The Use of Inquiry-Based Multi-Media Curriculum: It's Impact on Students' Perceptions of Learning

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The use of technology is growing and simultaneously changing the learning process, the structure of knowledge, and the nature of instruction.[1] In a 1995 survey of college campuses, Green and Gilbert[2] noted that major gains have been made in the use of informational technology as an instructional resource and Duffy ad Jonassen[3] indicate that new forms of teaching and learning are changing the way knowledge is constructed. One of areas most frequently cited as benefiting from this use of technology is student-centered, inquiry-based learning. From this point of view, instruction, and hence learning, is a process in which the student is building an "internal representation of knowledge, a personal interpretation of an experience[4]". This involves the sharing of multiple perspectives and the simultaneous changing of representations. Kerr[5] notes that the use of technology as a support to inquiry-based learning should result in greater communication and connectivity, more opportunities to participate in "real world settings via access to better simulations or to actual data, and the opportunity to explore unusual representations of data, knowledge, and opinions."

Purpose of the Paper

The purpose of this paper is to present the findings of a formative pilot study conducted to investigate the preliminary effectiveness of an interactive, multi-media supported, inquiry-based curriculum module developed for use with engineering students in the materials handling domain. The primary variables under study were student perceptions of the process of learning via this technique; more specifically, it addressed their perceptions of the relevance of the module to learning and applying course specific content, the relevance of module use to learning in general, and the impact of module use on their general learning affect.

The Module Under Study

The module developed for this pilot study had as its basic educational objective the integration of knowledge of materials handling with expected practices and outcomes. Its goal was the development or refinement of problem-solving skills via virtual interactions in increasingly complex materials handling settings. The content reflected basic principles of materials handling with interpretations and uses offered by managers, engineers, and students. Diverse settings were portrayed via media-supported clips of actual uses and oral as well as written overviews.

The module was targeted to meet the needs of two types of learners:

- Engineering juniors or seniors who had strong modeling skills but limited knowledge of technology or practice, or

- Working professionals who had “rusty” modeling skills, but a strong knowledge of current technology and practice.

This pilot study addressed the impact of the use of the multi-media materials for students in a traditional higher education setting.

The pedagogical method utilized a layered approach to learning where students first were introduced to, or reviewed, basic facts and elementary examples. This was followed by a progressively more complex presentation in which students had to analyze and synthesize information. Ultimately, the goal of the module has to place users in a position where they could combine knowledge and practice across and within sub-modules to perform in-depth problem solving activities that were similar to those of the real practitioner.

Methodology for the Pilot Study

Sample. Participants in the study consisted of 36 students enrolled in materials handling courses at Rensselaer Polytechnic Institute. These students were primarily juniors or seniors in industrial management engineering; approximately 25% were female; almost all had English as their primary language; and most had a high school GPA of 3.5 or higher. In addition, almost all participants had utilized computerized instructional modules in college classes prior to this experience.

Instrumentation. Three types of instrumentation were developed for this study. The first consisted of an observation protocol that was used to guide the researchers’ collection of data and the process of use while it was taking place. Key variables included: perceived student interaction with the material, perceived student motivation, documentation and impact of hardware/software problems during use, and student-student and student-instructor interactions. To support the collection of these data, two observers were present in the classroom; one was a participant observer, the second only observed. In addition, selected participant usage was videotaped and reviewed to document reliability and validity of observation findings.

The second instrument developed for this study was a paper-pencil survey to be completed by students at the end of module use. Items included student demographics, prior use of modules, perceptions of the relevance of the content, the availability of technological and instructor supports, the format of the classroom, and perceived outcomes of use. Perceived outcomes of use, the variables under review in this study, consisted of a series of 11 five-point Likert-type items (strongly agree to strongly disagree) addressing cognitive and affective outcomes. Three different domains were measured by these items: outcomes related to specific learning, outcomes related to general learning, and outcomes reflective of learning affect. These items have been field tested and proven to be valid in a series of studies investigating the impact of technology-supported instruction and learning. Coefficient-alpha internal consistency for the current study was greater than .65 in all domains. This instrument was distributed to all students participating in the project.

The third instrument designed for the pilot was an individual face-to-face interview protocol used by the researcher/non-participant observer. A sub-sample of students participated in this data collection (n=7). Variables included: prior experience in using a technology supported learning module, perceptions of the overall relevance of the module, the best and worst aspects of use, suggestions for modifications, areas in which learning took place, and desire for further use of similar modules. Inter-rater reliability of interview coding was greater than .85.

Findings

Findings for this study are addressed under four major headings: those related to perceptions of specific content outcomes, those related to perceptions of general learning outcomes, those related to learning affect, and those related to unexpected outcomes. Relevant data from surveys, interviews and observations are synthesized under each heading.

