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The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **ISCAP** (Information Systems and Computing Academic Professionals). Publishing frequency is six times per year. The first year of publication was 2003.

ISEDJ is published online (http://isedj.org). Our sister publication, the Proceedings of EDSIGCON (http://www.edsigcon.org) features all papers, panels, workshops, and presentations from the conference.

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Active Learning and Formative Assessment
in a User-Centered Design Course

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Abstract

Trends in higher education call for teachers to do more to provide students an engaging and meaningful classroom experience. When active learning activities are added to classes, students interact and investigate topics in an interactive manner instead of relying solely on lecture to learn content. Often planned learning activities can also serve as formative assessments which support instruction and learning as they provide feedback to both students and instructor. This paper reviews literature related to active learning and the use of formative assessments. Then five different activities that were used as formative assessments in a user-centered design course are explained. Students responded to a survey asking about the learning benefit and enjoyment of the activities. Survey results, discussion, limitations, and comments about future ideas are also included.

Keywords: active learning, formative assessment, student perceptions, Human Computer Interaction (HCI), User-centered design

1. INTRODUCTION

Higher education is experiencing many changes and challenges with shrinking state budgets, fewer available students, pressure to build new facilities, and deeply discounted tuition rates (Marcus, 2017). These challenges prompt colleges to look more carefully at their priorities and determine ways to retain more of their current students. The emphasis on current students can also be seen in the classroom as we experience a shift from a teacher-centered emphasis where a faculty member lectures and students sit passively in class to student-centered approaches to learning (Lumpkin, Achen, & Dodd, 2015).

Researchers are finding that college faculty need to do more than just lecture during class (Keeley, 2011; Lavy & Yadin, 2010; Lumpkin et al., 2015). Heinerichs, Pazzaglia, and Gilboy (2016) emphasized that exposing students to lectures limits students to "remember" and "understand," the lowest two levels of Bloom's taxonomy. In addition, teachers who only lecture during class need to rely on student questions in class or during office hours to estimate student learning (Heinerichs et al., 2016). Lectures are less effective for keeping students engaged, lacking the communication needed for effective feedback (Lavy & Yadin, 2010). Without this feedback loop, "what we think we are teaching our students is not necessarily what they are learning" (Owen, 2016, p. 168).

This paper begins with a review of literature related to the use of both active learning activities and formative assessment in classrooms. Then several examples of how active learning and formative assessment were used in a college user-centered design (HCI) course are explained. The results of a student survey are also shared.

2. LITERATURE REVIEW

Active learning can be defined as "any activity encouraging students to participate in learning approaches engaging them with course material

and enhancing critical thinking as they make applications beyond the classroom" (Lumpkin et al., 2015, p. 123). While lectures can still be used, the emphasis is on engaging students during class. Engagement is encouraged in today's classrooms and can take on many forms including collaborative learning, problem-based learning, or cooperative learning (Hyun, Ediger, & Lee, 2017). Several studies examined the impact of active learning on student attitude and learning. Most studies report that active learning positively influences student learning as students comprehend and remember new content better (Hyun et al., 2017).

Some teachers prefer to combine lectures and learning activities. Incorporating group work as class activities does not mean the class must be lecture-free (Cavanagh, 2011; Cooper, MacGregor, Smith, & Robinson, 2000). In one study, large classes were presented with a combination of lecture and cooperative learning activities, each part lasting 10-15 minutes. In one session, students were exposed to two or three learning activities including large group discussion, small group or pair activities, and case studies. Nearly all of the participants indicated the activities helped them learn and understand the content while all of the participants agreed that the activities kept them interested and paying attention during class (Cavanagh, 2011). Research modeling, role playing, and problem-based learning were used as active learning and formative assessments in another large group study in a psychology course. The common themes of the free-form student responses were engagement and retention of material (Winstone & Millward, 2012).

Lumpkin et al. (2015) used exploratory writing assignments, small group and pair discussions, minute papers, and oral reports in an effort to incorporate active learning in five different courses. Students reported the activities helped to clarify the material and increase their understanding and recall. Activities were described as "an invigorating break, interesting, interactive, and enjoyable" (Lumpkin et al., 2015, p. 129).

Activity-based learning design was incorporated in a GIS map drawing exercise which allowed thinking and doing to be connected. The students who had the exposure to these activities and feedback did better on their final assessment than students in a previous semester when the

activities were not used (Srivastava & Tait, 2012).

