program) and 5 (The program gave me enough opportunity to practice) between the treatments who received practice and those who did not. No items showed significant difference for the navigation type (linear versus non-linear navigation). There was no interaction between practice and navigation type on the attitude data. For both the above items that had practice main effect, the participants who received practice had rated it significantly higher than those who did not receive practice.

The attitude data also showed that participants who used the program with practice had higher attitudes and had rated higher on all the six items compared to those who did not receive practice. Item 2 "The overall quality of the program was good" was the rated the highest (M = 3.28) by both the practice and no practice group. Those who did not receive practice recognized the absence of practice in their programs and rated item no 5 "The program gave me enough opportunity to practice what I was learning", the lowest (M = 2.48). There weren't much difference in attitudes of the participants when comparing the navigation method they received and were almost equivalent in their ratings based on navigation.

The attitude survey also included two open-ended questions that asked the participants what they liked the best and least about the program. The four most frequent responses for what participants liked the best in the program were (1) the practice questions (n=65) (2) clear navigation and structure (n=45) (3) the review section (n=43) (4) graphics, animations and visuals (n=34) (4) Highly informative (n=30). The most frequent response for what parts liked the least were (1) Very long program (n= 36) (2) Lot of information (n=23).

Time

On calculating the time spent in the program (table 3), there were no significant differences between the groups based on practice and navigation. Those who received practice spent more time on the program (M = 35.56) than those who did not receive practice (M = 31.33), but there were no significant differences. Both the navigation types, linear (M=33.49) and non-linear (M=33.40) spent about the same amount of time in the program.

Table 3. Means and Standard Deviations (SD) for Time spent in minutes by treatment

	Time		
Treatment	Linear Navigation Mean (SD)	Non-Linear Navigation Mean (SD)	Total
Program with Practice	35.98 (13.59)	35.14 (18.84)	35.56 (16.34)
Program without Practice	31.00 (13.15)	31.66 (16.19)	31.33 (14.68)
Total	33.49 (13.53)	33.40 (17.56)	33.44 (15.64)

Discussion

This study examined the effects of Practice and Navigation type (Linear and Non-Linear) on achievement, attitude and time. College students enrolled in a computer literacy course used a web-based lesson delivered on the web to learn about input, processing, storage and output of a computer (IPSO). The computer based lesson included multiple choice practice items and two types of navigation (Linear, Non-Linear). Linear navigation directed them from one page to the next where as in Non-Linear navigation they had the freedom to navigate in any path. They had control over the sequence of instruction.

Results indicated that there was a significant difference between the groups that received practice and no practice, but there was no significant difference in Linear and Non-Linear navigation. There was no significant interaction between practice and navigation type.

Achievement

Practice resulted with a significant difference both in achievement and in attitudes. Practice provides an opportunity for learners to confirm their correct understanding, and repetition increases the likelihood of retention of new knowledge (Kruse & Kevin, 1999). In this web-based lesson, participants who received practice were also given feedback which confirmed the student's answer as being correct or indicated that it was incorrect. This feedback strengthens the probability of correct responses and reduces the probability of subsequent incorrect responses. (Philips et al., 1988). The confirmation of the answer during practice increased the likelihood of retention of the content. Presence of practice results in interaction between the lesson and the learner. It is effective in performance when it is aligned with the assessment in the form of a posttest and with the skills, knowledge and attitudes reflected in the objectives (Reiser & Dick, 1996). In this web-based lesson, practice was directly aligned with the posttest and with the information presented. The findings of the current study is consistent with previous research on computer based instruction that found practice had an effect on learning (Hannafin, 1987; Philips et al., 1988).

Navigation types (linear, non-linear) did not result in a significant difference. This could have been due to the fact that even though the non-linear treatment had the flexibility to take any path that they decided, the computer based lesson was well structured and organized. The lesson was designed using all the instructional elements and was instructionally aligned from objectives to assessment. The results could have been different, if the instructional material was not well structured and did not have the other instructional elements or instructional alignment. Though there was no significant difference, participation of the linear navigation program scored higher than the participants of the non-linear program.

