Visual Control for Dynamic Presentation in Multimedia Learning

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Abstracts

English: The focus of this study is to report the use of two different visual control treatments (self-controlled vs. system-imposed) among students with different cognitive styles. Second-grade students in middle school were tested to determine how they learned from instructional materials generated using different design approaches. When prior knowledge of physics was used as a covariate, a 2 × 2 ANCOVA test indicated a significant main effect for visual control ($p < 0.01$), but not for cognitive style ($p > 0.05$). The interaction between visual control and cognitive style was insignificant ($p > 0.05$). The observation result indicated that students with different cognitive styles employed different learning strategies.

Français: Le but de cette étude est de faire rapport sur l'utilisation de deux traitements de contrôle visuel (auto-contrôlé ou imposé par un système) parmi des étudiants qui ont des styles différents d'apprentissage. On a testé des élèves de deuxième classe dans une "middle school" pour déterminer comment ils ont appris à partir de différentes approches dans l'élaboration des documents d'enseignement. Quand les connaissances antérieures de la physique sont utilisées comme co-variante de test, A 2 × 2 ANOVA indique un effet principal significatif en respect du contrôle visuel ($p = 0.0007$), mais l'effet est insignifiant par rapport au style cognitif ($p = 0.221$). L'effet du traitement de contrôle visuel est significatif parmi les étudiants de FI ($p = 0.049$) mais par pour les étudiants de FD ($p = 0.058$).

Deutsch: In dieser Studie wird über die Anwendung zweier verschiedener Sicht-Kontroll- Verfahren (selbstkontrolliert gegenüber systemvorgegeben) bei Schülern mit unterschiedlichen Lernstilen berichtet. 'Second-grader' der Mittelschule wurden untersucht, um zu ermitteln, wie sich unterschiedlich gestaltetes Unterrichtsmaterial auf ihre Lernleistungen auswirkt. Wenn 'Vorwissen in Physik' als Co-Variante eingesetzt wurde, ergab der ANOVA Test signifikante Ergebnisse in Bezug auf visuelle Kontrolle, nicht signifikante jedoch in Bezug auf 'cognitive style'.

Introduction

Limitations to human learning may be related to the fact that information may only be present in working memory for a very short period of time unless it is rehearsed (Wilshire and Dwyer, 1991). Therefore, it is necessary to take into consideration the variation in time required for deciphering information (ChanLin, 1996). Accurate interpretation of visual information entails sufficient time for visual processing. Thus in order to rehearse or process information efficiently in working memory, providing the option of control when presenting visual input is a critical design issue.

Students with different cognitive styles might vary in how the visual control should be arranged for their use. Although the literature suggests visual information assists learning (Rieber, 1994; West, 1992), learners need to invest extra time and mental effort to digest and encode it. Individual differences in the use of their perception and judgement (cognitive style) have become an indicator for analysing students' learning patterns, especially in hypermedia research. This study focused upon how the use of visual control strategies improved learning within different groups of learners.

Visual learning and visual control

One could argue that the use of visualization should be dictated by the needs of the learner and the demands of the learning tasks and employ strategic applications of the unique features of dynamic display (Park, 1994). When learning tasks involve visualization of dynamic processes or interrelated motions, designers of animation or visual presentation should be more cautious about the limited working capability of human short-term memory. Specifically, in scientific learning, it is critical to relate the visuals with learners' internal referent (Hays, 1996).

In multimedia instruction, viewers are provided with visual presentation techniques such as: self-controlled visualization or system-imposed visualization. In a self-controlled design, viewers are provided with key-pressing or mouse-clicking options to view animation. On the other hand, a system-imposed visual design arbitrarily directs viewers' attention with dynamic presentation techniques. With limited working memory to process information sequentially, some students might fail to perform their spatial operations successfully because of the inefficient use of the amount of rehearsal time spent with the dynamic information (Hays, 1996).

Cognitive styles

In multimedia learning, students with different cognitive styles also employ their own viewing strategies to accommodate various presentations provided by the learning materials. Hansen (1997) claimed that individual differences in cognitive style derive primarily from subtle variations in the function of hemispherical dominance. However, the differences observed between Field Dependent and Field Independent (FD/FI) individuals have also been affected by mental capability, task complexity, and strategic usage (Howard *et al.* Allen, 1993).

Individuals with different cognitive styles approach similar information processing situations in different ways (Wood *et al.* 1996). The Field Dependence-Independence dimension of cognitive style differentiates between individuals who are strong in global processing (FD), and those who are strong in analytic processing (FI) (Witkin *et al.* 1977).

Research purposes

It was hypothesized that due to different approaches to learning, the effectiveness of visual control might vary among students with different cognitive styles. At the beginning of this study, several issues were identified: (1) Whether the use of self-controlled visual presentation was better than system-imposed visuals in facilitating the learning of scientific content and (2) How students with different cognitive styles were influenced by the visual control treatment.

Research methods

Students participating in this study were in the second-grade of middle school. One-hundred were FI students and 100 FD students. The experimental material was a computer-based learning program used for teaching physics, in particular, it covered lever problems, direction of force, resultant force, composition of forces, component forces and equilibrium. The lesson was designed in two ways, which employed two different visual control strategies:

1. *System-imposed visual presentation*: In this version, the information was highly visual-directed. Students needed to adapt their viewing pace to the presentation.
2. *Self-controlled visual presentation*: In this version, the same content as the system-imposed visual presentation was covered. However, the lesson was provided with a control option for viewing visual materials. Students viewed the dynamic visual information at their own pace.

