Project 3: Mixed Methods Research Study

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Chapter 1: Introduction

Introduction

This mixed methods explanatory study will explore the relationship students have with their learning process and formative feedback provided to them via a computer based testing system. The study also examines the attitudes students and faculty have around technology and formative feedback as it pertains to the learning process. The students and faculty involved in this study will come from a STEM program at a liberal arts college. Results of this study are expected to give insight into how both faculty and students view and utilize a computer based testing system as part of the formative assessment process.

In the next few years, it we are expected that to see an increase in jobs in the science, technology, engineering, and mathematics fields, commonly known as SETM. The Bureau of Labor Statistics estimated that, in 2016, there were 8.8 million jobs in the STEM fields, representing 6.3 percent of the total jobs in the US (2016). It is predicted that the number of jobs will almost double between 2012 and 2022 as there will be an increase of over 9 million new jobs (Vilorio, 2014). Schools are looking to educate students in these fields but it is reported by the National Center for Education Statistics (NCES) that attrition rates for in college STEM programs sits between 48 to 69 percent. Chen (2013) found that students were leaving STEM programs in one of two ways. They were switching into another non-STEM program (28 percent) or they left college all together before earning a degree of certificate (20 percent) Factors associated with the high attrition rates include factors such as college preparedness and performance in STEM courses.

There are many factors that can be attributed to high attritions. Sanabria (2017) outlines several specific to STEM programs. These include discrimination, inflexible curricula, student confidence, as well as students attaining low grades in what are considered gatekeeper courses. Students transfer out of STEM programs as a result of low grades in these ‘weed out’ courses and into courses and programs in which they are receiving higher grades. Understanding this trend and looking to meet its mission of producing more graduates in the STEM fields, Massachusetts Academy is looking to better understand how their students understand their role in the learning process. One particular aspect involves formative feedback and metacognition.

Statement of the Problem

According to Massachusetts Academy, their attrition rate for their STEM programs is in line with national norms and sits at close to 50 percent. Of this total amount of students leaving a STEM program, close to 80 percent switch to another non-STEM related major within the institution with the balance withdrawing from the college entirely before earning a degree or certificate according to school statistics (School HEOA information). It is believed, but not confirmed, that some of these students enter a STEM program at another institution.

In reviewing student course evaluations, it was determined that the freshman chemistry course, CHEM101, was a weed-out course. It is believed by the Chair of the Department of Chemistry that the problems experienced in this course, in part, attribute to students either changing major or eventually leaving the institution all together. Massachusetts Academy has, as one of its missions, an initiative to increase the retention rate and decrease the time to completion for students within the STEM programs. Identified as a barrier course, CHEM101, is being used by the administration as a research site for new methodologies in teaching and learning. As such, the CHEM101 course is the environment in which we are exploring computer based testing as a medium to give formative feedback in an effort to develop metacognitive skills.

Purpose

The intent of this explanatory mixed methods research study is to examine how formative assessment data, as delivered through a computer-based testing platform, can be used by students to develop metacognitive skills. This two phase study will involve collecting quantitative data on student perceptions of their role in learning through the use of pre- and post- intervention surveys. In the second phase of the study, students as well as faculty will be interviewed using open ended questions in an effort to explore their attitudes and experiences in the utilization of a computer based testing platform in relation to metacognitive skills. The results of this explanatory study are expected to give insight into the role technological interventions can play in the development of students as learners.

Research Questions

In this study, the author is exploring effects formative assessment feedback from a computer based testing platform can have on metacognitive development of undergraduate STEM students. In the first phase of the study, students will be asked quantitative questions about their metacognitive skills pre- and post- technological intervention. In the qualitative arm of this study, a phenomenological approach is taken where students and faculty will be interviewed and asked to reflect upon their experiences with the tool.

The specific questions asked in this study are:

1. How prepared do students feel in their own learning process?
2. What are the experiences of learners in receiving formative feedback from a computer based testing platform?
3. How do faculty see themselves in the process of formative feedback?