Multiple studies have found that small group activities are an effective way to allow students to engage in material (Cooper et al., 2000; Griffiths, Kutar, & Wood, 2010; Lumpkin et al., 2015). Students working collaboratively not only benefit from hearing others which may prompt them to look for better answers (Lavy & Yadin, 2010) but also feel the need to contribute higher quality ideas since others will be listening to their ideas, too (Griffiths et al., 2010). Cooper et al. (2000) found that the small group activities increased critical thinking and confidence in students while also increasing class attendance. Students in the Lumpkin et al. (2015) study showed overwhelming support for the use of pair and small group work to improve their learning.

Clearly many of the examples of active learning include group work where it would be best if students were physically arranged in groups in classrooms. College classrooms are often not set up with tables or movable furniture. One study looked at sixteen classes taught in either an active learning classroom (with round tables, multiple flat-panel display projectors, a glass marker board, and central teacher station) or a traditional lecture classrooms with desks. The active learning pedagogy was a significant predictor variable of student satisfaction in both the traditional and active learning classrooms. The number of active learning methods incorporated in the class were positively associated with student satisfaction (Hyun et al., 2017). Students indicated a preference for the active learning classrooms, but evidence shows a traditional classroom arrangement does not have to be an impediment to small group activities.

Another way for students to be more involved in the classroom is to provide formative assessment opportunities. When students think of assessment, they think about tests and grades which are generally related to summative assessments used to evaluate learning. Black and Wiliam (2009, p. 9) describe formative assessment as "Practice in a classroom is formative to the extent that evidence about student achievement is elicited, interpreted, and used by teachers, learners, or their peers, to make decisions about the next steps in instruction that are likely to be better or better founded, than the decisions they would have taken in the absence of the evidence that was elicited." Formative assessments are designed to improve

learning and support instruction (Crisp, 2012; Keeley, 2011). Formative assessments are normally not graded and often are anonymous (Angelo & Cross, 1993). An assessment can be considered formative if "a teacher uses information from a particular assessment to track learning, give students feedback, and adjust instructional strategies in a way intended to further progress toward learning goals" (Greenstein, 2010, p. 29). The introduction of formative assessments fits with activities being done already in a classroom and allows students to examine their own ideas as well as hear from their peers (Keeley, 2011).

Most agree that teachers should provide a variety of assessment tasks (Crisp, 2012). Summative assessments are typically required in order to earn a grade, but formative ones are not. There are many advantages to using formative assessments. When students have completed formative assessments, they can be less dependent on teachers and can better prepare for future assessments and assume greater responsibility for their own learning (Owen, 2016; Srivastava & Tait, 2012). In fact, multiple sources emphasize the validity of the feedback loop that is available on an ongoing basis when formative assessments are used (Crisp, 2012; Heinerichs et al., 2016; Yu & Chia-Ling, 2015). Teachers can use the assessments to make data-driven decisions about how to adjust and plan for future instruction (Keeley, 2011).

The biggest drawback to incorporating formative assessments and active learning activities is that teachers spend more time preparing for class (Hyun et al., 2017; Lavy & Yadin, 2010; Winstone & Millward, 2012). Another concern is using class time for activities and formative assessments reduces the available time to cover the content in class. This means some content may not be included; however, better learning ranks higher than just covering more material (Lumpkin et al., 2015).

There are entire books devoted to formative assessment and the different techniques that can be used in the classroom. Some common techniques are using clickers to test knowledge or take a poll, muddiest point to find out what students do not understand, and minute papers to have the students summarize something from class (Angelo & Cross, 1993; Heinerichs et al., 2016). Researchers have attempted to create categories or strategies to classify formative assessments. Wiliam and Thompson (2006, p. 64) identified five key strategies, "1. Clarifying

and sharing learning intentions and criteria for success. 2. Engineering effective classroom discussions, questions, and learning tasks that elicit evidence of learning. 3. Providing feedback that moves learners forward. 4. Activating students as instructional resources for one another. 5. Activating students as the owners of their own learning." Keeley (2011) used the categories: engagement and readiness, eliciting prior knowledge, exploration and discovery, concept and skill development, concept and skill transfer, and self-assessment and reflection. The formative assessments in this course fit into one or more of the strategies or categories identified by William and Thompson (2006) and Keeley (2011).

In this study, both active learning activities and formative assessments were used. Other studies have also used both including Heinerichs et al. (2016), Srivastava & Tait (2012), and Winstone & Millward (2012). The active learning activities can serve as a basis for evaluation and feedback to fulfill formative assessment conditions.

3. USER-CENTERED DESIGN COURSE ACTION RESEARCH

This action research project was undertaken to get feedback from students on the use of various activities and formative assessments in a User-Centered Design course with Human Computer Interaction (HCI) content. Twenty-two Information Systems graduate students were enrolled in the course which met for 75 minutes two times a week. The class used a lecture and activity approach with a short lecture at the beginning of most class periods and then activities, often group or pair activities where the students would share their findings with the rest of the class. Five activities that were used in the class and served as formative assessments are described next. None of the following activities had points associated with them; students knew class participation was a regular part of the course.

