Student Learning and Student Perceptions of Learning from Interactive Modules

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***Abstract*— The constructivist approach to online module design, whereby the learner constructs knowledge through activity, appears to offer instructors and students a way of achieving learning outcomes. However, analysis and evaluation of these new learning environments is lacking, especially in the area of how academic content in interactive environments impacts student actual learning and perceptions of learning. This paper documents the process to improve module design using focus groups and to test the effectiveness of the interactive elements based upon assessments of student learning outcomes tailored to online learning environments. Results from student learning assessments enable instructors to optimize instructional design to maximize learning opportunities and achievement in online environments.**

Keywords—multimedia instruction; interactive online modules; cognitive learning; student perceptions of learning; human geography

I. INTRODUCTION

By its very nature, geography is a visual and interactive subject [1, 2]. Traditional resources for classes in this subject area offer only limited interactive opportunities that challenge students to apply geographic concepts to real-world situations [2, 3]. For our introductory human geography course and as part of the development of a completely online textbook, we have developed a series of online interactive learning modules. These modules include imagery, custom videos, readings, discussions, animations, interactive exercises, and assessments. In these modules the integration of theory and applications takes place through activities in which theories and ideas are applied for use in practical situations to answer real-world geographic questions, bringing the course material "alive" for students. The purpose of this research is to investigate how these interactive e-learning activities affect student learning and student perceptions of their learning.

This paper begins with the literature associated with student interactivity and its importance related to student learning. Within the literature review, the theoretical framework for the design of the online interactive modules is presented. Specific examples of disciplines that have used interactive designs and how it has been applied to assist in student learning are included. Then, the design of the modules is detailed. Next, we outline the use of student focus groups and module testing using a control group experimental design. Finally, we conclude with the broader implications of this research on optimizing instructional design to maximize learning opportunities and achievement in future online and distance learning environments

II. LITERATURE

With the application of concepts in real-world situations, the intent is to engage students with the course materials to improve student learning. Much of the literature discussing interaction in online classes addresses either the interaction between student and instructor and among students [e.g., 4, 5, 6] or the level of interaction of students with the technology as determined by frequency counts and access rates [e.g., 7, 8, 9]. Less attention, however, has been given to studying the interaction between students and course content and achievement of learning outcomes. As technology has developed and become a more integral part of the distance learning environment, and, even in the traditional classroom setting, it has impacted the distribution of content, learning tasks, and assignments [10]. The ways by which information is presented and also the way in which students interact with that material is important. Furthermore, the medium employed can motivate and engage students as active and collaborative learners rather than just providing information to them. Multimedia instruction rather than "flat resources," such as static text documents, have been identified as an important element of high-level interactive engagement and student satisfaction [9].

The design of the online interactive modules for this study is based on a cognitive theory framework that supports multimedia design of educational materials [11, 12, 13]. Mayer's research on cognitive theory-based assumptions regarding the way that people learn from words and pictures indicates that animation and narration (what Mayer considers the two elements of the "Dual Channel Assumption) in computer-based multimedia presentations results in deeper understanding in learners [13]. Mayer also presented, but did not test, the "Active Processing Assumption" which states that students engage in meaningful learning when they actively process material through "selecting relevant words and pictures, organizing them into coherent pictorial and verbal models, and integrating them with each other and appropriate prior knowledge" [13]. This research seeks to study the impact on learning of actively processing content through interaction.

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Hence it attempts to expand upon the research that studies the link between cognition and instruction [13].

In the fields of computer programming, nursing, and biology, modules with various levels of interactive 'learning objects' have been designed to improve student understanding and learning [11, 12, 14]. In a Java programming course, Bradley and Boyle [14] made their learning objects optional resources. They found that students accessed the learning objects in large numbers and, in a survey students indicated that the learning objects helped them to learn the concepts being addressed. While they experienced an increase in the percentage points achieved on the modules, the authors felt that the exact contribution of the learning objects was difficult to assess because they were used as components in larger pedagogical systems [14]. Maag [12] found that while there were no statistically significant increases in math-test scores from the pre- and post-test with the use of interactive multimedia, those students who had used the interactive multimedia reported the highest satisfaction score. Black et al. [11] focused on the creation of interactive objects and did not report on the impact of the interactivity.

This concept of knowledge transmission is based on a constructivist point of view where knowledge is constructed by the learner through activity [10]. This construction has led to the development of "new learning environments" or what Martens et al. [10] call "constructivist e-learning environments" (CEEs) in which activities are created to challenge students and provide them with realistic contexts so that students become intrinsically motivated to explore and control their own learning process.