The following table summarizes the questions, items, and subjects.

|  |  |  |
| --- | --- | --- |
| Data Type | Data Collection Method | Subject |
| Quantitative | Pre- and Post- intervention surveys | First year CHEM101 students |
| Qualitative | Open ended interviews | Subset of students from the quantitative arm. |
| Qualitative | Open ended interviews | Selection of faculty teaching in the CHEM101 course. |

Limitations

Limitations to this study include the fact that this is a study taking place at a particular institution and in one particular course. The small nature of the study may not be transferrable outside of this course, program, or school. The set of students being studied may not be similar to other academic years. For the phenomenological qualitative arm of the study, the role of the researcher may have influenced the responses of the participants resulting in then responding in a way that may be deemed desirable. Participants may have felt pressured into participating through the perceived authority of those performing the study. It should also be understood that the researcher comes with certain biases and experiences and this lens could influence the data collection and interpretation process.

Chapter 2: Literature Review

Introduction

It is documented that approximately half the students that enroll in a STEM program fail to graduate (Chen, 2013). Academic institutions are feeling internal pressures as well pressure from industries to address the need for greater workers in STEM fields. (Matthews, 2017). It is the belief that understanding how students see formative feedback fitting into their metacognitive development will help administrations better design feedback mechanisms and, as a result, improve retention and completion rates among STEM programs.

Relevant studies and theory

Massachusetts Academy has, as one of their missions, the mandate of increasing the number of students graduating from STEM programs. Building on that mandate, the Department of Chemistry has set out to investigate how computer based assessment can be utilized to enhance the relationship between formative assessment and the metacognitive skills of its students. For the purposes of this study, metacognition with respect to learning is essentially the understanding one has about his or own condition and the level of control he or she has over it (Ibabe, 2010). Formative feedback has been defined by Shute as information that is communicated to a student with the intention of modifying their thinking or behavior in an effort to improve their learning (2008). It should be noted that formative assessment should be thought of as a process or system designed to help students improve their learning and not as a test given at a particular time (Hudesman, 2013).

The computer-based testing platform utilized by the Department of Chemistry at Massachusetts Academy is the Examplify testing software by ExamSoft, Inc. (Koch, 2016). The ExamSoft database is an item banking database that allows for the tagging of questions with user defined characteristics. The characteristics are grouped into categories that that one would like to track or trend over time for use by both faculty and learners. For the sake of this study, the categories being tracked include:

|  |  |  |
| --- | --- | --- |
| Category | Description | Example |
| Faculty | Question author | Professor A  Professor B  Professor X |
| Topic | General topic covered in the course such as bonds, periodic table, and stoichiometry. | Chemical Bonds  Periodic Table  Stoichiometry |
| Learning Objectives | Course level learning objectives | LO 1 – In this lesson student…  LO 2 – In this lesson students…  LO 3 – In this lesson students… |
| Depth of Knowledge | Modified Bloom’s Taxonomy | Level 1 – Recall  Level 2 – Understand  Level 3 – Apply  Level 4 – Analyze |
| Content Delivery | The manner in which the content was delivered to the students | Face to face lecture  Online learning module  Lab  Team Based Learning |

In addition to tagging of questions by categories, questions may can have rationale assigned to each answer choice. Typically, and as is the case in this study, rationale will be assigned to each incorrect and correct answer. Included in this feedback will be information on where to find the material from which the question was generated. As an example, a question covered in a team based learning exercise will provide information to the student on each possible answer chosen, whether it was current or incorrect, as well as information on which exercise it came from and information on the author, the general topic, the course learning objective, and the depth of knowledge at which the question was written.

The ExamSoft student portal provides information beyond questions within a particular exam. Students are also able to trend the data across examinations. For example, a student can run a report on how well they have performed for a particular category in a particular course. A student could essentially see how they are performing in questions on the periodic table across a term. They could also see how many questions they are getting correct at the different levels of learning. This type of data could be utilized in modifying study habits, preparing for future exams, or by faculty to determine areas where students are performing poorly.

