A STUDY OF QUALITY REQUIREMENT CONVEYANCE FOR ASSIGNMENTS IN TECHNOLOGY AND ENGINEERING MASTER'S DEGREE PROGRAMS

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by

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ABSTRACT

Quality requirements are not easy to define. In higher education, defining quality requirements and communicating those requirements to students may be accomplished through a variety of mechanisms. Students still may not know what it takes to get a good grade on an assignment and may have to wait for an instructor to clarify the assignment. This study was conducted because students and instructors may have different opinions as to which forms of feedforward and what technology are best to convey assignment requirements. The purpose of this study was to determine effective feedforward mechanisms as well as the technology used to convey quality requirements for assignments.

A Delphi Panel was utilized to identify feedforward mechanisms as well as technology currently used. A survey was conducted to quantify waste in the assignment process via statistical testing. Minitab 19 with selected T-tests were used to determine if there is a difference between students and instructors as to what feedforward mechanisms or combinations of feedforward mechanisms are preferred to effectively convey quality requirements. The study involved Master-degree seeking students and instructors as well as university resources from teaching excellence programs from three universities.

Combining the information from the Delphi Panel and the survey, a model was created that using the syllabus and instructions as mechanisms to convey quality requirements for assignments. Depending on the assignment a rubric, criteria sheet, or model/sample may be used to clarify requirements. Using the web-based learning management system allows students to

access information outside of the classroom and at any time. The LMS can contain written as well as video or audio recordings of assignment information. The results of this study have led to improvements in a Project Management course at the University of Kansas.

PREFACE

As an ongoing approach to quality improvement, this study was conducted because students and instructors may have different opinions as to which forms of feedforward and what technology are best to convey assignment requirements. In Lean Six Sigma reducing waste and improving quality are important. The lack of effective feedforward mechanisms in the assignment process causes waste such as increased waiting and rework culminating in increased office hours and unexpectedly low grades. To improve quality in the assignment process it is important to understand the feedforward mechanisms as well as the technology used to convey quality requirements for assignments. This study will be used as a guide to develop or revise feedforward to convey quality criteria for assignments to enhance learning effectiveness and help facilitate change in the assignment communication process.

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Throughout my life I have been a rebel always pushing boundaries and questioning why things are the way they are. I am always looking for another way to get things done and make the whole process better. No one knows this better than my parents, Lloyd and Jill Hull, my husband, Ralph McCain, my two sons, David Boss and Randy McCain, as well as my advisor and dissertation chair, Dr. Suhansa Rodchua. No matter how much of a pain I have been, my family and friends have always supported me. As I finish this degree, my oldest son will have experienced my graduations from high school, college with a BSEE, college with a ME EMGT, and now a PhD. Education has been an important part of my life as I love to learn new things and constantly strive to make things better.

Dr. Rodchua provided continuous guidance and advice throughout my program experience, even when she was not my chair. She is concerned with the quality of this product and provided excellent constructive criticism and comments. She was always quick to provide feedback on the many revisions of this document. I wish to thank her for all the work she did to help make this product meet requirements as well as become an interesting and useful publication.

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CHAPTER 1

INTRODUCTION

Quality requirements are not easy to define. Defining quality in manufacturing or service industries is often difficult and trying to define quality for education is equally, if not more, difficult. Philip Crosby (1979) defined quality as 'conformance to requirements' (p.17). Russ Westcott (2014) suggests that 'Quality - I'll know it when I see it' (p. 261) is used by customers to define quality (McCain, 2015). As a student, conformance to requirements typically means following the course syllabus or assignment instructions when completing the assignments for the course. Although students receive some information, they still may not know what it takes to get a good grade on an assignment. As an instructor, quality of a student's work sometimes follows the 'I'll know it when I see it'. Quality requirements should be the specific criteria as to what is required for the student to receive a specific grade. Criteria are abstract ideals to which students (ought to) aspire, and against which one hopes to assess student performance (Andrade, 2000). Assignments should be aligned with the goals and objectives of the course (Svinicki & McKeachie, 2014) and specific objectives related to the assignment or assessment used in the course should also be appropriately communicated. The specific objectives create the basis for the definition of quality.

Instructors are long-lasting transmitters of knowledge and the integration of technology into the instructional process will create effective learning environments (Esin, 2011). To

communicate the assignment, some conveyance mechanisms used include the syllabus, instructions, templates, rubrics and criteria sheets (Sadler, 2010). The technology used to convey the assignment could be via a Learning Management System such as Blackboard or traditional means such as paper, email, or verbal instructions. Dulamă and Ilovan (2016) listed several items used to create and offer feedforward including enouncing the task, the instructions, and the suggestions concerning work style; discussing the task to enable students' understanding; and dialoguing (answering some students' questions but offering this information to all students).

The technology used to convey assignment quality criteria has evolved over the last 100 years. Technology or any device available to instructors for use in teaching students in a more efficient and stimulating manner than the sole use of the teacher's voice (Cuban, 1986). In the 1800s chalkboards and books were primarily used. Technology evolved and in the 1900s overhead projectors, radio, film, and television became technology tools for instructors. Computers became readily available in the late 1980s and learning management systems (LMS) became prevalent after 2000 (Schulstad, 2013). Technology appears to alter the landscape of the college classroom in all formats: face-to-face, on-line, or blended (Parker, Bianchi, & Cheah, 2008). Higher education has embraced technology and according the EDUCAUSE Center for Analysis and Research (ECAR) study, 99% of educational institutions have an LMS in place. Students report that they use the learning management system in 82% of their courses. (Brooks, 2015).

Although technology and assignment mechanisms have changed over the years, it is unclear as to whether students really know what it takes to get an expected grade on an assignment and what instructors use to grade the assignment. There are several variables and customer/supplier relationships involved within the process. Lean Six Sigma projects utilize a

tool known as SIPOC or Suppliers, Inputs, Processes, Outputs, and Customers as well as process mapping and other tools such as a fishbone diagram or Cause-and-Effect Diagram to help understand the variables influencing the process. According to Tague (2005), SIPOC provides a quick, broad view of key elements of a process. SIPOC is used to help define the process. For an assignment, suppliers or those providing inputs into the process are both students and instructors. Students provide some of the inputs including knowledge and expectations. Instructors provide knowledge, information about the assignment, expectations, and determine the mechanisms as well as the technology used to convey the assignment.

According to Kubiak and Benbow (2017) each step of the process has inputs and outputs. Some inputs are controllable and some are uncontrollable or considered noise. Only controllable inputs can be manipulated in studies, but uncontrollable or noise can be reduced through robust processes (Breyfogle, 2003). Waste in the process can also be identified and reduced. Waste is any activity that consumes resources but creates no value for the customer. In higher education waste includes dropout students, unfilled classrooms, redundant paperwork, unclear assignments, and bureaucracy according to Wendy Athens (2019). She also states that we should think in terms of process optimization in academics to find new and better ways of educating students. When thinking about assignments given to students, waste consists of recommunication, redefining assignments, and redoing assignments. Waste is created when feedforward mechanisms in the assignment process are ineffective. This waste can be identified and measured by studying office hours and grade expectations as well as satisfaction.

Value of the Study

The results of this study may lead to improvements in the development of effective feedforward mechanisms to convey quality requirements for assignments in master's degree courses. As an instructor the results of this study may help me as well as other instructors become more consistent in utilizing appropriate means to convey quality requirements plus improve grading consistency and feedback to students. This study could be used to encourage instructors to control and standardize quality requirements for assignments in their courses. Effective feedforward mechanisms could reduce waste in the assignment process such as waiting and rework resulting in more effective use of office hours and students receiving the grade they expected. This study will be used as a guide to develop or revise feedforward to convey quality criteria for assignments and help facilitate change in the assignment communication process.

Need for the Study

Currently courses taught in master's degree programs use various forms of feedforward mechanisms as well as technology to convey assignment requirements. The various feedforward mechanisms include the syllabus, assignment instructions, templates, criteria sheets, and rubrics. Technology used to convey the requirements may be paper, verbal, and/or electronic such as a learning management system. Many universities utilize learning management systems (LMS) such as Blackboard and some instructors use the LMS to convey requirements. There may be other feedforward mechanisms and other technology means that are used to convey requirements. This study explores the variety of feedforward mechanisms and the technology

used. This study compares students' and instructors' opinions as to which forms of feedforward and what technologies are best to convey assignment requirements. Determining best mechanisms in the form of a model could help instructors determine what to use to convey feedforward requirements and thus reduce waste in the assignment process.

Dulamă and Ilovan (2016) found in their study that feedforward mechanisms and tools increased efficiency and improved assignment quality. They noted that feedforward more than feedback increased students' learning efficiency and the quality of their results. What they found was that by proactively communicating criteria, students were able to correctly solve tasks. The feedforward helped prevent students from making mistakes and thus reduced waste in the process.

When analyzing this in terms utilized in Lean Six Sigma, feedforward is considered preventive as it helps students understand the quality criteria prior to completing the assignment, while feedback is considered reactive and mistakes are considered defects (Mirth, 2017). When instructors do provide feedback, Baker and Zuvela (2013) found that responding to student assessment items with constructive commentary further enhanced the student's professional achievement in higher education. Constructive commentary rather than just pointing out defects were more beneficial to student learning.

Significance of the Study

The results of this study may lead to improvements in the conveyance of quality requirements to Master-degree seeking students. The results may benefit students in that they understand the requirements for an assignment and that instructors are more consistent in

defining assignment requirements as well as grading and providing feedback. This study could be used to encourage instructors to use the feedforward model to convey quality requirements for assignments in their courses. The feedforward could improve feedback to students as well as standardize and control the conveyance process. Improvements conveyance could reduce waste in the assignment process.

Statement of the Problem

The problem identified for this study is that there is waste in assignment processes for technology and engineering students and instructors. The assignment process uses feedforward mechanisms to convey quality requirements for assignments. The problem exists due to differing opinions from Master-degree seeking students and instructors as to what feedforward mechanisms and what technology should be used to convey quality requirements for an assignment.

Purpose of the Study

The purpose of this study is to determine possible feedforward mechanisms as well as the technology used to convey quality requirements with minimal waste for assignments. Once the feedforward mechanisms and technology are identified, there may be a difference between students and instructors as to what feedforward or combination of feedforward mechanisms are preferred to effectively convey quality requirements. The study involves Master-degree seeking students and instructors as well as university resources from teaching excellence programs from

three different universities. The outcome of this study is a proposed graphical model of feedforward mechanisms to convey assignment quality requirements. This study can be used as a guide to develop or revise feedforward to convey quality criteria for assignments and help facilitate change in the assignment communication process.

Research Questions and Hypotheses

RQ1: What feedforward mechanisms and technology are utilized to convey quality requirements for assignments?

RQ2: What combinations of feedforward mechanisms and technology used to convey quality requirements for assignments resulted in the average lowest amount of time being clarified?

RQ3: What activities do students and instructors use office hours for?

RQ4: Are there differences between students (S) and instructors (I) among the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) and technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments?