Guzley et al. [4] suggest that students' motivations are linked to their satisfaction with distance learning as a mode of instruction, in turn affecting their perceptions and influencing the overall effectiveness of the learning. This makes students' satisfaction with, and perceptions about, the learning environment and process critical [10]. Since measurements of the causal effect of pedagogical techniques on student learning can be difficult to isolate, student self-reported learning gains also have been identified as a useful indicator of actual learning [15, 16, 17, 18]. The literature on student perceptions of learning indicates that student perceptions may be more important than reality since decisions are often based on perceptions [15]. Furthermore, Chesebro and McCroskey [15] concluded in their research that, "students can provide reasonably accurate reports of the extent to which they are learning in their classrooms" (301).

Designing new learning environments is challenging. Much of the available research shows an emphasis on delivery of these new learning environments rather than on analysis or evaluation [20]. Designers of these tasks rarely gain knowledge of how students will perceive the tasks before they are delivered to the students. Greenberg [21] asserts that quality assessments should be taking place during the design of the course and include the course creators. Finally, while claims about the positive results obtained using these new learning environments have been made, strong empirical research regarding their influence on students' perceptions and the motivational impact of CEEs are lacking [10].

III. MODULE DESIGN

Each interactive multi-media module is designed using a similar structure, requiring approximately 30 minutes for completion. Using a web-based format, the module begins with a short reading providing an overview of the applied topic and lists the learning objectives. This reading is approximately 1-2 paragraphs in length. Next, a 3 minute narrated animation illustrates a key concept. This is followed by a five minute interview with an expert in the field discussing the geographic implications of the topic. Finally, a series of interactive exercises allows the student to explore the topic using geographic tools (e.g., visual examination, verbal descriptions, digital mapping, cognitive perceptions, and mathematical modeling). For each module element described above, an interactive textbox appears to the right where the student is encouraged to take notes. The module ends with a self-assessment. This self-assessment is required for completion of the module.

IV. MODULE IMPROVEMENT USING STUDENT FOCUS GROUPS

To improve the e-learning modules, we will use focus groups to investigate student perceptions of learning and teaching effectiveness [e.g., 22, 23, 24, 25, 26]. For example, Kingston *et al.* [23] utilized mobile technologies and virtual fieldtrips to teach physical geography. Students who had taken the old module and completed the new module were given questionnaires and then participated in a focus group to investigate the effectiveness of the new technologies. Lederman [26] also suggests that focus groups can be very useful for pre-testing educational materials as they "provide an opportunity for extensive commentary, unrestrained by the limits of a survey questionnaire or the student-teacher relationship which may affect course evaluations at the end of a class" (126).

The interactive modules will be tested with focus groups, comprised of approximately 5-7 student volunteers in each group. Each student in the group will be asked to complete a common module in advance of the focus group interview. Based upon established learning outcomes for the modules, students will provide feedback on how the interactive exercises affected their learning. The semi-structured focus group interviews also cover topics of engagement, clarity of concepts, ease and usefulness of exercises, and suggested improvements (Fig. 1). To ensure data acquisition both members of the research team will be present – one to serve

Introductions
Facilitator introduces members of the research team and each of the group members introduce themselves. The facilitator provides the background and ground rules (confidential and anonymous reporting, honest opinions, etc.). The facilitator will inform the group that we would like to collect notes made by the participants during the session to ensure we collected as much feedback as possible, if the participants are willing.
Issues and Discussion Questions (Semi-structured)*
Overall Impressions
- *Please share with us overall how you felt about the modules?*
- *What did you like about the modules? What didn't you like about the modules?*

Engagement
- *What about the material (videos, photos, readings) did you find the most engaging?*
- *How did the interactive exercises affect your interest in the content?*
- *Did any of the material or exercises make you want to learn more about the topic? If so, which and how?*

Clarity and Ease of Use of Elements
- *What concepts or parts of the module were the most clear? The least clear?*
- *What aspect of the interactive exercises did you find the clearest/easiest? What aspects were unclear/more difficult?*

Learning
- *Overall, how useful did you find the exercises?*
- *How did the interactive exercises assist you in understanding course content? In applying course content?*
- *How did the interactive exercises challenge you?*

Improvements
- *What improvements could we make to improve the elements of the modules?*

Summary of what we have heard
- *Have we missed anything?*

Collect notes (to review later).
*Questions may be modified based upon results from post-module questionnaire.

Figure 1. Focus Group Questions

as moderator and the other as a note taker who records speakers, comments and significant non-verbal behavior [27]. A summary of the issues will be presented to the group at the conclusion to ensure no notable comments were excluded.