Cognitive style classification

Prior to the study, students were tested using the Group Embedded Figures Test (GEFT) for cognitive style classification. Students in each cognitive style classification were randomly assigned into one of the two visual presentation groups. They received their respective instructional treatment and completed a criterion test.

Criterion reference test

To assess students' performance, a criterion reference test containing 16 item sets was created based on the content provided. The test items were reviewed for construct validity. A Kuder-Richardson 21 reliability test was conducted on the test items and produced a reliability of 0.82. Several problem sets were provided to the learners. For example, students were asked to balance a beam on a fulcrum to lift a piece of luggage.

Results and discussion

From the test scores gathered, FI students learned better than FD students. Average scores obtained from FI and FD students were 63.14 (sd = 16.57) and 56.2 (sd = 17.38) respectively. Students in the self-controlled visual presentation group learned better than those in the system-imposed visual presentation group did. Average scores obtained from self-controlled visual presentation and system-imposed visual presentation were 63.53 (sd = 16.75) and 55.81 (sd = 15.5) respectively.

In order to make a direct comparison of the observed factors, prior physics scores were used as a covariate. When physics scores were used as a covariate in the 2 (treatment) X 2 (cognitive style) ANCOVA test, the main effects were significant for the visual control treatment [$F(1,191) = 7.47$, $p = 0.007$) and insignificant for cognitive style [$F(1, 191) = 1.51$, $p = 0.221$). No interaction was found between the two variables ($p = 0.949$) (table 1).

Although FI students learned better than FD students, the data revealed an insignificant difference at $\alpha=0.05$ level ($p = 0.221$), when the mean scores are adjusted on the basis of the covariate – prior physics knowledge. However, students in self-controlled treatment learned better than students did in the system-imposed treatment. The difference was significant at $\alpha=0.05$ level. Adjusted mean scores and the comparison were listed in table 2.

Table 1 *2 × 2 ANCOVA table for visual control and cognitive type*

	SS	DF	MS	F	Sig of F
Visual control	1627.08	1	1627.08	7.47	0.007*
Cognitive style	328.63	1	328.63	1.51	0.221
Visual control × Cognitive style	0.89	1	0.89	0.00	0.949
Total	539442.75	195	276.63		

Covariate: prior physics score
* Significant at p= 0.05 level

Table 2 *LSD comparison of main effects*

	Main effect	Adjusted Mean	Comparison
Cognitive style	FD FI	58.24 60.98	No significant difference p = 0.221
Visual control	System-imposed Self-controlled	56.70 62.52	Significant difference p = 0.007**

**Significant at p= 0.01 level

Observations

From the study, the observation data showed that individuals differing in cognitive styles tended to adapt a particular strategy in learning from computer-based materials. FD students tended to go through the instructional materials first to get the whole picture of the lesson and then came back for the second or the third review of the problems and questions in the lesson. They adapted more readily to different ways of presenting visual information. FI students, on the other hand, tended to stay at a specific lesson point for a long period of time. Students in the FI group often replayed the animated visuals over and over (when the control option was not provided) to build up a conceptual understanding. They constructed their own learning in a bottom-up way, using detailed support to construct their own logical reasoning.

Conclusion

When prior physics scores were used as a covariate, the results of this study indicate a significant main effect from the visual control treatment ($p < 0.01$). Students learning the instructional materials with a self-controlled visual presentation performed better than those learning with system-imposed design. The self-controlled visual presentation allowed learners to integrate their own viewing strategies during interaction and learning.

While in the two-way ANCOVA, the effect of cognitive styles was not significant, the study reflected the difference in learning patterns between FI and FD styles. An analysis of observation data reflected similar findings to those summarized in the research literature: the FI students are more analytic and the FD students are more global learners.

Although the FD style has been characterized by a reliance on common sense and intuition and FI learners have demonstrated a tendency to use a trial-and-error approach to problem-solving (Ayersman, 1993), in this study it was observed that the trial-and-error approach was employed by both FI and FD students. However, FD students tended to employ a global conceptual information processing, while FI students tended to employ analytical reasoning in their trial-and-error approach.

The control option in visual presentation allowed FI students to employ their own internal references for analytic thinking more effectively and efficiently. When the control option in visual presentation was provided, it did not substantially influence the FD students' learning, they tended to review the lesson in a holistic way. In processing the information, they preferred to go through the lesson first and then move back and forth to get a general idea about the lesson.

As proposed in this study, the use of the self-controlled visual presentation showed a positive learning effect. However, differences in learner characteristics should still also be considered. In this study, the field independent learners seem to take a more active approach, imposing their own structure on the concept and displaying differentiating performance in response to changing conditions.

As suggested in the literature, exercising control over instruction can be meaningful and successful if students perceive what is best for them and make good choices (Shin *et al.* 1994). The conclusions from this study must be tempered, because of the major limitation that it focused only on a single control issue – visual presentation control. Subsequent research is needed to determine whether the same patterns occur for other control questions. It seems worthwhile for instructional designers to be aware of the types of visual presentation that maximize the efficiency of learning among learners with various characteristics.

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