H_O: There is no statistically significant difference between students (S) and instructors (I) as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between students (S) and instructors (I) as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each preferred feedforward mechanism:

Mechanism	Null Hypothesis	Alternative Hypothesis
Criteria sheet (C)	$H_{OC}: \mu_{CS}=\mu_{CI}$	$H_{AC}: \mu_{CS}\neq\mu_{CI}$
Instructions/handout (I)	$H_{OI}: \mu_{IS}=\mu_{II}$	$H_{AI}: \mu_{IS}\neq\mu_{II}$
Model/sample (M)	$H_{OM}: \mu_{MS}=\mu_{MI}$	$H_{AM}: \mu_{MS}\neq\mu_{MI}$
Rubric (R)	$H_{OR}: \mu_{RS}=\mu_{RI}$	$H_{AR}: \mu_{RS}\neq\mu_{RI}$
Syllabus (S)	$H_{OS}: \mu_{SS}=\mu_{SI}$	$H_{AS}: \mu_{SS}\neq\mu_{SI}$
Template (T)	$H_{OT}: \mu_{TS}=\mu_{TI}$	$H_{AT}: \mu_{TS}\neq\mu_{TI}$
Textbook (B)	$H_{OB}: \mu_{BS}=\mu_{BI}$	$H_{AB}: \mu_{BS}\neq\mu_{BI}$

H_O: There is no statistically significant difference between students (S) and instructors (I) as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between students (S) and instructors (I) as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each technology:

Technology	Null Hypothesis	Alternative Hypothesis
Email/Text messages (E)	$H_{OE}: \mu_{ES}=\mu_{EI}$	$H_{AE}: \mu_{ES}\neq\mu_{EI}$
Mobile applications (A)	$H_{OA}: \mu_{AS}=\mu_{AI}$	$H_{AA}: \mu_{AS}\neq\mu_{AI}$
Verbal/lecture (L)	$H_{OL}: \mu_{LS}=\mu_{LI}$	$H_{AL}: \mu_{LS}\neq\mu_{LI}$
Video/audio recordings (V)	$H_{OV}: \mu_{VS}=\mu_{VI}$	$H_{AV}: \mu_{VS}\neq\mu_{VI}$
Web-based/LMS (Black Board) (W)	$H_{OW}: \mu_{WS}=\mu_{WI}$	$H_{AW}: \mu_{WS}\neq\mu_{WI}$
Written/paper (P)	$H_{OP}: \mu_{PS}=\mu_{PI}$	$H_{AP}: \mu_{PS}\neq\mu_{PI}$

RQ5: Using the top box response of "Extremely Effective", what mechanisms and technology are rated extremely effective most often (percentages of responses)?

RQ6: Are there significant differences between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms and technology used to convey quality requirements for assignments?

H_O: There is no statistically significant difference between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each preferred feedforward mechanism:

Mechanism	Null Hypothesis	Alternative Hypothesis
Criteria sheet (C)	$H_{1C}: \mu_{CF}=\mu_{CP}$	$H_{2C}: \mu_{CF}\neq\mu_{CP}$
Instructions/handout (I)	$H_{1I}: \mu_{IF}=\mu_{IP}$	$H_{2I}: \mu_{IF}\neq\mu_{IP}$
Model/sample (M)	$H_{1M}: \mu_{MF}=\mu_{MP}$	$H_{2M}: \mu_{MF}\neq\mu_{MP}$
Rubric (R)	$H_{1R}: \mu_{RF}=\mu_{RP}$	$H_{2R}: \mu_{RF}\neq\mu_{RP}$
Syllabus (S)	$H_{1S}: \mu_{SF}=\mu_{SP}$	$H_{2S}: \mu_{SF}\neq\mu_{SP}$
Template (T)	$H_{1T}: \mu_{TF}=\mu_{TP}$	$H_{2T}: \mu_{TF}\neq\mu_{TP}$
Textbook (B)	$H_{1B}: \mu_{BF}=\mu_{BP}$	$H_{2B}: \mu_{BF}\neq\mu_{BP}$

H_O: There is no statistically significant difference between full-time (F) and part-time (P) master's degree students as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between full-time (F) and part-time (P) master's degree students as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each technology:

Technology	Null Hypothesis	Alternative Hypothesis
Email/Text messages (E)	$H_{1E}: \mu_{EF}=\mu_{EP}$	$H_{2E}: \mu_{EF}\neq\mu_{EP}$
Mobile applications (A)	$H_{1A}: \mu_{AF}=\mu_{AP}$	$H_{2A}: \mu_{AF}\neq\mu_{AP}$
Verbal/lecture (L)	$H_{1L}: \mu_{LF}=\mu_{LP}$	$H_{2L}: \mu_{LF}\neq\mu_{LP}$
Video/audio recordings (V)	$H_{1V}: \mu_{VF}=\mu_{VP}$	$H_{2V}: \mu_{VF}\neq\mu_{VP}$
Web-based/LMS (Black Board) (W)	$H_{1W}: \mu_{WF}=\mu_{WP}$	$H_{2W}: \mu_{WF}\neq\mu_{WP}$
Written/paper (P)	$H_{1P}: \mu_{PF}=\mu_{PP}$	$H_{2P}: \mu_{PF}\neq\mu_{PP}$

RQ7: What graphical models help explain the quality requirements for the assignment process and how could the model be used to improve course assignments?

Definition of Terms

Assignment -- allow for the assessment of critical thinking, synthesis and other higher order skills via the use of essays, papers or other documents submitted by students. Assignments in Blackboard allow students to type in a short answer or essay response and/or attach a document with their submission (Blackboard.com).

Blackboard – a web-based learning management system. Blackboard is a global leader in enterprise technology and innovative solutions that improve the experience of millions of students and learners around the world every day. Blackboard's solutions allow thousands of higher education, K-12, professional, corporate, and government organizations to extend teaching and learning online, facilitate campus commerce and security, and communicate more effectively with their communities. Founded in 1997, Blackboard is headquartered in

Washington, D.C., with offices in North America, Europe, Asia, and Australia (Blackboard.com).

Conveyance for assignments – the communication of a task or piece of work that you are given to do for a course by an instructor. Some conveyance mechanisms include the syllabus, instructions, templates, rubrics and criteria sheets (Sadler, 2010).

Delphi Panel -- a group of individuals contacted to determine, predict and explore group attitudes, needs and priorities. The Delphi method is a structured research approach using a directed group, frequently experts on the topic of interest, to deal with a complex problem (Hasson & Keeney, 2011).

Evaluation criteria – something used to make a judgement or decision (Mertler, 2001)

Feedforward - includes communications relating to assessment task specifications and assessment criteria (Sadler, 2010).

Feedback - includes communication about the quality of an appraised work and advice about how future responses to similar assessment tasks should be tackled (Sadler, 2010).

Quality – a subjective term for how acceptable or unacceptable something is to the customer (Westcott, 2014).

Rubric – a document that articulates the expectations for the object being evaluated by listing the critical criteria of what is deemed as necessary and assesses the levels of quality from poor to excellent (Reddy & Andrade, 2010).

Student – a person attending a school or college. Full-time students in Graduate School are students enrolled in 9 credit hours or more. Part-time students in Graduate School are enrolled in less than 9 credit hours (University of Kansas, 2010).

Syllabus – a contract between students and the instructor that can include how learning will be assessed and how grades will be determined (Svinicki & McKeachie, 2014).

Waste – any activity that consumes resources but creates no value for the customer. Some examples of waste are waiting, defects, overproduction, unnecessary processing, and transportation (Ohno, 1988).

Assumptions

The participants in the Delphi Panel will consist of personnel in the teaching excellence groups at the three universities. At the University of Kansas, the groups that were invited to participate were the Center for Teaching Excellence and the Center for Online and Distance Learning. At the University of Central Missouri, the Center for Teaching and Learning was invited. At Indiana State University the Faculty Center for Teaching Excellence was invited. Meetings were setup for participation. The participants, without coercion or obstruction, participated freely in the Delphi process.

For the survey, Likert-scale questions will be validated and able to discern differences. Participants were honest in their answers to the survey questions and participated without coercion or obstruction. Participants were able to select the correct items associated with their knowledge and experience related to technology and engineering assignments.

Limitations

The reliability of the study is limited using a Delphi Panel and survey. There are a limited number of students and instructors from selected universities available to participate in the Delphi Panel and survey. There were more students available for the survey than instructors. The timing of the study as well as access to email distribution limited results. Students are on campus from mid-January to mid-May and from mid-August to mid-December. Conducting a survey between semesters or over the summer or when most students and instructors are not on campus can impact the results. Conducting the survey too early in the semester will result in fewer assignments available for the survey. Not having access to email distribution lists meant having limited ways to access students and instructors.

CHAPTER 2

REVIEW OF LITERATURE

A review of literature was conducted around three study areas. The first area studied was the definition of quality. Quality is a subjective term so a study of the literature available is beneficial to understanding this term. The second area studied was quality in higher education. As stated previously, the definition of quality is subjective and defined in different ways in various businesses. The third study area investigates the intersection of higher education and technology. Technology impacts the way businesses communicate and operate.

Defining Quality

Quality is a subjective term and people have their own definition of what quality means to them. Defining quality can be difficult for any business as the definition can be specific to a product or service as well as related to the strategy of an organization. The quality gurus also have differences of opinion on the definition. For example, Philip Crosby (1979) defined quality as ‘conformance to requirements’ (p.17). Russ Westcott (2014) suggests that ‘Quality - I’ll know it when I see it’ (p. 261) is used by customers to define quality. These definitions are related to product quality.

Quality as an organizational strategy is summed up by Deming. Deming believed that quality was related to the way an organization is managed. In his book "The New Economics" Deming (1994) suggested that the quality of the output of a company cannot be better than quality determined at the top. Jobs are dependent on management's leadership to design and produce product and service that will satisfy customers. Performance excellence models such as the Malcolm Baldrige National Quality Award focus on how a company is organized and managed to focus on customers to produce quality goods and services (Westcott, 2014). The Baldrige Award recognizes organizations for their performance achievements in seven categories. The Baldrige Award also raises awareness that quality and performance excellence are important as a competitive advantage (National Institute of Standards and Technology, 2017). The Baldrige Criteria espouses a systems perspective to quality.

In efforts to improve both product quality and organizational excellence, quality improvement methodologies such as Total Quality Management (TQM), Six Sigma, and Lean were developed. These methodologies utilized tools and techniques improve processes and systems. For example, Lean Standard Work are procedures and practices that could help create consistency and define quality (Westcott, 2014). Tools such as SIPOC can help organizations understand their suppliers, process inputs, the process under study, process outputs, and customers (Tague, 2005).

Lean Six Sigma projects utilize SIPOC as well as process mapping and other tools such as a fishbone diagram or Cause-and-Effect Diagram to help understand variables impacting the process. According to Tague (2005), SIPOC provides a quick, broad view of key elements of a process. SIPOC is used to help define the process. For an assignment, suppliers or those providing inputs into the process are both students and instructors. Students provide some of the

inputs including knowledge and expectations. Instructors provide knowledge, information about the assignment, expectations, and determine the mechanisms as well as the technology used to convey the assignment.

According to Kubiak and Benbow (2017) each step of the process has inputs and outputs (Figures 1 and 2). The inputs and outputs can be demonstrated using a production process classification diagram or more commonly the Fishbone Diagram (Tague, 2005). A Fishbone Diagram is drawn for each step of the process and then the inputs for each steps are identified. The categories for each fishbone can follow the items under Inputs in Figure 1 or can be categories that are relevant to the process under study. Some inputs are controllable and some are uncontrollable or considered noise. Only controllable inputs can be manipulated in studies, but uncontrollable or noise can be reduced through robust processes (Breyfogle, 2003).

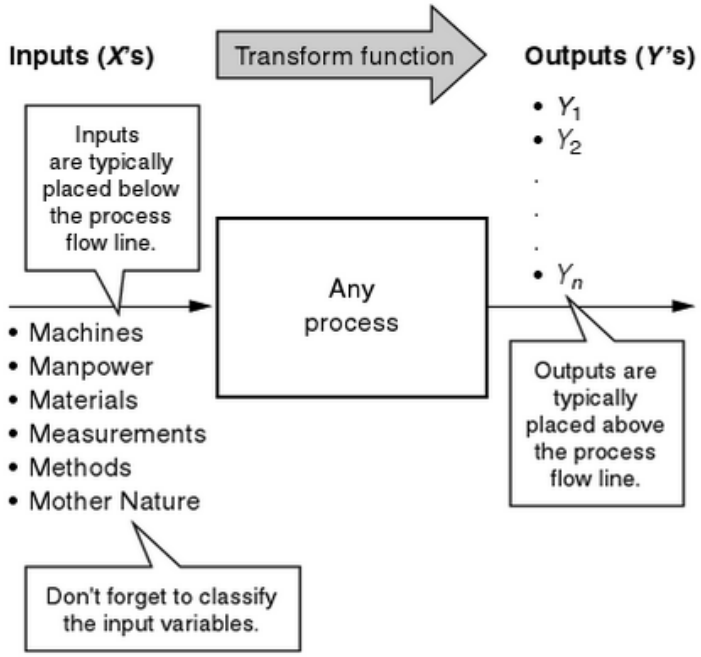

Figure 1. Inputs and outputs of any process
Note. This diagram was originally published in *The Certified Six Sigma Black Belt*. Third Edition by Kubiak, T. & Benbow, D. (2017).