The first activity was a key to class (sometimes referred to as a ticket to class or entrance slip). The key to class is a learning task to produce evidence of learning and provide a way to gauge engagement and readiness. It was assigned at the end of the first class meeting, and students were asked to identify an item or device they had trouble figuring out. They were to describe the design problem and to determine at which stage the action failed. The book "The Design of

Everyday Things" by Donald Norman was being studied at this point.

As students entered the classroom on the second day of class, they handed me their paper with the answers. I then randomly selected papers, read some of them aloud, and then we discussed their answers. Discussion can stimulate student interest in the subject as well as provide feedback on how well the students are understanding the content (Greenstein, 2010). The students appeared to enjoy hearing what others had discovered and it led to a lively discussion. From this assessment, it was clear that they were becoming more cognizant of design in their daily living but were confused with the stages of action. Adjustments were made to include more examples of the steps in the upcoming classes.

Muddiest point asks students to share what the most confusing or unclear part of an assignment (Greenstein, 2010). The muddiest point exercise serves as a stimulus for providing feedback to advance learners as well as enhancing concept and skill development. The students were still studying the Norman book when they were instructed to read a chapter before class and then write 2 questions. The first question was their muddiest point. The second was a discussion question the class could use. As students entered class, they handed in their papers which were quickly scanned to see what the most common confusing points were. Muddiest point exercises are easy to give but require the teacher to quickly analyze answers and determine what to share. Mental models was a common muddiest point so that part of the lecture was explained more carefully. The discussion questions were not used, but it was evident that students struggled to come up with questions that could be discussed.

The next activity was planned right before the first exam. Student-generated test questions can serve as a summary assessment as students are expected to review the material to come up with the questions (Greenstein, 2010). These questions allow teachers to see what content the students believe to be most important, what they deem to be fair and reasonable test questions, and how well they know the material in order to answer the questions (Angelo & Cross, 1993). Student-generated test questions compel students to take ownership for their own learning and allow self-assessment. Having the students serve in a different role could provide them some insight into the assessment process (Lavy & Yadin, 2010). Yu and Chia-Ling (2015) referenced

several studies where student-generated questions helped students become more active learners, concentrate on important ideas, reflect on material, and improve problem-solving abilities. Their latest research went further to have students create and edit a test found that students noted cognitive advantages including the opportunity to apply material instead of memorize and use higher-order thinking skills (Yu & Chia-Ling, 2015).

Students were asked to write six questions that could be included on the first exam. Class time was used to review the questions and answers, providing a review of the material covered. Many of the questions students submitted were similar in concept and wording. The students quickly realized that writing test questions was hard as often more than one of their multiple choice options could be correct. I also made comments like "I like this question" or "I would not ask this" and then explained my reasoning. Some of the questions were used or adapted slightly and used on the first exam.

One class topic was usability testing with paper prototyping as well as using electronic methods. Two videos were selected to demonstrate these ideas. Prior to class, the instructor watched the videos and created an empty outline. An empty outline includes a partially completed outline with spaces for the student to complete during the lesson (Greenstein, 2010). The empty outline activity fits into clarifying and sharing criteria for success as the students knew what they needed to learn from the videos. The students submitted their completed empty outlines at the end of the videos, and the outlines were analyzed to see what concepts the students knew well and which ones were unclear. For example, students knew the messages to share with the subjects in a usability test as their answers were thorough and appropriate. This is probably because both videos addressed this step. The part of the outline that was incorrect for many was the role of content in paper prototyping. In the next class, this concept was clarified and explained more thoroughly.

Information Systems graduates secure roles in organizations where they are known as liaisons between technology and business professionals since they have background in both areas. They must be able to adapt their message to their current audience. Directed paraphrasing requires the students to summarize and restate important material for a given audience, making it more challenging than simple paraphrasing (Angelo &

Cross, 1993). Directed paraphrasing provides feedback for moving forward as well as allowing students to be a resource for others in the class. In addition, the activity fulfilled concept and skill transfer as the students had to apply their knowledge in new situations.

The instructor created 11 directed paraphrasing tasks related to web colors and fonts, usability testing, and prototyping. The students worked in pairs to generate their response. One of the tasks was: "You are a systems analyst, and your current project is designing a new kiosk for a local car wash. Your manager has heard of wire framing and thinks you should start immediately with electronic designs. Your colleague wants to start with simple paper prototypes. What questions would you ask before determining whether you agree with your manager or colleague? Then share how you would explain to your manager that your colleague may be right, remembering she is your manager."