Being able to provide feedback at this level is important as it provides evidence of student learning to the faculty and gives the instructors feedback on their instruction It also gives students accurate evidence of their learning and allows them to engage in focused activities (Chan, 2014). For learners to benefit from the formative feedback process, Gibbs stated that should be able to take action to improve their work (2016). The feedback provided by the ExamSoft system is designed to do just this. By giving students this type of feedback, they are able to develop a better understanding of their learning. In other words, they are learning about learning – or developing their metacognitive skills.

Developing metacognitive skills or being able to self-regulate their learning is a sill that is associated with improved academic outcomes. It motivates students on the path towards being lifelong learners (Clark, 2012). For students, feedback provided through the formative assessment process can help reduce their uncertainty about their performance, provide information useful in correcting misconceptions, and help reduce cognitive load. It has been documented that low performing students in particular benefit from this type of feedback (Schute, 2008).

As the long-term goal of school is to increase retention and persistence in STEM programs, it is hoped that utilizing a computer based testing platform to provide feedback as part of a formative assessment process students will have a better understanding of their learning process. It is ultimately hoped that developed metacognitive skills will result in higher retention rates and lower time to completion rates. Even though there are many factors that attribute to STEM persistence, such as high school GPA, socioeconomic status, and gender (Chen, 2103), it is hoped that developing these skills as described in this study will help students overcome a multitude of risk factors.

Summary

This study is an investigation into some of the factors that are associated with the development of metacognitive skills necessary for students to persist in a STEM program at a small liberal arts college. By better understanding how students utilize formative feedback provided through the process of computer based testing, faculty and staff may be able to better adapt to the needs of their learners. A potential long term benefit of this study would be to decrease student indebtedness, develop skills necessary for live longer learning, and decrease the predicted worker gap in the STEM fields.

Chapter 3: Methodology

Introduction

An explanatory mixed methods approach is being utilized to better understand the manner in which students and faculty respond to a technological intervention to the formative assessment process. Specifically, a quantitative approach is being used measure student attitudes towards the use of a computer based testing system in providing assessment feedback. A subset of students as well as course instructors will then be interviewed in the qualitative arm of the study as a means of better understanding beliefs and attitudes towards technology in the development of student metacognitive skills. This will allow the researchers to give a voice to the results of those being studied with the belief that this will provide better guidance for future studies.

Research Design

An explanatory mixed methods research approach (Creswell, 2015) was taken to better understand the experiences students have towards formative feedback provided to the students through a computer-based testing platform. The study started out with a quantitative arm where students were surveyed at the start and end of the term on their attitudes towards computer based testing and its role in the learning process. This is followed by a qualitative study where a subset of students were asked to share their experiences in receiving formative feedback from the computer based testing system. Additionally, in this qualitative study, faculty will be asked to discuss how they see their roles in the formative assessment process.

A phenomenological approach to the qualitative portion will be followed where data from interviews will be 1) collected, 2) read, 3) coded, 4) organized, and then 5) summarized as described by Giorgi (1997). Interviews will be performed at the completion of the first year Chemistry course and will be performed by the researcher. The sessions will be video recorded and coded in order to identify trends around the interviewee experiences.

Population and Sample

This study seeks to describe student attitudes towards the use of computer based testing as a tool in the process of formative assessment. The study will then explore experiences of students and faculty in the use of this tool as it pertains to the development of metacognitive skills. These questions will be asked in the setting of an undergraduate STEM program.

Surveys were sent out at the 2017 annual meeting of the International Society for Technology in Education in San Antonio, TX asking for participants in this study. A request for a small liberal arts college with several STEM programs was made. The Massachusetts Academy in Snow Valley, MA was chosen as a site due to ease of access by the researchers. Massachusetts Academy is a small liberal arts college of approximately 2,700 undergraduate students with a majority of students living on campus in student housing. The school was founded in the late 18th century and is located in a rural town in the Berkshire mountains. Forty percent of the student population is enrolled in a STEM program at the school. The STEM programs include Astronomy, Biology, Chemistry, Computer Science, Engineering, Environmental Science, Mathematics, Nursing, and Physics. Clinical programs are also offered with undergraduate degrees being offered in the fields of dental, forensic, and veterinary sciences.