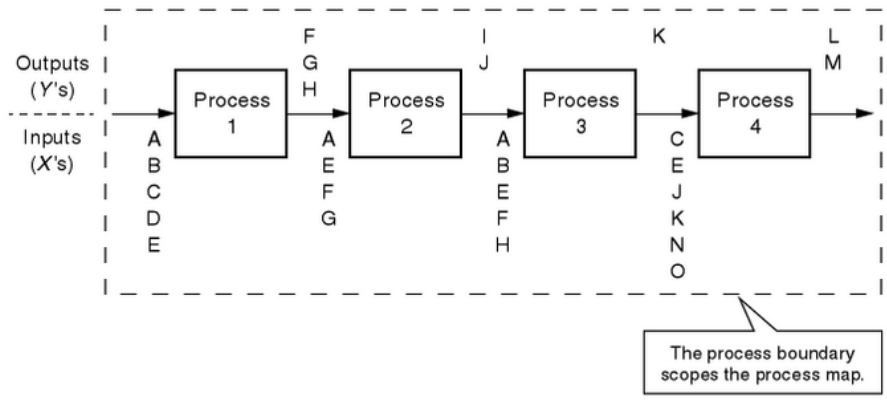

Figure 2. Inputs and outputs for process steps
Note. This diagram was originally published in *The Certified Six Sigma Black Belt*. Third Edition by Kubiak, T. & Benbow, D. (2017).

Lean focuses on eliminating waste and creating value for customers (Ohno, 1988). Once process inputs and outputs are defined, waste can be identified and eventually eliminated. Ohno (1988) identified several types of waste or muda. Waste is any activity that consumes resources but creates no value for the customer. Some examples of waste are waiting, defects, overproduction, unnecessary processing, and transportation. In higher education waste includes dropout students, unfilled classrooms, redundant paperwork, unclear assignments, and bureaucracy according to Wendy Athens (2019). She also states that we should think in terms of process optimization in academics to find new and better ways of educating students. When thinking about assignments given to students, waste consists of recommunication, redefining assignments, and redoing assignments. Process steps are determined to be value added or what the customer is willing to pay for or non-value added. One goal of lean is to reduce non-value-added activities. Another goal of lean is to increase communication throughout the process. Good communication helps ensure everyone is aware of the process, so waste and non-value activities are prevented.

An instructor's ability to communicate the assignment is influenced by several items. Feldman (1989) did an extensive study of factors that influence student achievement. His findings suggest that an instructor's clarity impact student achievement more than the knowledge of the instructor. Clarity is impacted by the instructor's native language as well as communication preferences. He also found in his study that knowledge, skill, and experience are important characteristics.

To communicate the assignment, some mechanisms used include the syllabus, instructions, templates, rubrics and criteria sheets (Sadler, 2010). The technology used to convey the assignment could be via a Learning Management System such as Blackboard or traditional means such as paper, email, or verbal instructions. Dulamă and Ilovan (2016) listed several items used to create and offer feedforward including enouncing the task, the instructions, and the suggestions concerning work style; discussing the task to enable students' understanding; and dialoguing (answering some students' questions but offering this information to all students). They also suggest a two-step sandwich technique, which is accomplished by presenting orally or in writing a suggestion/instruction for solving the task and paying attention to whether or not students have solved the task according to the respective suggestion. McNeill, Bellamy, and Burrows (1999) suggest a quality-based process that requires instructors to define the expectations for each assignment and then add student self-assessment. This was found to have a profound impact on the quality of student work.

The output of communicating the assignment is the feedforward information, which includes communications relating to assessment task specifications and assessment criteria (Sadler, 2010). The outputs of this process now become the inputs for the next step in the

process. Once the student completes the assignment, the instructor grades the assignment and provides feedback to the student.

Assignments allow for the assessment of critical thinking, synthesis and other higher order skills via the use of essays, papers or other documents submitted by students. Assignments in Blackboard allow students to type in a short answer or essay response and/or attach a document with their submission (Blackboard.com). Assessment instruments such as tests and exams are used to measure what students know (American Educational Research Association, American Psychological Association, & National Council of Measurement in Education, 2014). These instruments are used to observe student behavior, gather data, and draw reasonable inferences from the data (Pellegrino, 2012). As with assessment instruments, assignments are often used to determine whether course objectives are being met.

For the most part, students are passive participants in the grading process since they complete the work and then wait for the grade (McNeill, Bellamy, & Burrows, 1999). The process for grading the assignment as well as the transparency of how the assignment is graded is important to perceptions of fairness. Once the grading is complete, feedback information should include communication about the quality of an appraised work and advice about how future responses to similar assessment tasks should be tackled (Sadler, 2010). Sadler (1989) also suggests that feedback should help the student understand more about the learning goal, more about their own achievement status in relation to that goal, and more about ways to bridge the gap between their current status and the desired status. Diefes-Dux, Zawojewski, Hjalmarson, & Cardella (2012) also found that rubric criteria influenced the way instructors provide feedback to students and that instructors comment back to students in different forms such as questions or direct suggestions depending on the perceived quality of the student's work.

Where a student feels they have not been marked fairly, rubrics provide examples of higher and lower performance could be presented to the student to justify the grade. Fink (2007) described effective feedback as "FIDeLity" feedback. FIDeLity stands for frequent, immediate, discriminating and delivered lovingly. Fink suggested that feedback should be descriptive and non-judgmental. It should be used to guide students in learning as well as to reflect on their learning process (Fink, 2007).

Instructors invest considerable effort in providing feedforward and feedback to their students. To provide good feedback to students, instructors need to develop evaluation criteria. Craig Mertler (2001) created a list of steps in one of his articles for developing criteria. Evaluation criteria are developed by first reviewing the learning objectives of the assignment. Next specific observable attributes in the product or process that you want to see as well as those that you don't want to see are identified. Once attributes are developed, Mertler suggests brainstorming characteristics that describe each attribute. These characteristics will help define the quality of the product. Narrative descriptions for excellent work and poor work are created as bookends.

Quality in Higher Education

Defining quality in Higher Education can also be specific to a product such as a graded assignment as well as related to a course or the entire program. Quality Matters (2014) developed a standard to evaluate course quality by reviewing learning objectives. Learning outcomes assessments are used to determine the quality of the program via accreditation criteria. For example, the Accreditation Board for Engineering and Technology (ABET) accreditation provides assurance that a college or university program meets the quality standards of the

profession for which that program prepares graduates (ABET, 2017). Purzer, Fila, and Nataraja (2016) build on Pellegrino's definition of quality assessment and state that assessment serves two purposes: to improve student learning (formative) and improve curriculum, instruction, and programs (summative) (p. 2). The Council for Higher Education Accreditation (CHEA) also publishes guides that help define quality through accreditation. CHEA maintains that accreditation assures threshold quality and encourages confidence in the value of higher education to the public, students, and government (Eaton, 2016).

For a product such as an assignment, students may define quality as conformance to requirements such as following the course syllabus or assignment instructions or a rubric. For instructors, quality of a student's work sometimes follows the 'I'll know it when I see it' (McCain, 2015). Assignments should be aligned with the goals and objectives of the course (Svinicki and McKeachie, 2014) and specific objectives related to the assignment or assessment used in the course should also be appropriately communicated. The specific objectives create the basis for the definition of quality. Quality requirements should be the specific criteria as to what is required for the student to receive a specific grade. Criteria are abstract ideals to which students (ought to) aspire, and against which one hopes to assess student performance (Andrade, 2000). Assignments are an important tool in determining students' grasp of the course objectives. Assignments are assessments that require students to demonstrate skills and proficiency (Sadler, 2010). Sadler also notes that feedforward offers a critical opportunity to explain not just criteria, but also the form and structure of what is expected from a student in response to an assessment task. He defines quality as the degree to which a work comes together as a whole to achieve its intended purpose. Todd Zakrajsek, Executive Director, Center for Faculty Excellence University of North Carolina at Chapel Hill, stated that responding to student

assessment items with constructive commentary that emphasizes the global issues of quality that the student can develop to further enhance his or her own professional achievement in higher education. This broader focus means that markers' comments can overcome the problem of ineffectuality of feedback (Doyle, 2011).

One way to convey quality requirements for assignments to students is by using criteria and levels to develop rubrics. A rubric is a document that articulates the expectations for the object being evaluated by listing the critical criteria of what is deemed as necessary and assesses the levels of quality from poor to excellent (Reddy & Andrade, 2010). The criteria, known in advance by the students, provide descriptions of each level of performance in terms of what students are able to do. Students can use the rubrics information as a self-assessment prior to assignment submission (Andrade, 2007).

Instructors can use rubrics to evaluate the quality of student work. In addition to criteria that describe the expectations for work, a scoring rubric includes a scale of possible points for varying levels of performance in relation to the criteria (Goodrich, 1996; Popham, 1997; Wiggins, 1998). These criteria specify the "what;" the performance levels specify the "how well" (Mabry, 1999). If the rubric is well designed then it should be easy for the instructor to distinguish performance and to justify and explain results (Shirran, 2006).

Existing literature includes the development of evaluation criteria and rubrics as well as the ways that rubrics can be used to improve the course experience for students. Much of the literature on evaluation criteria and feedback to students is found in articles written by D. Royce Sadler. He is also referenced in many articles on the subject. He found that to develop knowledge students must understand the meaning of feedback with relationship to task compliance, quality, and criteria. Students need to identify the particular aspects of their work

that need attention. Feedback should help the student understand more about the learning goal, more about their own achievement status in relation to that goal, and more about ways to bridge the gap between their current status and the desired status. Although the students may accept a teacher's judgment without question, they need more than summary grades if they are to develop expertise intelligently (Sadler, 1989).

Dulamă and Ilovan (2016) found in their study that feedforward mechanisms and tools increased efficiency and better assignment quality. They noted that feedforward more than feedback increased students' learning efficiency and the quality of their results. What they found was that by proactively communicating criteria, students were able to correctly solve tasks. The feedforward helped prevent students from making mistakes and thus reduced waste in the process.

When analyzing this in terms utilized in Lean Six Sigma, feedforward is considered preventive as it helps students understand the quality criteria prior to completing the assignment, while feedback is considered reactive and mistakes are considered defects. When instructors do provide feedback, Baker and Zuvela (2013) found that responding to student assessment items with constructive commentary further enhanced the student's professional achievement in higher education. Constructive commentary rather than just pointing out defects were more beneficial to student learning. Yuen-Reed and Reed (2015) found that students need to be confident in their answers and created confidence-based scoring to provide more than just correct/incorrect feedback to students.

Quality control can be difficult to maintain within large departments where multiple graders are expected to be consistent. Quality and consistency can be difficult to preserve within large universities where multiple instructors are involved and often grade independently

(Atkinson & Lim, 2013). With common information such as a checklist or rubric, grades will be more consistent. Additionally, if these items are automated, the calculation should ensure consistency and thus perceptions of fairness (Shirran, 2006).

Higher Education and Technology

Esin (2011) states that instructors are long-lasting transmitters of knowledge and that the integration of technology into the instructional process will create effective learning environments. Technology or any device available to instructors for use in teaching students in a more efficient and stimulating manner than the sole use of the teacher's voice (Cuban, 1986) has evolved over the years. Back in the 1800s chalkboards and books were primarily used. Later in the 1900s overhead projectors, radio, film, and television became technology tools for instructors. Whiteboards were introduced in the 1960s. Computers were available in the 1980s and learning management systems became prevalent after 2000 (Schulstad, 2013). Technology appears to alter the landscape of the college classroom in all formats: face-to-face, on-line, or blended (Parker, Bianchi, & Cheah, 2008). Americans now consume information for about 1.3 trillion hours each year or on average about 12 hours per day. The amount of information consumed totaled 3.6 zettabytes and 10,845 trillion words, with each person using, in some form, 34 gigabytes of information on an average day (Bohn & Short, 2009). In contrast, people living in the mid-1800s would have consumed in their lifetimes less information than is published in one week of the New York Times (Doyle, 2011).

