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An Assessment Methodology for Examining the Role of Slate Enabled Technology in Developing Innovative Thinking

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Innovative thinking skill development among engineering undergraduates is of critical importance to the global economy. The ability to transform creative ideas into useful products and services through problem-solving that requires applying known information to unknown situations, finding new information and assessing its value or worth, and collaborating synergistically to develop ideas can be developed through pedagogical approaches that create engaging and active learning environments [1,2, 3].

This presents a challenge when considering the fact that developing the skills needed to generate innovative solutions takes place over time. Recent literature describes how these skills can be learned if individuals are provided with the opportunity to exercise and practice thought processes associated with innovative thinking. For instance, engaging in questioning that challenges commonly known or accepted behavior, critically observing processes in order to identify new ways of doing things, networking in order to meet people with different ideas, and having the opportunity to experiment to identify new insights allow for associational thinking. The steps tied to associational thinking allow individuals to draw connections between ideas or problems from unrelated fields and generate innovative ideas' [4]. While previous research has shown that engineering undergraduates' have the opportunity exercise these skills in upper-level capstone design courses[1,2, 3] little is known about how large lecture classes can be designed to target development of these skills.

Previous studies have demonstrated that using instructional technology can enhance the educational environment. In particular, effective instructor use can serve as a means to engage students and promote active learning; facilitating educational environments that are related to the development of innovative thinking among undergraduates [5, 6, 7, 8,9]. In particular, Tablet PCs have been identified as one form of instructional technology that can facilitate learning among engineering undergraduates since this medium allows for drawing on the computer screen. This educational activity is a valuable way for students to annotate prepared lesson documents, replicate graphs and other visual content, and take and share notes that include diagrams [5]. While these activities have been shown to positively impact general student learning behaviors such as critical thinking, little is known about how this form of slate-enabled technology as well as new versions impact innovative thinking skills.

In order to more closely examine this topic, a comprehensive assessment strategy has been identified and is being implemented at Virginia Tech. Specifically we are using a mixed-method design that focuses on examining student and faculty use of slate enabled instructional technology in large lecture classes. We have identified two groups of students to examine what impact use of the slate technology has on innovative thinking skills, including: entering freshmen enrolled in a first-year course and upper-level students, primarily comprised of second year undergraduates, enrolled in a Statics course. Student survey data, observation of student engagement with course content, and focus groups among students enrolled in the courses are being used in this study. These activities are being coupled with faculty observations and professional development activities.

Specifically, student survey data is providing one measure of the impact of slate enabled technology on development of innovative thinking skills. Changes in students' innovating thinking skills are being measured by an online pre- and post-test administration of the Modified Strategies for Learning Questionnaire (MSLQ). The MSLQ is a valid and reliable survey that provides a measure of the skills identified in the literature as linked to innovating thinking. This instrument has items that ask students how often they utilize the following skills including: knowledge acquisition (e.g., repetition of words or concepts), scaling (e.g., outlining, organizing information), elaboration (e.g., paraphrasing, summarizing), critical thinking (e.g., application of new knowledge to situations, generation of new ideas), self-initiated exploration (e.g., self-directed learning, setting goals, monitoring one's own comprehension), and peer collaboration (e.g., using a study group or friends to help learn and generate new ideas)[8] through the creation of scales from multiple items. Our previous assessment efforts indicate that the scales indicate a high degree of reliability ($\alpha \leq .60$) based on Chronbach's alpha scores. This instrument also has an item that asks students how frequently they use slate technology and related slate enabled features in their courses during the semester and how often faculty use this form of technology and slate enabled features in their courses during the semester. Demographic information is collected by items that ask gender and racial/ethnic status. In addition, a more complete picture about how to effectively develop innovative thinking skills among students enrolled in a large lecture course and whether effective use of slate enabled technology facilitates that development is being provided by direct observations of students and faculty members in class. We are looking at how faculty use the technology in relation to different skills and also what students' responses are to those the strategies designed to develop innovative thinking will also be examined during classroom observations. Students in all course sections will be asked to participate in focus groups that will explore the degree to which students perceive different instructional strategies have helped them develop innovative thinking strategies. Focus groups with students will help identify what pedagogical approaches were most useful for helping them learn and whether slate enabled technology facilitated that learning. We have identified two faculty that previous assessment efforts have shown make extensive use of slate enabled technology in their courses. We have also identified two faculty that we know currently do not use any slate technology. Students in the course sections that have an experienced faculty member are essentially serving as the treatment group. Students enrolled in the class section with another instructor who teaches this same course but does not use this form of technology are serving as the control group.

In terms of the quantitative data, having students grouped by treatment and control groups will allow us to examine the impact that slate enabled technology and active learning strategies that employ this technology has on student learning and the development of innovative thinking skills. This will be done by comparing the growth in innovative thinking skills in each skill area after creating the scales (i.e., knowledge acquisition, critical thinking, scaling, collaboration, entrepreneurialism, self-initiated exploration) as measured by the MSLQ, between and among students enrolled in the different sections using a Factorial ANOVA.

Given the data that we have collected thus far, we are preparing professional development sessions for faculty who are not experienced slate users. The sessions will cover key topics that we have found are useful for developing students' innovative thinking. Implemented in the upcoming spring semester they will feature curricular activities that faculty members can employ in large lecture classes as well as a model how to use the associated technology.

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