Content Specific Learning Outcomes. Data in Table 1 indicate that the majority of student participants perceived positive results when queried as to specific learning outcomes. A large majority (88%) indicated that use of the module helped them to think pictorially and 70% noted that its use helped them to recall course content. A lesser number (58%) perceived that use of the inquiry-based module helped to develop specific problem solving skills. During interviews with students, several noted that the use of video's and "real" settings as portrayed via the multi-media technology helped them to see how they would use the material as practitioners. Observations of students during use supported this finding; students spent more time on the real use videos than on the script sections and used the pictorial displays as reference points when back-scrolling through material

Table 1
Participants' Perceptions of Specific Content Learning Outcomes
Percent of Agreement

Item	% Agree
Helped me think about problems in graphical or pictorial ways	88
Recalled course content	70
Developed my skills in solving problems in the course content	58
Improved my grade	42

General Learning Outcomes. An overwhelming majority of students (Table 2) noted that use of the module helped them to apply course content to new problems (82%) and to transfer knowledge to problems outside the course (70%). A majority of students (61%) also indicated that the module helped them to develop different ways of solving problems. When queried during interviews, students noted that they liked the modules' presentation of different stakeholder perceptions (manager, engineer, and student) and that the use of these viewpoints made them think of the use of knowledge in different ways. Classroom observations and the review of tapes supported this finding. It was noted that the majority of students accessed multiple viewpoints and questions. No specific order was noted in selecting the stakeholders during the pilot, but students did consistently talk about the manager point of view first.

Table 2
Participants' Perceptions of General Learning Outcomes
Percent of Agreement

Item	% Agree
Apply course content to new problems	82
Transfer knowledge/skills to problems outside the course	70
Develop different ways of solving problems	61

Learning Affect Outcomes. Use of the module also was perceived to impact learning affect. A majority of students (Table 3) noted that use of the inquiry-based, media-supported module assisted in developing both their confidence in their knowledge of the content area (82%) and their interest in the content (64%). Approximately two-thirds of the students agreed that use of the hands-on interactive material also motivated them to learn the content, while about half (48%) noted that it helped to develop attitudes of self-direction and self-responsibility for their own learning. During interviews, students noted that the ability to try out different approaches, to work at their own pace, and to look at the material from different viewpoints was very effective in developing confidence and interest. Several noted that this "personal growth" was more important than learning the actual content. Observations in the classroom support the intensity of these affects; students were noted to be actively engaged in using the module, to be involved in the problem-solving efforts, and to be willing to tolerate hardware and software failures with low levels of frustration when re-commencing work.

Table 3
Participants' Perceptions of Learning Affect
Percent of Agreement

Item	% Agree
Develop confidence in content area	82
Develop interest in content area	64
Become motivated to learn content area	64
Develop attitudes of self-direction/self-responsibility in learning	48

Overall, an overwhelming number of students perceived their interaction with the modules to be a valuable experience. As noted in Table 4, 85% of the respondents agreed the module was valuable, and during interviews, all the participants indicated that they would like to have more modules in the current class and in other classes.

Table 4
Participants' Perceptions of Value
Percent Agree

Item	% Agree
Overall, the instructional module was valuable	85

Unexpected Outcomes. During interview and in open-ended questions on the paper-pencil survey, data were found to support three unexpected outcomes. First, although the module was not developed to be used in collaborative learning settings and the classroom setting was arranged for autonomous learning, approximately half the students noted that it supported collaborative or group interactions. When queried further, they specifically noted the use of collaboration in learning how to use the module, interest in the inclusion of the multiple perspectives within the modules, and the discussion that these perspectives generated, especially the perspectives of the managers and engineers. Several noted that the "student" questions presented as part of the module made them feel more open to self-questioning. A second unexpected outcome was frequent reference to the "depth and breadth" of knowledge in the field that they still had to learn. As one student noted "there are still so many things I don't know." This outcome is related to the third unexpected outcome: the need to know and appreciate different viewpoints. During interviews, students repeatedly remarked on the importance of understanding problems from different points of view and how it was "interesting" to think about and to try to understand them.

Conclusions

The findings of this project have clear implications for the continued development of multi-media supported curriculum modules. The project designed, created, and tested an inquiry-based approach to learning that used multi-media tools to bring the "real world" to the classroom. Preliminary evidence was found to support an impact on college students' cognitive and affective domains. Further work in this mode of instruction and learning should be continued and adapted to other disciplines and to other users. The project still needs to be replicated with more content and with other forms of media support; in addition, long-term outcomes of cognitive and affective change need to be documented for students in traditional and non-traditional classroom settings. The utility of this mode of instruction for in-service training and workforce development also must be examined along with the concomitant learner variables. Overall, the use of inquiry-based, multi-media instruction appears to hold a great deal of promise as a method of enhancing learning for students and this study supports the continued documentation of its impact with different groups of learners.

[1]Alley, Lee R. and Repp, Phillip C. (1996, March/April). Technology precipitates reflective teaching: An instructional epiphany and the evolution of a Red Square. Change, 28, 2, 48-54

[2]Green, Kenneth C. and Gilbert, Steven W. (1995). Great expectations: Content, Communications, and the role of Information Technology in Higher Education. Change, 27, 8-18

[3] Duffy, Thomas M. and Jonassen, David H. "Constructivism: New Implications for Instructional Technology" in Duffy, T. M. and Jonassen, D. H. (eds.) Constructivism and the Technology of Instruction: A Conversation. Lawrence Erlbaum Associates, Publishers, Hillsdale New Jersey pp1-16.

[4]Bednar, Anne, K., Cunningham, Donald, Duffy, Thomas, M., and Perry, J. David. (1992) Theory into practice: How do we Link?" in Duffy, T. M. and Jonassen, D. H. (eds.) Constructivism and the Technology of Instruction: A Conversation. Lawrence Erlbaum Associates, Publishers, Hillsdale New Jersey pp17-34.

[5]Kerr, Stephen T. (1996) "Visions of Sugar Plums: The future of technology, education, and the schools" in Kerr, S.T. (ed.) Technology and the Future of Schooling. 95th Yearbook of the National Society for the Study of Education Part II. University of Chicago Press, Chicago, Illinois pp1-27.

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