Many universities now rely on computer or web-based technology to convey course information to students. This technology is often in the form of a Learning Management System

(LMS) or Course Management Systems (CMS). A learning management system is "a software application that automates the administration, tracking and reporting of training events" (Ellis, 2009). The LMS or CMS not only helps students, but also helps institutions with assessment via goals and rubrics. Svinicki and McKeachie (2014) describe a systems approach to teaching with technology (Figure 3). They also state that course or learning management systems make it easy for instructors to distribute course materials to students and manage student grades especially when working with online or distance students. They suggest that instructors develop clear expectations and standards for assessment that are aligned with learning objectives and develop flexible assessment methods but maintain rigorous standards. According the EDUCAUSE Center for Analysis and Research (ECAR) study 99% of educational institutions have an LMS in place. Students report that they use the learning management system in 82% of their courses. (Brooks, 2015).

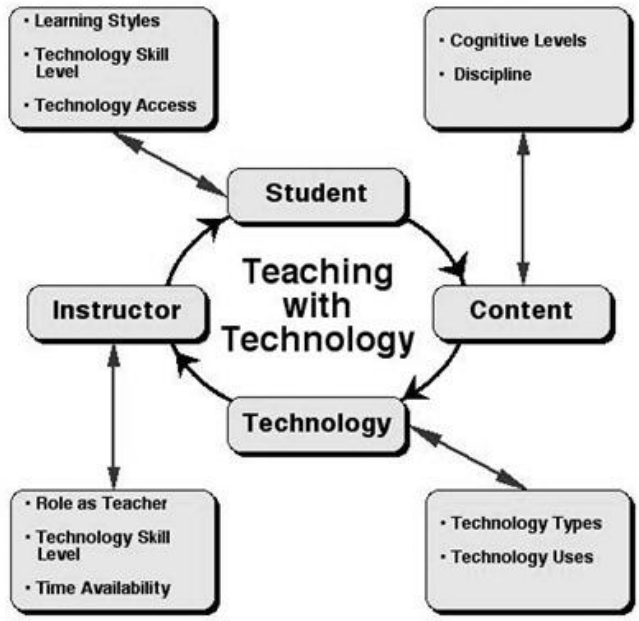

Figure 3. Teaching with Technology
Note. This diagram was originally published in *McKeachie's teaching tips: strategies, research, and theory for college and university teachers.* Fourteenth Edition by Svinicki, M. and McKeachie, W. (2014).

Researchers have shown the added benefits of computerization using either personal computing software (Mitri, 2005; Czaplewski, 2009) or dedicated assessment systems (Anglin, Anglin, Schumann, & Kaliski, 2008). These systems are popular since they can be utilized asynchronously or synchronously. Burrows and Shortis (2011) identified 29 different technologies related to computerized marking and feedback such as LightWork, RemarksXML, Blackboard, Turnitin 2 GradeMark, RubiStar, Waypoint, Moodle, Canvas, and Sakai. They also note that complete learning management systems include grade management, submission or assignment management components, and usually most or all of these.

A major goal of course management software is to integrate a suite of teaching technologies into a powerful set of tools that make it easy for faculty to use technology in instruction (Morgan, 2003). LMS tools and functions not only help instructors manage materials and information for courses, but also help facilitate communication between class members and other faculty and as a means to electronically distribute information. (Lonn & Teasley, 2009). A 2019 Inside Higher Education survey found that 39% of professors said they "fully support" the increased use of educational technology (Lederman & Jaschik, 2019). Being that the LMS is a set of tools, it is up to the instructors as well as the students to use it in a way that benefits all involved with the course. Typical left menu buttons utilized in Blackboard shells include:

- Syllabus: a contract between students and the instructor that can include how learning will be assessed and grades determined (Svinicki and McKeachie, 2014)
- Announcements: standalone messages created by the instructor for all site participants to see. The announcement may be sent immediately by email.

- Course Documents / Lessons: created by the instructor to post information needed for the course or an individual lesson. Documents such as Powerpoint can be uploaded as well as videos and Internet links.
- Assignments: created by the instructor to post assignments and other course activities. The assignments can be for a grade or as a check of progress.
- Discussion Board / Forums: individual discussion threads that can be organized around a topic or question. These asynchronous messages can be read by all site participants. Individuals can post as anonymous.

Blackboard allows for the streaming of live course content via Collaborate or Collaborate Ultra. With Collaborate, distance students can participate in the course in real-time. Collaborate also has an option for recording so students that miss class can catch up.

There are tools specifically for instructors to add to their Blackboard course shell related to course work. These course tools include:

- Assignments
- Tests/quizzes
- Discussion Board
- Surveys
- Pools
- Rubrics

Assignments are created by the instructor for students to review instructions and submit assignments. Specific instructions about the assignment can be included as well as documents associated with the assignment. The assignment can be adaptively released or made visible at specific times. Rubrics for the assignment may be included with additional information about

the assignment requirements. Students can upload papers or other documents as needed to fulfil the assignment. Assignments can be created as a graded item or as a progress check.

Tests or quizzes are sets of questions or essays. Instructions for how to complete the test or quiz can be included. The types of questions can be multiple-choice, true/false, multiple answer, essays, fill-in-the-blank, and others. Adaptive release is also available for tests and quizzed. One benefit of using LMS tests or quizzes is that many question types are automatically graded allowing students to get immediate feedback on performance.

Discussion boards or forums are used to help stimulate online conversations. The discussion threads are organized around a topic or a question. These asynchronous messages can be read by all site participants. Students can post as anonymous. Discussion boards can be graded and can have rubrics associated with them.

Surveys are polls of students' opinions. Surveys can be created regarding individual experiences, behaviors or knowledge but they are not graded. The results are only available as aggregated statistics and are useful for gathering data from students that is not related to student performance.

Pools are sets of test/quiz questions that are stored in Blackboard. These questions can be used across content and can be added to any test or survey. Pool questions can also be randomly deployed for a test or quiz so that not every student sees the same questions.

Rubrics in Blackboard are grids consisting of rows and columns. The rows are the criteria and the columns are the levels of success. Once setup, students can see the criteria for each assignment and instructors can add notes to the students. Levels are created on a continuum that range from poor to excellent work for each attribute (Mertler, 2001). To create a meaningful continuum, Walser (2011) suggests using a rubric ranging from 0 to 4 points, with a score of "3"

serving as the fulcrum, representing the instructional goal, and a score of "4" representing work that goes beyond level 3 performance (Figure 1). This idea came from a book called Making Standards Useful in the Classroom (Marzano & Haystead, 2008). The score of "4" represented "in-depth inferences and applications that go beyond what was taught" (Marzano & Haystead, p. 29). This rubric scale accommodates, rewards, and motivates more creative, innovative, and in-depth student performance beyond what was described as meeting an instructional goal. Once the rubric is created, Mertler (2001) suggests collecting samples of student work that exemplify each level. After reviewing student work, determine if the rubric is acceptable. If it is not, revise the rubric as necessary for improvement.

Table 1

Standard Rubric for Study Guide Assignments for Teacher, School and Society Course

Grade	**Criteria**
4	Demonstrates in-depth understanding
3	Clearly demonstrates understanding. ✓ Responses to questions are complete, accurate and appropriate. ✓ Communication is clear with minimal spelling and grammatical errors. ✓ Submitted in the specified format by the deadline.
2	For the most part, demonstrates understanding.
1	For the most part, doesn't demonstrate understanding.
	Does not demonstrate understanding of at all OR did not complete and submit before the deadline.

Note. The information for this table was adapted from "Using a Standard Rubric to Promote High Standards, Fairness, Student Motivation, and Assessment for Learning." by T. Walser, 2011, *Mountainrise*, *6*(3), 1-13. It was modified to shorten criteria descriptions and excludes 0.

In Blackboard the calculations are automated and the results are available to students. The rubric helps instructors consistently and efficiently grade assignments. A rubric, when serving as a marking tool, can boost the validity and accuracy of grading (Brown, Glasswell, & Harland, 2004). Teachers can use feedback comments from a bank of comments built up through

repeated assessment cycles. Atkinson and Lim (2013) found that the rubric decreased the time to grade assignments by 40%. Also, the automation of grading by using the rubric ensures consistency.

Summary

Quality requirements are important to students as they need to know what is required to receive an expected grade on an assignment. Quality can have different meanings for students and instructors. For assignments, students may define quality as conformance to requirements such as following the course syllabus or assignment instructions or a rubric. For instructors, quality of a student's work sometimes follows the 'I'll know it when I see it'. Instructors may invest considerable effort in providing quality requirements for assignments to students and then feedback in the form of a grade just to learn that the student expected something else. Reviewing the process of feedforward and feedback utilizing Lean Six Sigma tools such as SIPOC, process maps, and fishbone diagrams to determine the mechanisms used as well as technology may benefit both students and instructors.

CHAPTER 3

METHODOLOGY

The major sections of methodology chapter include theoretical framework, research design, population, instruments used, validity and reliability, research questions and hypotheses, statistical analysis, and research questions and hypotheses. Case and Light (2011) state that "the choice of methodology (with its underlying theoretical perspective and its related set of methods) is determined by the kinds of research questions that one wishes to ask." (p. 189). Since the research questions for this study seek to understand what is on the horizon as well as what is currently in use, this study utilized the Delphi method and survey questions to explore the topic. As stated in a recent Journal of Engineering Education guest editorial on quality considerations in engineering research, a researcher should examine the nature of the phenomenon, the question, the data, and then determine an appropriate statistical model (Hjalmarson & Moskal, 2018).

Seven research questions were formulated for this study. The first research question and associated information was posed to the Delphi Panel. The panel consisted of teaching excellence groups at the University of Kansas and the University of Central Missouri. Representatives from Indiana State University were invited to participate but did not. The purpose of the initial Delphi Panel was to add to the survey and model since technology and teaching techniques are constantly changing. The original Delphi Panel questions and diagrams

are located in Appendix A. The initial survey questions reviewed by the Delphi Panel are in Appendix B. The informed consent form is in Appendix C.

The survey part of the study utilized various types of questions to gather data on feedforward mechanisms and the technology used to convey them. The initial survey was revised (Appendix B) after the first Delphi Panel meeting and then made available to students and instructors at Indiana State University, the University of Central Missouri, and the University of Kansas after IRB approval. The Qualtrics survey questions are located in Appendix D. The Qualtrics survey contained an initial question asking for consent (Figure 4).

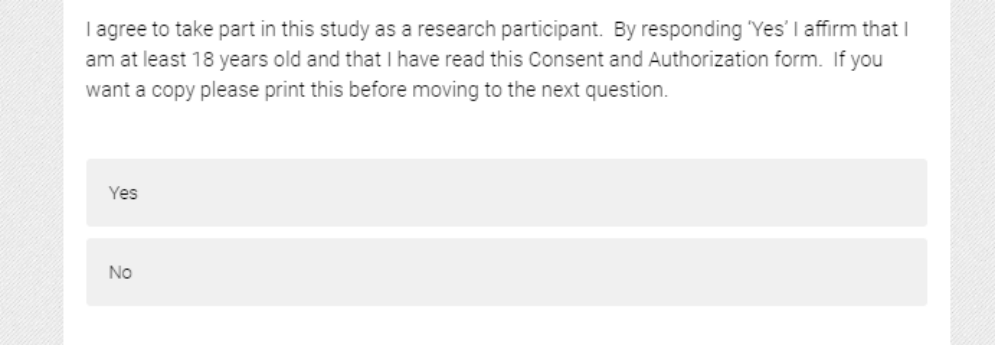

Figure 4. Consent to Participate Survey Question
Note. This is a screen shot from the Qualtrics survey.

Since the survey was electronic, only questions associated with either students or instructors were visible to the participants based on their selection (Figure 5).

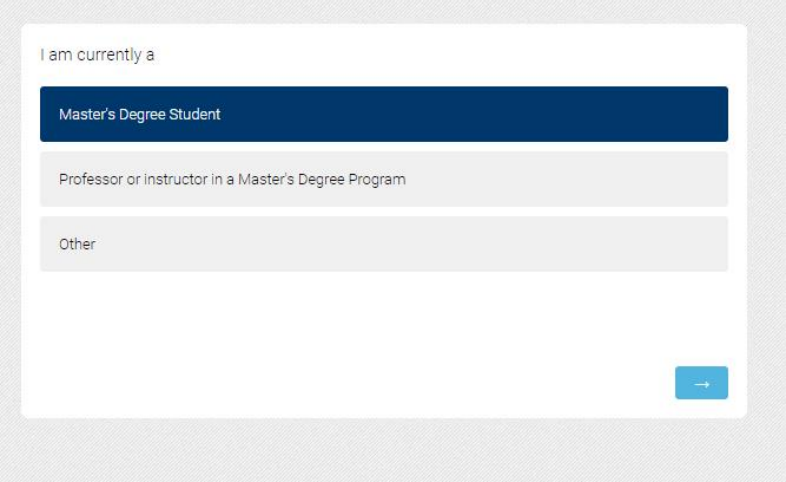

Figure 5. Survey Participant Self Identification
Note. This is a screen shot of the survey from Qualtrics.