Concerns about the use of focus groups persist, including "groupthink" [28]. We have two mechanisms to minimize this. First, students will each fill out a short questionnaire at the completion of the module (Fig. 2). The questionnaire allows us to obtain individual feedback that may not come out in the group discussion but that may be vital to improving the e-learning modules. Second, we will ask the focus group members to jot down notes during the group interview. These notes will be collected at the end – in the event that members did not get a chance to share their comments.

For the analysis of the focus group interviews, we will code the data, create categories emerge and develop summary statements which capture the essence of the responses [26, 29]. The results of the coding offer two outcomes. First, the student responses will identify which of the interactive exercises have greater perceived value to students. We will compare these responses to student performance on the various assessments to see if there is a correlation between perceptions of learning and performance. The modules will then be revised to address weaknesses.

V. MODULE TESTING IN CLASSES

The revised modules will then be implemented using a pre-test/post-test control group design to test for effectiveness of the interactive components on student learning and perceptions of learning. In one semester, two separate classes (approximately 40 students in each class) will be presented with two of the applied geography topics. The control group (Class 1) will have access to only the multi-media elements and the experimental group (Class 2) will receive the full interactive module. The modules will be completed within 2 days to alleviate threats to external validity with exposure to the subject material from the pre-test. Both groups will be tested at beginning of the module and at the conclusion of the modules based upon the learning objectives. The pre-test will enable the researchers to determine existing knowledge base, which the post-test will allow for determination of learned knowledge. Differences between the control group and the experimental group will illuminate the effect of the interactive elements.

1. The interactive exercises helped me to (learning outcome #1).
⎸Strongly agree ⎸Agree ⎸Neither agree nor disagree ⎸Disagree ⎸Strongly disagree

2. The interactive exercises helped me to (learning outcome #2).
⎸Strongly agree ⎸Agree ⎸Neither agree nor disagree ⎸Disagree ⎸Strongly disagree

3. Overall, the interactive activities:
⎸Made no difference to how I learned ⎸Helped me learn more ⎸Were detrimental to my learning process

4. The interactive activities in these modules are challenging
⎸Strongly agree ⎸Agree ⎸Neither agree nor disagree ⎸Disagree ⎸Strongly disagree

5. I am comfortable with the interactive activities in these modules
⎸Strongly agree ⎸Agree ⎸Neither agree nor disagree ⎸Disagree ⎸Strongly disagree

6. I would like to have more interactive exercises in my courses
⎸Strongly agree ⎸Agree ⎸Neither agree nor disagree ⎸Disagree ⎸Strongly disagree

7. Please comment on how specifically the interactive exercises can be improved.

Note: The questions will be modified to reflect each module's learning outcomes.

Figure 2. Perceptions of Learning Questions

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Independent t-tests will be conducted to examine the mean values of the control and experimental group scores and the gain scores for the control and experimental groups will be analyzed for ANCOVA (analysis of covariance) [30].

Beyond assessment of student learning from end of module quizzes, students from the experiment group will also be asked about their perceptions of learning using the questions from Fig. 2. The results of these questions will be presented as descriptive statistics. Finally, data from student notes recorded next to the module elements will be coded. The student perceptions of learning and engagement of students (documented through note-taking) will be compared to student post-test scores to look for correlations.

The researchers will then review the results from the pre-test/post-test control group design assessments of learning and perceptions of learning to complete final revisions of the interactive modules.

VI. CONCLUSION AND FUTURE WORK

Educational delivery models for college courses have changed from primarily the traditional lecture in the 1980s. Contemporary educational delivery models include online and distance education; however, there has been a gap in the assessment of these learning technologies of their impact on student learning [19]. As new generations of students arrive at institutions of higher education with, "a greater reliance on visual imagery and on participating actively in the learning process that probably stem from experience with electronic media during formative years" [11], this type of interactivity with course content has become increasingly important. Given the rising importance of the computer and interactive learning, how should multimedia be designed and integrated into teaching to promote deeper understanding and learning for students? Educational research of this nature tackles the fundamental question of how to optimize instructional design to maximize learning opportunities and achievement in online and distance learning environments [5]. Knowledge about the outcome of interactive activities in distance learning instruction will be valuable for educators and researchers to make more informed decisions about future online and distance learning course development and implementation [10]. Thus, by enlisting students in curriculum development, we expect to improve the module content and interactive activities by directing revision based on student perception of learning. More broadly, this research will be a contribution to the existing literature that has been limited in its analysis of how students learn in interactive e-learning environments. Future research will include a study to better understand the specific learning benefits and constraints involved in student interaction with a variety of interactive elements and combinations of interactive elements in the online environment.

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