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ABSTRACT

This study evaluated the effectiveness of an expert instructional system used to provide timely and quality feedback about the quality of a variety of visual materials production techniques to undergraduate students in a basic instructional materials production class. One group of students generated its own feedback by using the expert system, and the other group received feedback from a teacher. The expert system used a question and answer approach which required students to relate textual information to what they already knew, and to evaluate each production project based on a set of criteria for that project. The evaluation task was subjected to two measurements: (1) a content analysis, which was used to count the number of standard criteria cited and the number of new criteria applied or generated; and (2) opinion measurements, which included a self-rating of learning and a rating of the expert system. Nether the quality measurement nor the citation of details measurement (except for evaluation of lettering samples) produced significantly higher results for the group using internally generated feedback. However, the internally generated feedback group produced a significantly greater number of non-standard criteria in the second measurement of the evaluation task. Overall, the opinion measurements of the students who used the expert system to generate their own feedback about their project were favorable. The text is supplemented by 2 figures, 5 tables, and 19 references. (EW)

Internally Generated Feedback with an Instructional Expert System

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Background

The provision of feedback is a major part of instruction. This is especially important in a procedural task, such as the production of instructional materials, where students learn and practice new skills with unknown expectations. Appropriate feedback confirms the learner's expectancy, directs attention to relevant factors, and stimulates recall of relevant skills and knowledge (Gagne, 1977). Generally, research indicates that "appropriate feedback" is precise, frequent, and most valuable immediately following completion of a task (Van Houten, 1980). However, the feedback process is often highly dependent upon the quality of the teacher administering the instructional system.

The impetus for this study arose from the need to provide timely and specific feedback about the quality of a variety of visual materials production techniques (dry mounting, laminating, rubber cement mounting, lettering, and cutting). The provision of appropriate feedback was a persistent problem because minimally qualified teaching assistants (TAs) were used to staff the class lab sessions. The TAs main weaknesses were in the areas of consistency, accuracy, and knowledge of production techniques. Students frequently had to wait long periods for advice on the quality of their skills and projects. There was also a long gap between completion of a project and its evaluation report. While the learning of procedural skills was for the most part successful, there were wide differences in quality and the ability of the students to evaluate their own or others application of the skills.

The purpose, then, of this study was to develop an instructional system that would provide precise and timely feedback. More specifically, the objectives of this project included both basic and applied concerns: first, was the need for a teaching strategy that would facilitate the learning of production skills and their subsequent transfer to an evaluation and self-critiquing task; and second, was the need to develop an instructional system that would efficiently and effectively teach a large number of undergraduates with minimally qualified teaching assistants.

The proposed solution called for an expert system as a central part of a complete instructional system. An expert system seemed a creative and effective because of the likelihood of a change in student processing strategies. It was believed that the expert system would enable the students to use processing strategies not used when receiving feedback from TAs. The TAs, who facilitated learning by offering suggestions and brief critiques of student techniques, did not foster the growth of a schemata appropriate for learning to evaluate productions because their method did not illuminate nor involve the student in using the evaluation criteria. The expert system, on the other hand, offered a method that would illuminate the production criteria by taking learners through questions, choices and decisions in a step-by-step manner. It was expected that the expert system would permit the active manipulation of variables (production criteria) while testing the affects of hypotheses (production practices) would affect learning (Salomon, 1985). Salomon (1985) stated that

> "The more a technique can be designed to activate, model, or short-circuit cognitions hitherto untapped by other means, the greater its opportunity for fostering unique learning effects and for making a difference in learning and development." (p. 210)

In this case, the expert system embedded strategies in the instructional presentation that would encourage the learner to process the information in a systematic and precise way in order to work through the material (Rigney, 1978). In other words, the expert system fostered a more "mindful" (Salomon, 1985) approach to instruction on the part of the learner by directing attention and encouraging a more mentally active role in evaluating their own projects. The expert system also moved the focus of feedback provision from external to internal. The students, in a sense, generated their own feedback rather than having it provided externally from the teaching assistant. Hillman (1970) showed that a group receiving immediate feedback through self-scoring showed considerably more improvement on a standard test than the group receiving 24-hour feedback.

The proposal to use an expert system under such conditions raised several questions. First, could an expert system provide feedback as effectively as a "skilled" instructor? Second, how would the use of an expert system affect the learning of procedural objectives? Third, how would the use of an expert system affect the learning of the ability to apply the production skills to an evaluation task? Finally, what would be the reactions and opinions of students using a "machine" for feedback? The following hypotheses were formed to guide the study:

1. The learning and application of procedural production skills would be equal between a group using the expert system for feedback and a group receiving teacher provided feedback. No difference in procedural skills was expected, despite the feedback system because both groups would be instructed by the same teacher in the same manner and complete the same assignments. Clark (1984, 1985) and Hagler and Knowlton (1987) emphasized that if the message is the same the learning will be the same.