Building on the findings from the survey part of the study, the last part of the study utilized the Delphi Panel to gather responses to proposed graphical models of feedforward mechanisms that include conveyance methods.

Theoretical Framework

Prior to convening the Delphi Panel, a literature review was conducted to create initial graphical tools (SIPOC, flowchart, and fishbone diagrams). The graphical tools were utilized to start the first round of the Delphi Panel discussion (Appendix A). To understand the assignment process, a SIPOC and a high-level process map were created and reviewed with the Delphi Panel (Figures 6 and 7).

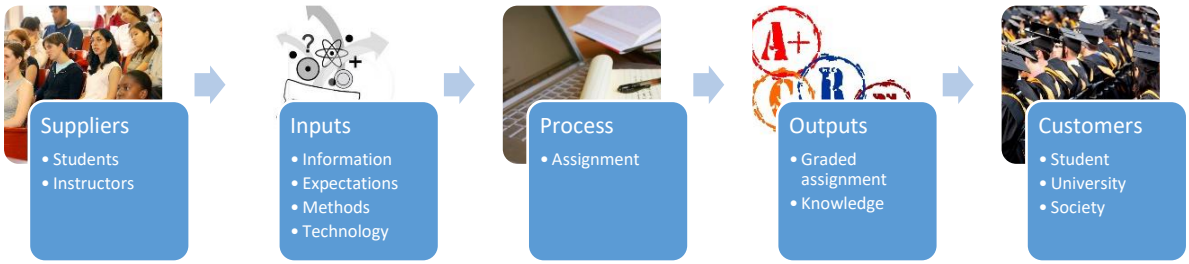

Figure 6. SIPOC for the Assignment Process
Note. SIPOC is the abbreviation for suppliers, inputs, process, outputs, and customers.

The output of the assignment process is the graded assignment as well as knowledge. The customers include the student receiving the grade. In a larger context, the university and society are also impacted by the assignment process since one of the outputs is the knowledge of the student who is part of society and a product of the university.

The process diagram or flowchart shows the high-level process steps as well as how is involved with that step of the process (Figure 7). Instructors follow a sequence that involves setting up an assignment, as well as appraising student responses then providing information about performance that results in a grade. Students review the assignment information then complete the assignment and eventually review the grade. The first step is for the instructor to communicate the assignment to the student. The student then completes the assignment based on what was communicated. Once the assignment is complete, the instructor grades the assignment and provides the grade to the student. The student and the instructor then review the grade. If both the instructor and the student agree that the grade is correct, the process is complete. If either the instructor or the students disagree with the grade, parts or the entire process may need

to be completed again. This constitutes rework and is considered waste when reviewing processes from a Lean perspective.

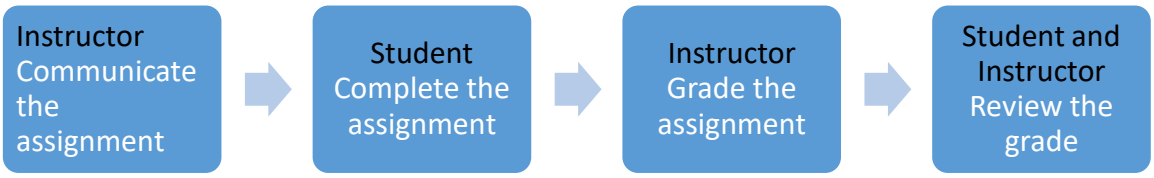

Figure 7. High-Level Process Diagram for Assignments

For the first step in the process "Communicate the assignment," the categories of Mechanisms and Technology were studied to develop sub-bones for each category. Figure 8 depicts the inputs for this step of the process as well as the sub-bones. The outputs of this process step are also included.

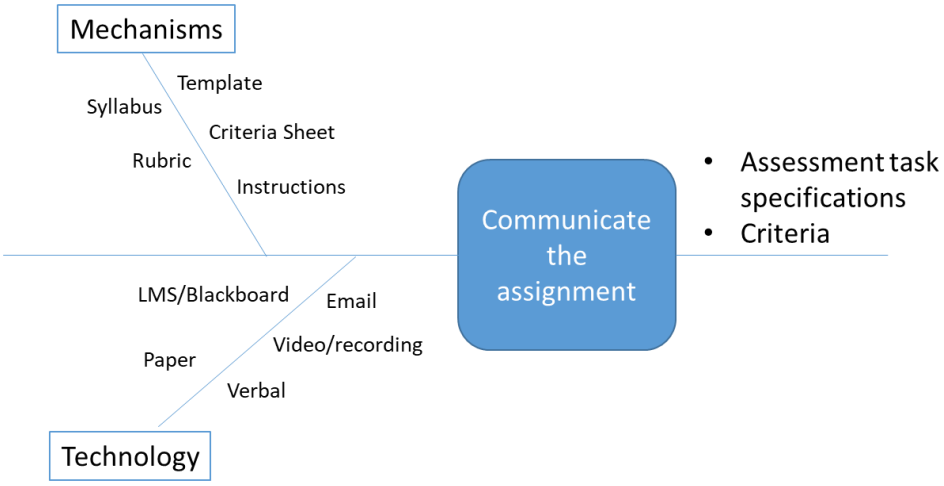

Figure 8. Inputs/outputs for the process step of communicating the assignment

At the end of the process, the student reviews the grade and either agrees with the grade or disagrees (Figure 9). The mechanisms and technology inputs to "Review the Grade" are listed.

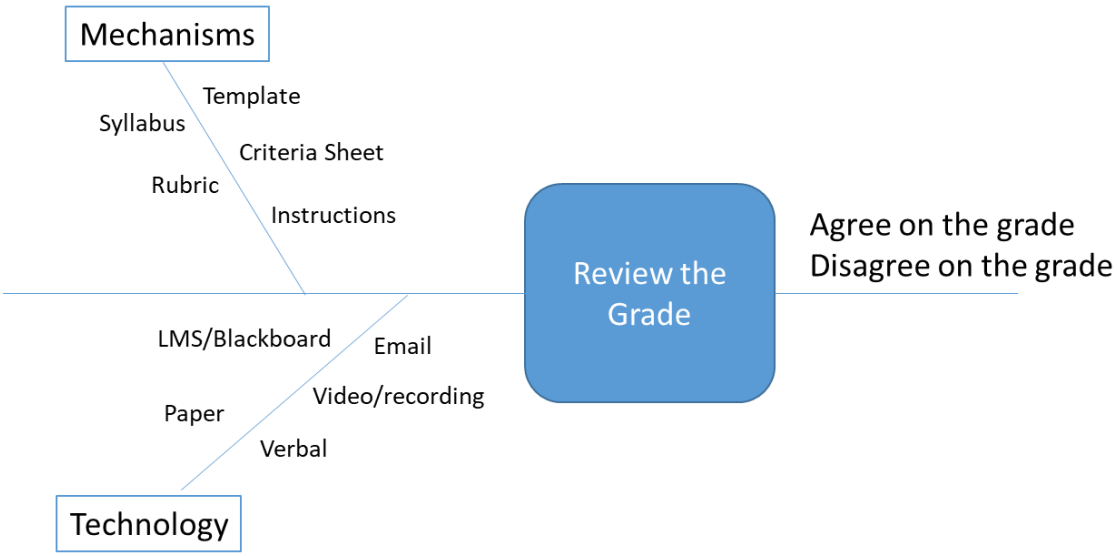

Figure 9. Inputs/outputs for the process step of reviewing the grade

As stated earlier, if either the instructor or the student disagrees with the grade, parts or the entire process may need to be completed again. There are at least three rework loops in the process (Figure 10). If the student doesn't understand the assignment, they may contact the instructor for further instructions or clarification prior to completing the assignment (Rework Loop 1). A student might also complete the assignment and once it is graded contact the instructor about why this grade is not what the student expected (Rework Loop 2). Another rework loop exists after the instructor reviews the grades and decides to rewrite or format the assignment instructions (Rework Loop 3).

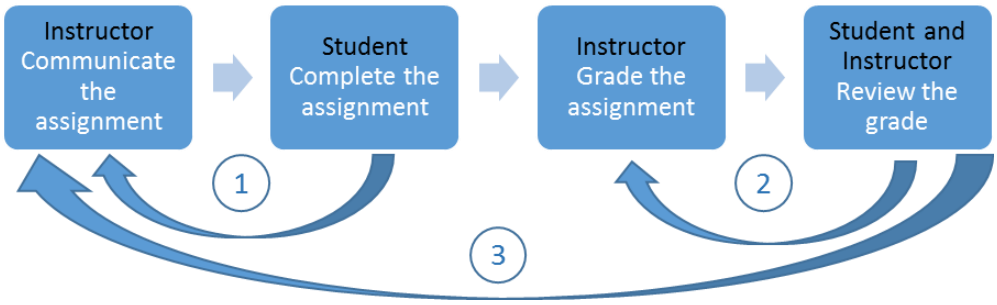

Figure 10. Rework loops in the assignment process
Note. (1) represents Rework Loop 1. (2) represents Rework Loop 2. (3) represents Rework Loop 3. The numbers correspond with the rework loop information displayed in the Table 2, Table 3, and Table 4.

From a Lean perspective, these rework loops are considered waste. For example, Rework Loop 1 waste consists of overproduction or unnecessary processing, waiting, and defects (Table 2). These types of waste cause rework consisting of recommunication, redefining assignments, and redoing assignments. This waste is reflected in the amount of time spent during office hours recommunicating or redefining the assignment.

Table 2

Waste examples for Rework Loop 1

Lean Waste	Assignment Process Rework Loop 1	Rework
Overproduction/ Unnecessary processing	• Too much information communicated about the assignment (confuses the student) • Too much work added to the assignment by the student	• Recommunication • Redefining the assignment
Waiting	• Waiting for information about the assignment or clarification	• Redefining the assignment
Defects	• Misinterpretation of assignment instructions by the student	• Redoing the assignment (if allowed)

Rework Loop 2 waste consists of waiting and defects (Table 3). Redoing the assignment and renegotiating the grade are the types of rework involved. Waiting is waste and frustrates both student and instructors.

Table 3

Waste examples for Rework Loop 2

Lean Waste	Assignment Process Rework Loop 2	Rework
Waiting	• Waiting for the grade • Waiting to meet with the instructor to talk about the grade	
Defects	• Misinterpretation of the assignment • Assignment not complete (or does not meet instructor's expectations of completeness) • Assignment does not meet instructor criteria • Grade does not meet student expectations	• Redoing the assignment (if allowed) • Renegotiating the grade

Rework Loop 3 involves the review of assignments after grades were assigned (Table 4). For example, if an assignment was not completed or it did not meet instructor's expectations of completeness, a review of the instructions may be needed. Also, if the assignment did not meet instructor criteria, the criteria may need to be communicated or communicated in a different manner. Svinicki and McKeachie (2014) suggest reviewing assignment items that may be troublesome then determine how to fix them. They also outline procedures that can improve evaluation such as establishing a rubric or criteria set.