A second example was: "You are a web developer and just listened to a webinar about making web sites accessible for those with disabilities. You recommend that the company web site be updated for this reason. The vice president of your company does not think that many people with disabilities use the web site and thinks it's pretty good already. How do you respond to him? Support your argument with details."

The student pairs wrote their responses and all papers were collected. Then the instructor shared the scenarios and the response written. Students were able to hear feedback about all of the situations and suggestions were made on how to word ideas more carefully. Providing feedback to entire cohort at one time can be a benefit of formative feedback (Winstone & Millward, 2012).

4. INSTRUMENT

Students were invited to complete a survey at the end of the semester about the learning benefits and enjoyment of the activities. Sixteen students participated in the survey. The survey described each activity since it had been a while since some of the activities were done. Then students were asked to respond to these questions on a 5-point scale ranging from 1 = strongly disagree to 5 = strongly agree.

1. This activity was beneficial to my learning.
2. I enjoyed this activity.

There was also a question to rank order the activities and optional open-ended questions asking for positive and negative comments.

5. RESULTS

Table 1 shows the average score of each activity on the 5-point scale.

	Beneficial to Learning	Enjoyable
Key to class	4.50	4.31
Muddiest point	4.15	4.17
Test questions	3.92	3.92
Empty outline	4.23	4.00
Paraphrasing	4.07	4.08

Table 1: Average scores

The results of ranking the activities from most important to least important to keep in class are shown in Table 2.

Activity	Rank in importance
Key to class	1
Test questions	2
Empty outline	3
Muddiest point	4
Paraphrasing	5

Table 2: Ranking in importance

Five positive comments and one negative comment were included in the open-ended questions.

6. DISCUSSION OF RESULTS

Overall, students thought the activities were both beneficial to learning and enjoyable. A clear result was the key to class activity scored and ranked the highest. The students viewed this as a valued activity even though they did it outside of class time. I have used key to class in other classes as well and find that nearly all students will participate to have a "key" to get into class.

Directed paraphrasing ranked at the bottom of importance of keeping it in the class. This finding was surprising as it seemed the students were participating well when this activity was done. This activity was probably the most challenging as they had to determine an answer and then write it for a certain audience. Given the relevance of this skill, additional practice with directed paraphrasing is probably necessary.

Student-generated test questions had interesting results. It was ranked second in importance to keeping in class but least beneficial to learning and least enjoyable. The only negative comment on the survey was "student generated test questions" so it's clear that at least one student had strong negative feelings about this activity. Perhaps some students were uncomfortable in the role of writing questions or didn't think they should participate in a typical teacher process.

The positive comments included "I really liked the class activities. They helped me learn new things," "Key to class session is good", and "All activities are very good which helped us to understand more about the material." The students are generally unaware that they are participating in formative assessments; they view them as just part of the class.

While these activities and formative assessments were not graded, the material was included on summative assessments. For example, a directed paraphrasing essay question about mobile apps and web sites was included on the final exam. Seventy-seven percent of the students (N=22) earned an A (100 percent) on the question while 23 percent earned a B (83 percent). It was evident they recalled strategies from their practice and the class discussion that followed.

7. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The small sample size is definitely a limitation making it difficult to be confident the findings are applicable in other situations. The findings were based on student opinion of their learning, not based on their actual scores on summative evaluations.

Changes to be made in future studies would be to ask students about the activity right after it is completed or at a few set times in the semester instead of waiting until the end of the semester when recall could be an issue. Also requiring or asking for more qualitative feedback could give more insight into student views.

Future studies could use other formative assessment strategies. While Heinerichs et al. (2016) encourages educators to select 3-4 activities to use repeatedly in class, others including Lumpkin et al. (2015) urge teachers to try different activities and to adjust them to meet the needs of students. Both have valid points. If there is a lot of time spent on figuring out how an activity works, time is lost for learning the content and using only a few types of activities is probably better. Trying new ones could lead to better ways for students to learn material.

8. CONCLUSION

As teachers prepare for class each day, they should attempt to think of ways to make their students active participants. Resorting to lectures only does not provide students the chance to be challenged to think about the content (Heinerichs et al., 2016). Often the phrase "guide on the side" is used to describe this new role that a teacher may have when not lecturing the entire class period. This shift does not relieve the teacher of instructional effort or the responsibility of making sure that learning is occurring. Well-designed instructional environments are engaging to students but are also well regulated (Wiliam & Thompson, 2006).

Teachers can improve by integrating active learning activities, varying the approach to meet student needs, and assessing students and making adjustments as a result (Lumpkin et al., 2015). Incorporating these ideas could help teachers to deliver better teaching methods for increased student learning.

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