2. A group using an expert system for feedback would provide more detailed evaluations of new projects than a group receiving teacher feedback. The contention is that students using an expert system would receive feedback, but would utilize different processing strategies. If different processing strategies are used, then it is likely that different learning will result. It seemed likely that the expert system users would learn more of the details about the criteria used to evaluate the projects since they would be forced to work through the criterial in detail and this difference would show up on an evaluation task.

3. Expert system users would have a positive attitude about using the system. Several studies (Hess and Tenezakis, 1973; Schurdak, 1967; and Schwartz and Long, 1967) have found that CAI is frequently preferred

by learners, therefore it seemed reasonable to expect that the students would have positive opinions regarding the use of the expert system.

Method

Subjects:

Subjects were 43 undergraduate students from a basic instructional materials production class that was a requirement in the teacher preparation program. Ages ranged from 20 to 40 years of age. There were 25 women and 18 men.

Treatment Groups:

Two treatment groups were used: one group generated itgs own feedback by using an expert system and the other group received feedback from a teacher.

Procedures:

The subjects, though from one class, belonged to two different labs: a morning lab and an afternoon lab. To minimize confounding (Kulik, Kulik, and Cohen, 1980; Clark, 1985; and Hagler and Knowlton, 1987) both groups received the same instruction at the same time from the same teacher.

After attending the morning lecture, the first lab group went directly to a lab session while the afternoon lab left and returned at their appointed time. The treatments were assigned to the lab sections: the morning lab received the expert system feedback treatment and the afternoon lab received the human feedback treatment. Each student performed five production tasks: dry mounting, laminating, rubber cement mounting, lettering, and cutting.

Labs were used as practice and production time. For both groups, the only assistance given by the instructor was in cases of correcting improper or unsafe techniques. When the expert system group had questions regarding the quality of a particular technique or project, they were required to use the expert system for advise. When the teacher-provided feedback group had questions regarding the quality of their work they were answered by the teacher.

One week following completion of the production tasks they evaluated a new sample of each production task. The evaluation task took the form of a written essay whereupon the student wrote as much as they chose about the strengths and weaknesses of each of five project samples.

Expert System Materials:

The expert system was created with an a shell, **Expert Ease** (Human Performance Technolgy, 1984) and used a question and answer approach. Students had to read the questions, analyze their work, make an evaluative judgment, and enter responses to work through the program. The question/response technique was used because questions that require learners to relate textual information to what they already know, to interpret and infer, make the textual material more meaningful and more memorable (Lindner and Rickards, 1985). There was a separate section within the expert system for each production project. Each section was composed of a series of questions based on the criteria (see Figure 1 for a summary of the criteria for each project) used to evaluate each project (see Figure 2 for two screen samples from the expert system program). At the end of each criterion the student was asked to judge whether the project was satisfactory or unsatisfactory with respect to that criterion.

Testing and Measurements:

Each of the five production projects were evaluated on a five point scale. Evaluators used a checklist comprised of the standard criteria for each project. The evaluation task was subjected to two measurements. Within each of the five written project evaluations content analysis was used to count the number of standard criteria cited and of the number of new criteria applied or generated. Opinion measurements included a self-rating of learning, a rating of the expert system.

Results

Table 1 reports the results of the quality of the production projects when compared using a two-tailed t-test (Chase, 1976). Each project was evaluated on a 10 point scale (10 was excellent). Although each project mean for the internally generated feedback group was higher than the corresponding project mean for the externally provided feedback group, the differences were not significant ($p < .05$).

Table 2 reports the t-test results for the number of details that the participants cited from the standard criteria in their written evaluations of sample projects in the evaluation task. The only significant difference ($p < .05$) in the ability of the two groups to evaluate a project was in the evaluation of lettering samples. The internally generated feedback group (2.9333) cited significantly more details than the group receiving external feedback (2.5455).

The second measure of the evaluation task, the number of non-standard criteria generated, showed a significant effect ($p < .05$) for the internally generated feedback group (see Table 3). The internal feedback group generated an average of 1.6 new items for all five evaluation tasks, while the externally provided feedback group provided generated an average of 1.3 new details.