Table 4

Waste examples for Rework Loop 3

Lean Waste	Assignment Process Rework Loop 3	Rework
Defects	• Misinterpretation of the assignment or grade • Assignment did not meet instructor's expectations of completeness • Assignment did not meet instructor quality criteria	• Reevaluation of the assignment • Recreation or creation of criteria • Review of communication forms/manner

Research Design

The research hypothesis questions were created based on the Theoretical Framework to support the creation of a model. From the research hypothesis questions, several survey questions as well as discussion questions for the Delphi Panel were proposed (Appendix A and Appendix B). The survey questions were made available to the Dissertation Committee via the dissertation proposal for review. Once the proposal and oral defense of the proposal were complete, the Delphi Panel questions and survey were submitted to Indians State's Institutional Review Board (IRB). IRB approval was necessary since this research falls into the category of Psychological, Sociological, or Behavioral Research (Category 7). This type of research involves individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies

(Indiana State University Institutional Review Board, 2010). IRB approvals were also gained from University of Central Missouri and the University of Kansas. (Appendix E)

Potential Delphi Panel participants were invited to an online meeting to discuss the questions approved by the IRB. Informed consent was obtained from those who chose to participate prior to the online meeting. From this meeting the survey wording was revised to reflect current feedback mechanisms and technology terms. The survey was then deployed via a Qualtrics link to instructors and students.

Informed consent was obtained from all survey participants by through a question at the beginning of the survey. Survey participants could leave the survey at any time prior to the completion of the survey. Once survey results were received and analyzed, potential Delphi Panel participants were contacted and invited to another meeting. Informed consent was obtained from those who chose to participate prior to the meeting. The results were reviewed, and the model updated to reflect the survey results and the Delphi Panel input.

Population

The participants for this study were Master-degree seeking students and instructors that teach in a master's program. Students and faculty members could be full-time or part-time. Participants for the Delphi Panel were recruited from the University of Kansas (KU), Indiana State University (ISU), and the University of Central Missouri (UCM) from the teaching excellence organizations at those universities. The expectation was that at least 6 people will comprise the Delphi Panel with at least 2 from each university.

Surveys were electronically sent to students and instructors at the University of Kansas (KU), Indiana State University (ISU), and the University of Central Missouri (UCM). There are currently 19 Master's degree programs in the School of Engineering at the University of Kansas with approximately 400 students and 50 instructors. At ISU there are 100 students and 20 instructors for technology related master's degree programs. UCM has approximately 70 students and 12 instructors in their technology related master's degree programs. Each university has some full-time and some part-time students. The expectation was to receive responses from 50 students from KU and 20 from UCM and ISU or at least 90 responses in total from students. For instructors the overall sample number is lower as the population is smaller. The expectation is to receive at least 35 responses from instructors or 15 from KU and 10 from ISU and UCM.

Instruments Used

This study was produced in three phases. The first phase utilized a Delphi Panel to compliment information gathered during the literature review and improve the survey. The second phase of the study used a survey to identify waste, communication preferences, and office hour utilization. The third phase of the study again used the Delphi Panel to review the survey data and adjust the model.

The Delphi method was utilized for the first and third phases of the study. The Delphi method is a structured research approach using a directed group, frequently experts on the topic of interest, to deal with a complex problem (Hasson & Keeney, 2011). It is an iterative process to collect and refine the anonymous information or opinions from people familiar with a process often called a Delphi Panel. The Delphi Panel is a group of individuals contacted to determine,

predict and explore group attitudes, needs and priorities. According to Skulmoski, Hartman, and Krahn (2007), the Delphi method works especially well when the goal is to improve our understanding of problems, opportunities, solutions, or to develop forecasts.

The Delphi method was selected for this study due to the need to gather information from experts on the use of various feedforward mechanisms as well as identify current technology used to convey assignment requirements. The potential panel was to be comprised of teaching excellence groups at the University of Kansas, the University of Central Missouri, and Indiana State University. At the University of Kansas, the groups that were invited to participate included the Center for Teaching Excellence and the Center for Online and Distance Learning. At the University of Central Missouri, the Center for Teaching and Learning were invited. At Indiana State University the Faculty Center for Teaching Excellence were invited. An online meeting was used to facilitate discussion about the graphical items created to explain the process and which were updated to reflect information gathered from the Delphi Panel. An invitation to participate will be sent to the directors of each program. Participants were not limited to the directors and could be from any interested party from that program. The Delphi Panel was useful to study different opinions as to which feedforward mechanisms and what technology are best to convey assignment requirements.

Partington (2002) states that graphical models are useful in representing theories. Diagrams are easier for people to grasp than written or oral presentations. He also states that graphical models are tools and that the diagram is not a theory, but a visual representation of the theory. In Lean Six Sigma, graphical models include process mapping, flowcharts, and fishbone diagrams (Kubiak and Benbow, 2017). For this study graphical models assist in creating visual

representations of items studied as well as the results from the survey and Delphi Panel discussion.

For Round 1 of the Delphi Panel several questions were discussed (Appendix A). The first questions were related to Figure 6 SIPOC for the Assignment Process. The Delphi Panel was asked "What are the suppliers, inputs, process, outputs, and customers (SIPOC) for the assignment process? Are there any items missing from the SIPOC diagram?" The next questions were related to Figure 7 High-Level Process Diagram for Assignments. The Delphi Panel discussed the steps of the process flow for assignments. They were asked if any items in the diagram were missing or confusing. The next questions focused on Figures 8 and 9, which are fishbone diagrams showing inputs and outputs. The Delphi Panel was asked to think in terms of mechanisms and technology then asked to help identify the inputs and outputs for the first process step which is communicating the assignment. They were then asked about the last step of the process which is reviewing the grade and identify inputs and outputs. To wrap up the diagrams, the Delphi Panel was asked if any additional diagrams would help explain the assignment process. Finally, the Delphi Panel reviewed the survey tool for students and instructors and made suggestions for improvement.

The second phase of the study utilized an online survey. Surveys are commonly used to gain quantitative data for analysis. According to Check and Schutt (2012) survey research is the collection of information from a sample of individuals through their responses to questions. Survey research includes selecting potential participants, collecting data, and utilizing various statistical techniques to analyze the results. For this study, survey research utilized a quantitative research strategy with questions that are numerically rated.

The survey was developed and deployed through Qualtrics via a weblink. Qualtrics is survey software solution that it used to create and distribute questionnaires for research projects. Indiana State's Qualtrics software was used to design and deploy the survey. Qualtrics can reach respondents wherever they are with surveys on mobile devices, apps and websites (Qualtrics.com, 2018).

The survey was designed so that students and instructors answered questions specifically created for their demographic (Appendix D). The survey was divided into six parts. The first part of the survey asked for participant consent (Figure 4). This question was the same for students and instructors. If an answer of 'no' was selected the survey concluded and the respondent was thanked. If an answer of 'yes' was selected, the participant preceded to the next part of the survey. This assured that participants agreed with partaking in the survey as required by the IRB.

The second part of the survey asked participants for demographic information. The first question in this section asked which university they were affiliated with (Figure 11). If 'Other' was selected the survey concluded and the respondent was thanked. If the response was 'Indiana State University', 'University of Central Missouri', or 'University of Kansas', the respondent was asked the next question. This assured that the participants were from one of the three universities under study.

Figure 11. University Affiliation Survey Question
Note. This is a screen shot from the Qualtrics survey.

The next question in this section asked whether participants were students or instructors (Figure 12). If 'Other' was selected the survey concluded and the respondent was thanked. If 'Master's Degree Student' was selected, the next demographic question related to full-time or part-time status was asked (Figure 13). Once a student status response was recorded, the respondent was sent to the next part of the survey where assignment related questions were asked. If 'Professor or instructor in a Master's Degree Program' was selected the respondent was sent to the next part of the survey where assignment related questions were asked.

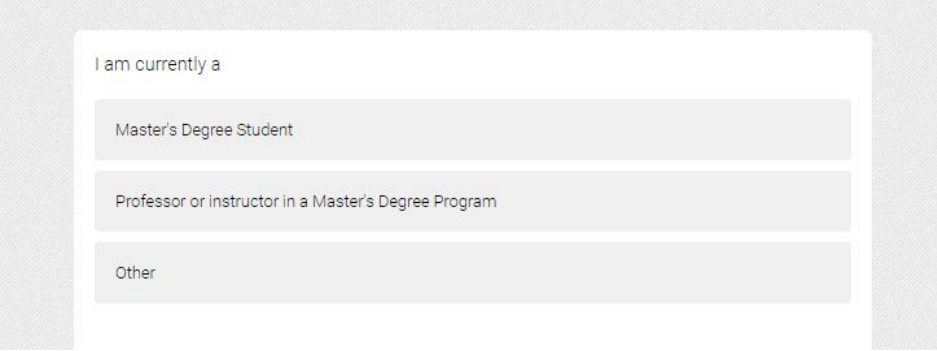

Figure 12. Participant Status Survey Question
Note. This is a screen shot from the Qualtrics survey.

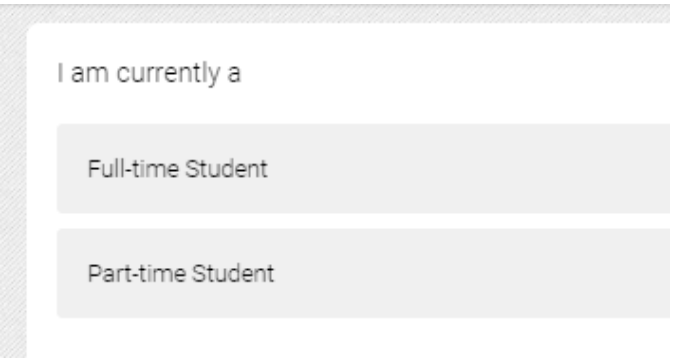

Figure 13. Student Status Survey Question
Note. This is a screen shot from the Qualtrics survey.

The third part of the survey asked for information about specific assignments. This question was worded differently for students and instructors. Students were asked to think about 3 recent assignments. They recorded the assignment type based on a drop-down list that included problem solving, essay, case study, presentation, research paper, and other. For each assignment type selected, students were asked to identify what the instructor used to explain the assignment. The choices were syllabus, instructions, rubric, or other. They could select one item or all that applied. The next part of the question asked how the instructor explained the assignment. The choices were verbally, paper/handout, electronically, or other. They could select one item or all that applied. Finally, students were to record how much time they spent asking the instructor for clarification before submitting the assignment in minutes as well as how much time was spent asking for clarification of the graded assignment in minutes (Figure 14).

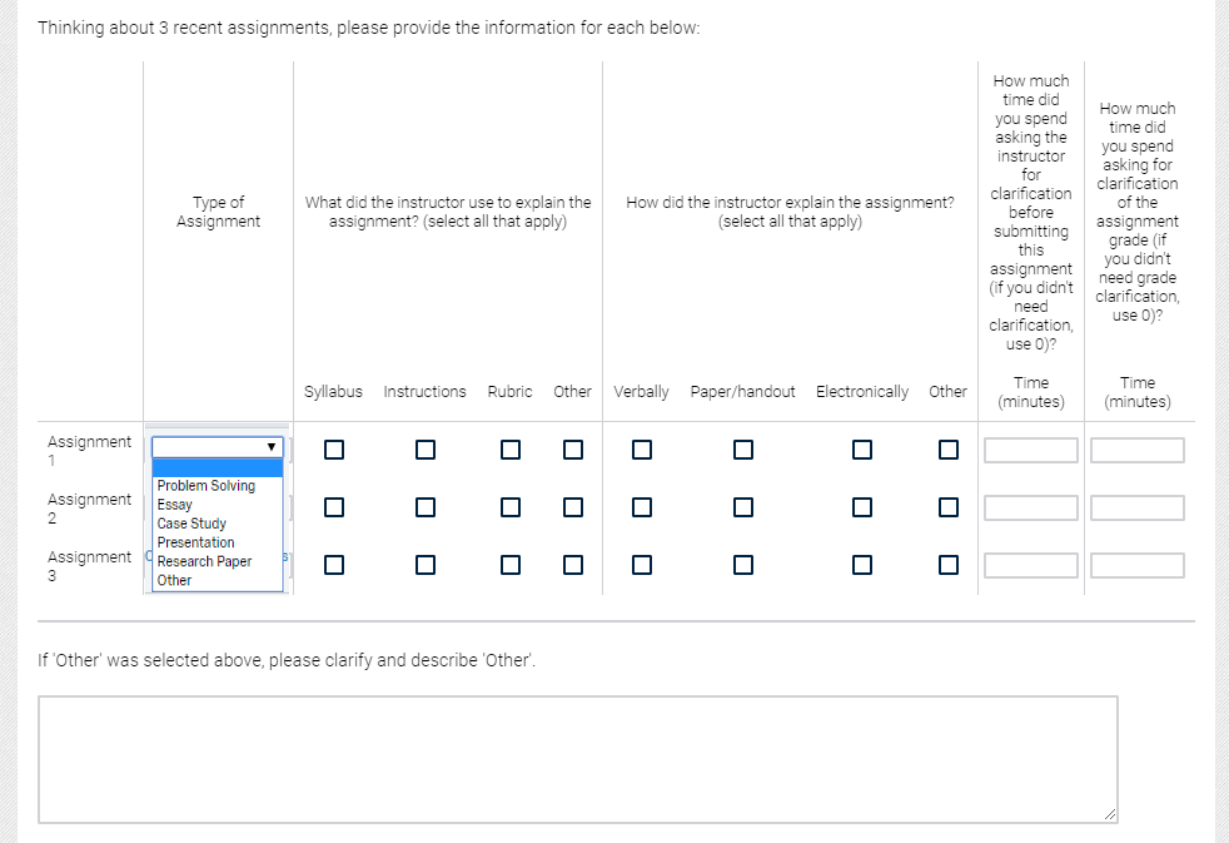

Figure 14. Student Assignment Information Survey Question
Note. This is a screen shot from the Qualtrics survey.