Participants who received practice and linear navigation scored the highest on the posttest and those who received no practice and had non-linear navigation scored the lowest on the posttest. When enough of structure is provided and the instructional material is well designed, the students do better when the navigation is linear and they are forced through every screen where they learn from every instructional element such as objective, practice, feedback and review. The absence of the instructional element practice and non-linear navigation resulted in the lowest posttest scores.

Presence of practice not only diminishes the importance of other instructional elements such as objectives (Hannafin, 1987; Hannafin et al, 1987; Philips et al, 1988) but also diminishes the importance of other non-instructional elements such as navigation. Practice was an instructional element which was directly aligned to the objectives and posttest and had an effect on student achievement, and navigation was the non-instructional element and did not have an effect on student achievement.

Attitude

The attitude survey had 6 Likert-type items. Participants who received practice in their computer lessons had higher attitudes compared to those who did not receive practice. Those who received practice had an opportunity to interact with the web-based lesson and it helped them perform better and have higher attitudes. Higher attitudes of the participants who received practice could have been due to the feedback they received during practice, which strengthened the probability of correct responses and reduced the probability of subsequent incorrect responses. The attitude results remained consistent with the achievement results.

Item 1 "I learned a lot from this program" and Item 5 "The program gave me enough opportunity to practice what I was learning" resulted with significant differences between the treatments which received practice and which did not receive practice. The significant difference on item 5 (The program gave me enough opportunity to practice what I was learning) reveals that the participants realized the presence of practice in their computer based lessons. And also on item 1 (I learned a lot from this program), those who received practice had higher attitudes that they had learned a lot from the program. The presence of interactive well aligned practice items, which provided feedback and corrected their understanding of the concepts, must have been the reason for them to state that they had learned a lot from this program. Item 6 "The program gave me enough control to move around the program" which is about the navigation aspect of the program did not result in significant differences. Thus both in attitudes and achievement, there was significant differences for the presence of practice but not for navigation type.

In the open ended section, practice topped the list for what the participants liked the best about the program and was followed by the clear structure and navigation. It can be noted that participants realized that practice made a difference in the program. We may not have had a significant difference in the navigation types, but from the open ended question it is shown that students were aware of the structure and navigation used in the program and had rated it as the second best feature in the program.

Time

Time did not result in any significant difference for both practice and navigation type. Though the participants in the practice treatment spent longer time in the program, it was not significantly different from the treatment who did not receive practice. But the time spent by both the navigation types were almost the same. Participants in the linear navigation treatment spent (M=33.49) minutes and those in the non-linear navigation treatment spent (M=33.40) minutes. This shows that the different navigation types did not matter in regard to time spent.

Conclusion

This study has once again reinforced the importance of practice in web based/computer based lessons. It once again confirmed Practice to be effective in help in student achievement and attitude. If the lesson is instructionally sound with important instructional elements such as practice then irrespective of the non-instructional element such as navigation type, learners have high achievement and attitudes. It also showed that when the lesson is well structured then the effect of navigation is not seen.

This study has implications to the design and development of web-based instructional material. Practice is an effective instructional element for enhancing student achievement. This suggests that it should be included in web-based instruction especially when students are tested using items aligned with the objectives and practice items. We also recommend including different types of practice items. In this study, multiple choice practice items with immediate feedback to students were included. Also, the content was more on learning facts and concepts. Future

research should focus on variation in the instructional content and the type of practice and feedback involved. Additional research should examine how instructional elements in computer-based instruction influence outcomes such as problem solving and complex learning tasks. As was done in this study, research in these settings should include measures of student achievement, attitudes and time. Further studies can be conducted to test the effectiveness of the other instructional elements such as objectives, examples, and review along with the different non-instructional elements such as intelligent agents and other usability elements including navigation types. It will be helpful to measure the practice scores and their correlation to the posttest scores. Studies of this nature will continue to inform designers about the influence of instructional elements on learning and performance.

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