Overall, the opinion measurements of the students who used the expert system to generate their own feedback about their projects were favorable. Table 4 shows that the students believed that the knowledge they gained was essentially the same as the externally provided feedback group. They also believed that the use of the expert system neither improved nor hurt their project evaluation scores. Table 5 presents the summary of results for overall reaction to using the expert system to generate feedback about their projects. Two-thirds of the reactions were at level six or above on the 10-point scale (10 was positive).

Discussion

As predicted, both instructional methods were equally effective in the teaching of the procedural skills used for producing the projects. This result is consistent with Clark's (1984) statements that learning comes from effective instructional design — not from the medium used to deliver the instruction. Note, though, in Table 1, all of the project evaluation means of the internally generated feedback group are higher than the externally provided feedback group. Is this trend due to the novelty effect? Probably not because the use of computers for instruction was not new to the class. Did the students who used the expert system try harder? Again, probably not, because this was the first unit in the first week of a new session — a time when most students are motivated and ready to begin anew. The trend may be due to the positive and specific nature of the questions asked by the expert system. The expert system provided information related to both successes and failures, while the lab assistant usually concentrated on failures of production technique. The expert system provided a means to generated feedback that was non-threatening as well as specific and positive. The feedback generated through the expert system was also timely, students used the expert system either during or after production at a time when corrective feedback is most valuable (Van Houten, 1980).

There were also two indications that internally generated feedback encouraged a different kind of processing and learning. The first indication of this was the significant difference between the two groups on their evaluations of the lettering projects. This may be due to the complexity of the lettering project. The lettering project had seven rather unfamiliar criteria to learn, while each of the four other projects had only five similar criteria (see Figure 1). The step-by-step method of analyzing each criterion with the expert system may have given the participants more memorable practice. The second indication was the ability of the internally generated feedback group to be more creative in their evaluations as represented by their ability to cite more than the standard criteria and to apply criteria from one project to another. This seems to indicate a more thorough learning of all the criteria and their applications.

Finally, the opinions of the students regarding the use of the expert system as part of the instructional program was positive. The expert system was readily available, it was a non-threatening objective evaluation procedure, and permitted the students to take independent responsibility for a major part of their learning process.

It is not the contention here that the reason for the results is the medium — only that an expert system can be an effective part of a well designed instructional system. The results could probably be duplicated with more thorough TA training or student checklists or TA job aids. The computer provides the unique opportunity to demand a response (Avner, Moore, and Smith, 1980) before moving on -- it is a way to prevent short cuts through the designed learning processes. However, the expert system provided an instructional method that placed the responsibility for learning on the student. The internally generated feedback proved as effective as the externally provided feedback for the procedural tasks and better than the external feedback in a declarative task such as evaluation. In other words, the medium was more suited to the objectives for the learner (Allen and Merrill, 1985; Hagler and Knowlton, 1987) in this situation.

The reliance on internally generated feedback with the expert system raises several additional questions. A basic question is whether the expert system that copies or models an expert's reasoning actually teaches the same reasoning process to the users. It would also be interesting to examine the implementation of a more complex expert system, a system that is composed of many questions or that attempts to actually grade a project on a wider scale than pass/fail. The task complexity is also another factor worth investigation. Writing, drawing, or problem solving tasks may also have roles for internally generated feedback.

References

Allen, B. and Merrill, D. (1985). System-assigned strategies and CBI. Journal of Educational Computing Research, 1,(1), 3 - 21.

Avner A., Moore, C. and Smith, S. (1980) Active external control, a basis for superiority of CBI. Journal of Computer-Based Instruction, 6(4), 115 - 118.

Chase, C. I. (1976). Elementary Statistical Procedures. New York: McGraw-Hill Book Company.

Clark, R. (1984). Research on student thought processes during computer-based instruction. Journal of Instructional Development, 7(3).

Clark, R. (1985). Confounding in educational computing research. Journal of Educational Computing Research, 1(2), 137 - 148.

Expert Ease. (1984).

Gagné, R. M. (1977). The Conditions of Learning, Third Edition. New York: Holt, Rinehart and Winston.

Hagler and Knowlton. (1987) Invalid implicit assumption in CBI comparison research. Journal of Computer-Based Instruction, 14,(3), 84 - 88.

Hess, R. and Tenezakis, M. (1973). Selected findings from the computer as a socializing agent: some socio-affective outcomes of CAI. AV Communications Review, 21, 311 - 325.

Hillman, B. W. (1970). The effect of knowledge of results and token reinforcement on the arithmetic achievement of elementary school children. The Arithmetic Teacher, 17, 676 - 682.