Instructors were asked to think about 3 recent assignments given to students. They recorded the assignment type based on a drop-down list that included problem solving, essay, case study, presentation, research paper, and other. For each assignment type selected, instructors were asked to identify what they used to explain the assignment. The choices were syllabus, instructions, rubric, or other. They could select one item or all that applied. The next part of the question asked how they explained the assignment, or the technology used. The choices were verbally, paper/handout, electronically, or other. They could select one item or all that applied. Instructors were then asked to record how much time they spent answering student's questions about assignments before they submitted the assignment in minutes as well

as how much time was spent providing clarification of the graded assignment in minutes. Based on input from the Delphi Panel the two questions were also framed in terms of percentages (Figure 15).

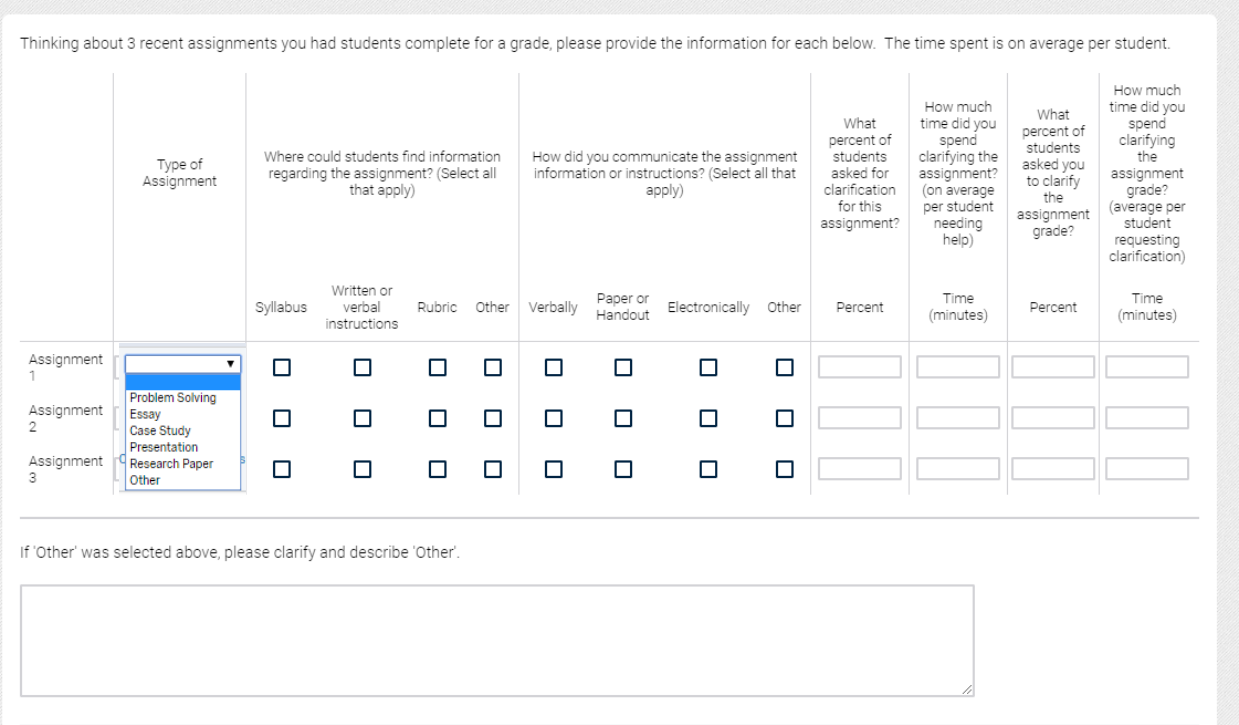

Figure 15. Instructor Assignment Information Survey Question
Note. This is a screen shot from the Qualtrics survey.

The fourth part of the survey asked about office hour use. Students were asked why they attended office hours, if they did. Students could also select that they didn't attend office hours. The potential responses included asking for an explanation of an assignment prior to submission, asking for clarification of a graded assignment, asking for clarification of a graded quiz or exam, asking about course material, asking about the program or future course, other, and never attended office hours (Figure 16).

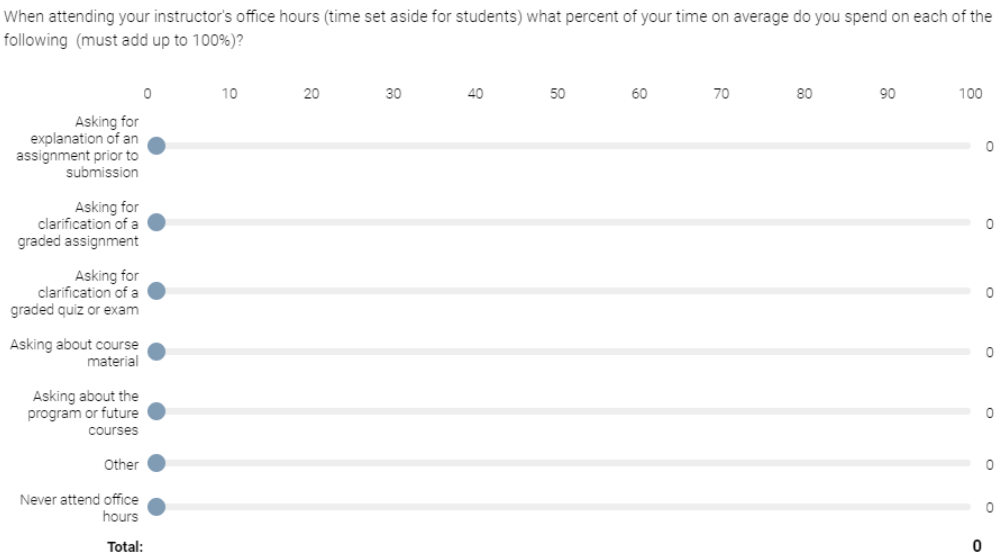

Figure 16. Office Hour Use Survey Question for Students
Note. This is a screen shot from the Qualtrics survey.

The questions for instructors about office hours utilization were similar to the student questions. The potential responses were clarifying course material, clarifying assignment information, clarifying grades for assignments, clarifying quiz or exam grades, advising current students, answering questions about the program for potential students, or other (Figure 17).

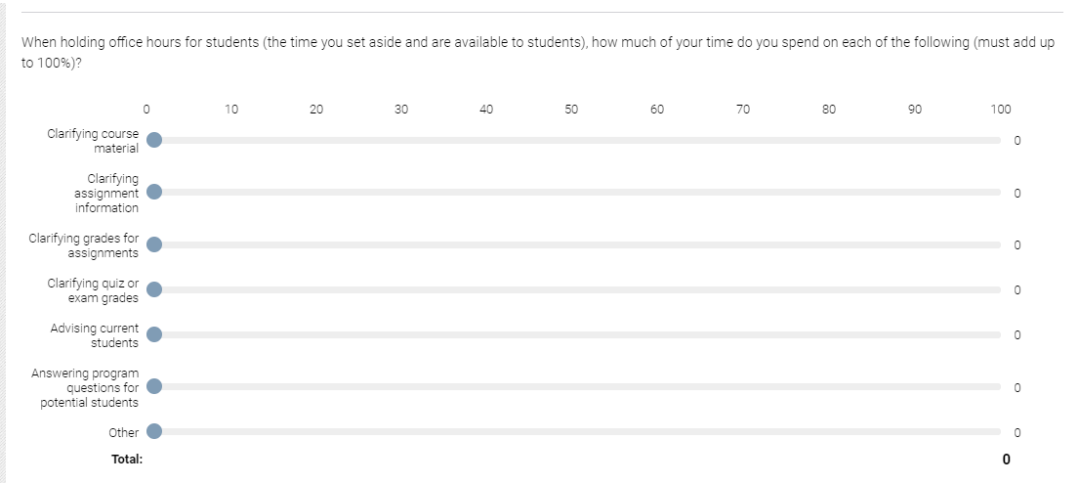

Figure 17. Office Hour Use Survey Question for Instructors
Note. This is a screen shot from the Qualtrics survey.

The fifth part of the survey asked about communication effectiveness of the mechanisms used as well as the technology. The questions were similar for both students and instructors. The mechanisms included syllabus, instructions/handout, rubric, criterial sheet, template, textbook, and model/sample (Figure 18). The technology categories included web-based/LMS (Blackboard), video/audio recordings, email/text messages, verbal/lecture, written/paper, and mobile applications (Figure 19). The scale for both questions for effectiveness included extremely effective, very effective, moderately effective, slightly effective, not effective at all, or do not use.

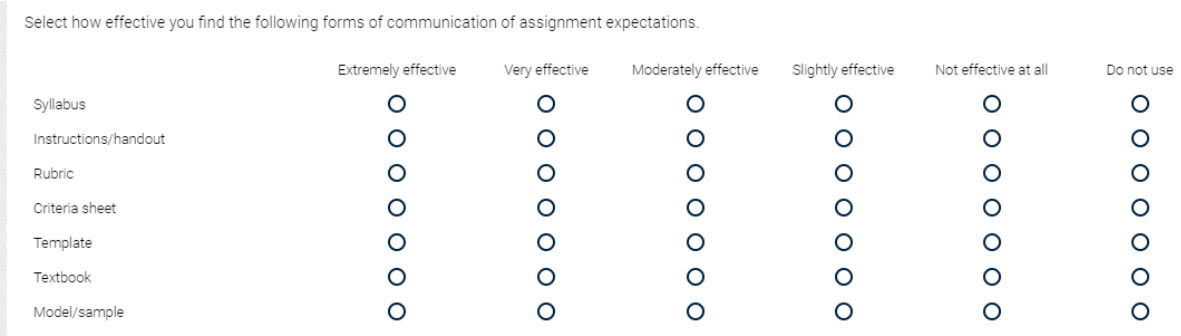

Figure 18. Communication Effectiveness Question for Mechanisms
Note. This is a screen shot from the Qualtrics survey.

Figure 19. Communication Effectiveness Question for Technology
Note. This is a screen shot from the Qualtrics survey.

The last question on the survey asked if there were any questions. This part of the survey was also used to determine if participants wanted to have their responses struck from the study (Figure 20). The survey participants could also denote what program they were aligned to.