The respondent to the ISTE survey was made by Torben Olof Bergman, Ph.D., Professor and Chair, Department of Chemistry. His interest in the study lay in the fact that academic research in the general area of student success aligned with the mission of the department and college. Prior to the start of the study, formal permission was granted by the school president, Emma Frost, Ph.D. Access to the Chemistry 101 course was given by the course director, Dorothy Hodgkin, Ph.D. A research protocol was developed and then submitted to the Institutional Review Boards of both New Jersey City University, Jersey City, NJ and Massachusetts Academy, Snow Valley, MA. Approval was granted by both boards for a one year study to take place in the 2018/2019 academic year.

During the first class, time was graciously given to the researchers to go before the students and describe the research study and ask for volunteers. All students were given packets containing background information on the study, information on potential risks and benefits, consent forms, and were told that their participation was completely voluntary. They were told that if they were interested in participating in the study, they could fill out the consent form and mail it to the researchers using the self-addressed stamped envelopes. Their choice to participate or not would not be shared with the faculty or staff of the institution. Of the 127 students originally enrolled in the study, 98 chose to participate. Of this, two decided not to stay in the study and only 77 completed the course to the end.

For the qualitative phase of the study, a purposeful sampling of ten students was performed. Five students with a final cumulative score of 90 or above and five students with a final cumulative score below 70 were selected to be interviewed about their experiences. The three faculty involved in the course were also interviewed. It is understood that the researcher’s role in the interview process is that of an outsider and this role may influence the responses so efforts were made to minimize this effect. Interviews took place in the same room outfitted with a video camera situated behind the researcher and partially hidden by a potted floor plant. The researcher wore the same clothes for each interview. The choice of clothes was casual in nature and included a light blue oxford button down collar shirt, belt, tan slacks, and penny loafers. The interview room had the door cracked during the entire time in order to allow the student and faculty member to feel as if they were in a safe environment with an easy route of exit.

The interviews were scripted and given in a flat friendly tone. The sessions started with a pleasant welcome and warm up question asking what they thought of the weather that day. They were then thanked for being part of the research study followed by a review of the goals and objectives of the study, their ability to withdraw from the study at any time, as well as the risks and benefits of participating. Every effort was made to ask the questions with the same tone and affect and participants were only asked to clarify a statement when it was believed they were not clear enough to be picked up on the recording. Upon conclusion of the interview, the subjects were provided with a $20 gift certificate to the campus bookstore.

Procedures

Quantitative data through the use of online surveys was collected from participating students during the first week of class and then again during the week after the final exam. Five point Likert surveys were administered through the SurveyMonkey polling platform and emailed to the participants’ student email accounts. Sample questions can be found in Appendix A. The data was collected and analyzed by the ZYX software package.

For the quantitative arm of the study, students representing high and low performing portions of the class were purposefully chosen so as to give a voice to a range of student experiences. The three faculty teaching in the course were also interviewed. All were interviewed as previously described. Transcripts from the interviews were generated by a transcribing service so as to minimize the effects of bias by the researcher. Transcripts were then coded and scored in order to identify themes and trends. The TRANSANA software package was used to do the statistical analysis.

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Appendix A

Quantitative Pre-Test Sample Questions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Question | Very true  (1) | (2) | Neutral (3) | (4) | Not true at all  (5) |
| I feel that I will do well in this course |  |  |  |  |  |
| I feel that I have good study habits |  |  |  |  |  |
| I am comfortable receiving feedback from my professors |  |  |  |  |  |
| I am comfortable taking tests on a computer |  |  |  |  |  |
| I feel that I will do well in this program |  |  |  |  |  |
| I am comfortable seeking academic help |  |  |  |  |  |

Quantitative Post-Test Sample Questions

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Question | Very true  (1) | (2) | Neutral (3) | (4) | Not true at all  (5) |
| I feel that I will did well in this course |  |  |  |  |  |
| I feel that I have good study habits |  |  |  |  |  |
| I am comfortable receiving feedback from my professors |  |  |  |  |  |
| I am comfortable taking tests on a computer |  |  |  |  |  |
| I feel that I will do well in this program |  |  |  |  |  |
| I am comfortable seeking academic help |  |  |  |  |  |