Kulik, J., Kulik, C., and Cohen, P. (1980). Effectiveness of computer-based college teaching: a meta-analysis of findings. Review of Educational Research, 50, 525 - 544.

Lindner and Rickards. (1985). Questions inserted in text: issues and implications. In D. Jonassen (Ed.), The Technology of Text, Volume Two. Educational Technology Publications: Englewood, NJ, 131 - 157.

Rigney, J. W. (1978). Learning strategies: a theoretical perspective, in Learning Strategies, H. F. O'Neil, Jr. (ed.), Academic Press, New York.

Salomon, G. (1985). Information technologies: what you see is not (always) what you get. Educational Psychologist, 20(4), 207 - 216.

Schurdak, J. (1967). An approach to the use of computers in the instructional process and an evaluation. American Educational Research Journal, 4, 59 - 73.

Schwartz, H. and Long, H. (1967). A study of remote industrial training via computer-assisted instruction. Journal of Applied Psychology, 51, 11 - 16.

Suppes, R. and Fortune, R. (1985). Computer assisted instruction: possibilities and problems. NAASP Bulletin, 69, 30 - 34.

Van Houten, R. (1980). Learning through Feedback: a Systematic Approach for Improving Academic Performance. New York: Human Sciences Press.

Weiss, S. M. and Kulikowski, C. A. (1984). A Practical Guide to Designing Expert Systems. Totowa, NJ: Rowman & Allanheld Publishers.

Figure 1

Production Criteria for Projects

Lettering

letter spacing
word spacing
line spacing
clarity
straight lines
layout
neatness

Mounting and Laminating

Rubber Cement	Dry Mount	Lamination
stray adhesive	stray adhesive	stray adhesive
bubbles or wrinkles	bubbles or wrinkles	bubbles or wrinkles
straight edges	straight edges	straight edges
layout/margins	layout/margins	layout/margins
neatness	neatness	neatness

Cutting

Name Plate	Easel
sturdiness	sturdiness
straight edges	straight edges
cutting quality	cutting quality
lettering	finishing quality
hinge quality	hinge quality
neatness	neatness

Figure 2

Expert System Shell Sample

Neatness Criterion for the Easel Project

OVERALL NEATNESS:

Neatness is a high priority for all projects. It is a prerequisite, meaning that this criterion must be met before any others will be considered.

PENCIL MARKS: When marking the boundaries of your easel use as few pencil marks as possible. And, make the marks as light as possible for easy erasure. There should be NO visible pencil marks on the easel.

ERASURES: If you need to erase pencil marks make sure that there are no erasures left on the easel.

MISCELLANEOUS MARKS: Avoid grease, coffee stains, and any other material that may make your easel look sloppy.

1) "SATISFACTORY" means that you have a neat, clean and professional appearing product.

2) "UNSATISFACTORY" means that you have one or more of the problems described above.

Sturdiness Criterion for Easel Project

STURDINESS:

The easel should be sturdy and solid. If the easel bends or "bows" as it sits up it is not sturdy enough. Generally, you should not use poster board, which is a bit thin for easels, especially those taller than three inches. You can solve this problem by dry mounting two pieces of poster board together to make a thicker and stronger piece of material from which to cut the easel, or by using corrugated cardboard.

1) "SATISFACTORY" means that you have a neat, clean and professional appearing product.

2) "UNSATISFACTORY" means that you have one or more of the problems described above.

Table 1

Project Scores

	Expert System	Teacher	Signif.
Lamination	7.9048	7.3478	.603
Rubber Cement	7.3333	6.9130	.700
Dry Mount	7.9524	7.6087	.187
Cut	7.1905	6.5652	.146
Lettering	7.1905	6.7391	.372
Overall Score	7.5143	7.0348	.672

Table 2

Number of Details Cited in Evaluation Task

	Expert System	Teacher	Signif.
Lamination	3.5333	3.0455	.618
Rubber Cement	2.8000	2.1818	.779
Dry Mount	2.4667	2.5909	.740
Cut	2.5333	2.5909	.301
Lettering	2.9333	2.5455	.028*

Table 3

Extra Details Mentioned on Written Evaluation Task

	Expert System	Teacher	Signif.
Total No. Extra	1.6000	1.3043	.015*

Table 4

Descriptive Summaries

	More	Same	Less
Amount of Learning	5	16	0
	Better	Same	Bad
Affect on Project Score	4	15	2

Table 5

Overall Reaction to Expert System

negative	0	1	2	3	4	5	6	7	8	9	10	pos.
Reaction	1				2	3	4	5	4	2		
Percent	5				9.5	14	19	24	19	9.5		