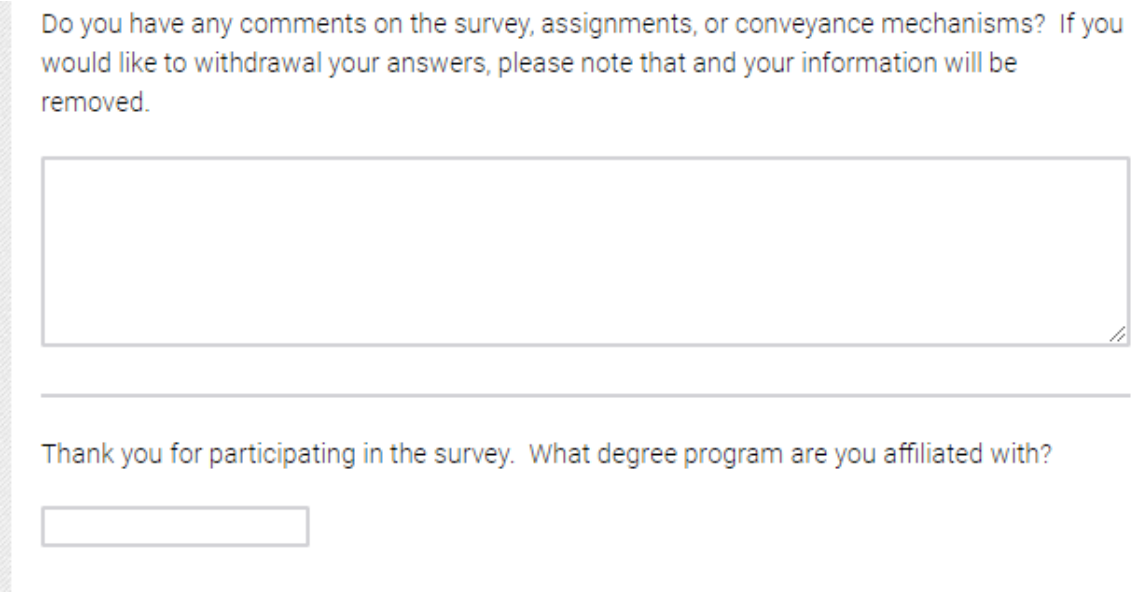

Figure 20. End of Survey Questions
Note. This is a screen shot from the Qualtrics survey.

The Qualtrics survey questions are in Appendix D. Participation was voluntary and no identifying information was collected. Qualtrics estimated that the survey would take approximately 9 minutes to complete. Participants could skip some of the questions and move on to the next question if they so elected.

Validity and Reliability

Walther, Sochacka, and Kellam (2013) suggest that validation and reliability in the research process must contend with ‘making data’ and ‘handling data’. In making the data or the

process of observation, validation relates to relationship and handling of data relates to appropriate interpretation. In making the data for surveys poor wording of the questions or use of language unfamiliar to certain groups are examples of how construct irrelevant variance is created (Douglas & Purzer, 2015). Limiting the population to technical and engineering students and instructors creates a more homogeneous group. Kubiszyn and Borich (2007) also encourage the use of homogeneous groups to reduce issues. They state that groups with a wide range of skill levels tend to produce lower levels of internal consistency, whereas homogenous groups tend to produce higher levels of internal consistency.

Although the Delphi method is widely used, there are differing opinions about the validity and reliability. For example, Clayton (1997) claims that the Delphi approach enhances reliability because of the interactive nature of the approach as well as the avoidance of group bias. Hasson and Keeney (2011) note that as the Delphi Panel size increases, the reliability of the respondent group also grows since their opinions will reflect the opinion of the population. One the other hand a larger sample size can increase variation in responses and make it harder to reach consensus.

The survey created as part of this study was created in Qualtrics. Some questions were similar to a survey conducted by Little-Wiles and Naimi (2011) in Faculty Perceptions of and Experiences in using the Blackboard Learning Management System. Their online survey contained 35 questions designed to garner information on faculty usage, attitudes and perceptions of Blackboard. This survey was designed to gather information about office hours usage as well as opinion on the effectiveness of feedforward mechanisms and technology to convey assignment quality criteria.

For face validity the survey was reviewed by the Delphi Panel as well as the University of Kansas' Center for Research Methods & Data Analysis (CRMDA). CRMDA reviewed the survey instrument and provided feedback on common errors such as leading questions and confusing language. CRMDA also reviews the way the survey collects data to address analysis issues. Qualtrics also has tools to review the survey and provides a report of issues and concerns as well as an overall score. Members of the Delphi Panel from the Center for Teaching Excellence, the Center for Online and Distance Learning, and the School of Engineering at the University of Kansas as well as the Center for Teaching and Learning at the University of Central Missouri participated in the draft survey. Three professors and one previous student also participated in the pilot survey to identify errors or misleading questions. Those participating in the pilot survey suggested wording changes for clarity. For reliability and consistency, the data from the pilot survey was reviewed for inconsistencies and common errors.

Research Questions and Hypotheses

RQ1: What feedforward mechanisms and technology are utilized to convey quality requirements for assignments?

RQ2: What combinations of feedforward mechanisms and technology used to convey quality requirements for assignments resulted in the average lowest amount of time being clarified?

RQ3: What activities do students and instructors use office hours for?

RQ4: Are there differences between students (S) and instructors (I) among the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric,

syllabus, template, and textbook) and technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments?

H_O: There is no statistically significant difference between students (S) and instructors (I) as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between students (S) and instructors (I) as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each preferred feedforward mechanism:

Mechanism	Null Hypothesis	Alternative Hypothesis
Criteria sheet (C)	$H_{OC}: \mu_{CS}=\mu_{CI}$	$H_{AC}: \mu_{CS}\neq\mu_{CI}$
Instructions/handout (I)	$H_{OI}: \mu_{IS}=\mu_{II}$	$H_{AI}: \mu_{IS}\neq\mu_{II}$
Model/sample (M)	$H_{OM}: \mu_{MS}=\mu_{MI}$	$H_{AM}: \mu_{MS}\neq\mu_{MI}$
Rubric (R)	$H_{OR}: \mu_{RS}=\mu_{RI}$	$H_{AR}: \mu_{RS}\neq\mu_{RI}$
Syllabus (S)	$H_{OS}: \mu_{SS}=\mu_{SI}$	$H_{AS}: \mu_{SS}\neq\mu_{SI}$
Template (T)	$H_{OT}: \mu_{TS}=\mu_{TI}$	$H_{AT}: \mu_{TS}\neq\mu_{TI}$
Textbook (B)	$H_{OB}: \mu_{BS}=\mu_{BI}$	$H_{AB}: \mu_{BS}\neq\mu_{BI}$

H_O: There is no statistically significant difference between students (S) and instructors (I) as to the technology (email/text messages, mobile applications, verbal/lecture,

video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between students (S) and instructors (I) as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each technology:

Technology	Null Hypothesis	Alternative Hypothesis
Email/Text messages (E)	$H_{OE}: \mu_{ES}=\mu_{EI}$	$H_{AE}: \mu_{ES}\neq\mu_{EI}$
Mobile applications (A)	$H_{OA}: \mu_{AS}=\mu_{AI}$	$H_{AA}: \mu_{AS}\neq\mu_{AI}$
Verbal/lecture (L)	$H_{OL}: \mu_{LS}=\mu_{LI}$	$H_{AL}: \mu_{LS}\neq\mu_{LI}$
Video/audio recordings (V)	$H_{OV}: \mu_{VS}=\mu_{VI}$	$H_{AV}: \mu_{VS}\neq\mu_{VI}$
Web-based/LMS (Black Board) (W)	$H_{OW}: \mu_{WS}=\mu_{WI}$	$H_{AW}: \mu_{WS}\neq\mu_{WI}$
Written/paper (P)	$H_{OP}: \mu_{PS}=\mu_{PI}$	$H_{AP}: \mu_{PS}\neq\mu_{PI}$

RQ5: Using the top box response of "Extremely Effective", what mechanisms and technology are rated extremely effective most often (percentages of responses)?

RQ6: Are there significant differences between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms and technology used to convey quality requirements for assignments?

H_O: There is no statistically significant difference between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms (criteria sheet,

instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each preferred feedforward mechanism:

Mechanism	Null Hypothesis	Alternative Hypothesis
Criteria sheet (C)	$H_{1C}: \mu_{CF}=\mu_{CP}$	$H_{2C}: \mu_{CF}\neq\mu_{CP}$
Instructions/handout (I)	$H_{1I}: \mu_{IF}=\mu_{IP}$	$H_{2I}: \mu_{IF}\neq\mu_{IP}$
Model/sample (M)	$H_{1M}: \mu_{MF}=\mu_{MP}$	$H_{2M}: \mu_{MF}\neq\mu_{MP}$
Rubric (R)	$H_{1R}: \mu_{RF}=\mu_{RP}$	$H_{2R}: \mu_{RF}\neq\mu_{RP}$
Syllabus (S)	$H_{1S}: \mu_{SF}=\mu_{SP}$	$H_{2S}: \mu_{SF}\neq\mu_{SP}$
Template (T)	$H_{1T}: \mu_{TF}=\mu_{TP}$	$H_{2T}: \mu_{TF}\neq\mu_{TP}$
Textbook (B)	$H_{1B}: \mu_{BF}=\mu_{BP}$	$H_{2B}: \mu_{BF}\neq\mu_{BP}$

H_O: There is no statistically significant difference between full-time (F) and part-time (P) master's degree students as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between full-time (F) and part-time (P) master's degree students as to the technology (email/text messages, mobile

applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each technology:

Technology	Null Hypothesis	Alternative Hypothesis
Email/Text messages (E)	$H_{1E}: \mu_{EF}=\mu_{EP}$	$H_{2E}: \mu_{EF}\neq\mu_{EP}$
Mobile applications (A)	$H_{1A}: \mu_{AF}=\mu_{AP}$	$H_{2A}: \mu_{AF}\neq\mu_{AP}$
Verbal/lecture (L)	$H_{1L}: \mu_{LF}=\mu_{LP}$	$H_{2L}: \mu_{LF}\neq\mu_{LP}$
Video/audio recordings (V)	$H_{1V}: \mu_{VF}=\mu_{VP}$	$H_{2V}: \mu_{VF}\neq\mu_{VP}$
Web-based/LMS (Black Board) (W)	$H_{1W}: \mu_{WF}=\mu_{WP}$	$H_{2W}: \mu_{WF}\neq\mu_{WP}$
Written/paper (P)	$H_{1P}: \mu_{PF}=\mu_{PP}$	$H_{2P}: \mu_{PF}\neq\mu_{PP}$

RQ7: What graphical models help explain the quality requirements for the assignment process and how could the model be used to improve course assignments?

Statistical Analysis

The Delphi Panel responses were used to answer Research Question 1 and Research Question 7. The survey was used to answer Research Questions 2, 3, 4, 5, and 6. The first research question was exploratory and used to determine the feedforward mechanisms used by instructors and identified by students as well as any new mechanisms and technology identified by the Delphi Panel. The initial research to determine some feedforward mechanisms and technology conveyance was from the literature review. The literature review as well as the Lean Six Sigma methodology were utilized as starting points for the development of flowcharts and fishbone diagrams used to develop survey questions. Since technology is constantly changing,

new feedforward mechanisms may be available. The first research question explored what is being used and identified new mechanisms or technology. No statistical analysis was used as this part of the study is only identifying items available.

The second research question determined how much time was used clarifying assignment quality requirements. The average time for specific types of assignments will be calculated as well as the average times for combinations of feedforward mechanisms and technology. A table of the top two combinations was produced and the items with the lowest times were identified.

The third research question was used to explore what students and instructors use office hours for. The data was summarized to show why students attend office hours, if they do. A similar summary was produced for instructors.

The fourth research question studied differences between the preferred feedforward mechanisms and technology between instructors and students. The questions were similar for both students and instructors. The mechanisms included syllabus, instructions/handout, rubric, criterial sheet, template, textbook, and model/sample. The technology categories included web-based/LMS (Blackboard), video/audio recordings, email/text messages, verbal/lecture, written/paper, and mobile applications. The scale for both questions for effectiveness included extremely effective, very effective, moderately effective, slightly effective, not effective at all, or do not use. The data was coded for analysis purposes with extremely effective at 5, very effective at 4, moderately effective at 3, slightly effective at 2, not effective at all at 1.

The coded data means were calculated for each mechanism for instructors and students as well as each technology. The t-value for the mean was calculated as well as the p-value from the t-test to test the hypothesis for each mechanism and each technology. If the test finds that at least one group is different, comparisons can be used to identify pairs of groups that are

significantly different. Alpha, which is the probability of committing a Type I error, was set to 5%. The data from survey questions were statistically analyzed using the Minitab.

$$t = \frac{(\bar{X}_1 - \bar{X}_2) - \delta_0}{s}$$

Term	Description
$\overline{X}_1$	mean of the first sample
$\overline{X}_2$	mean of the second sample
s	sample standard deviation of $\overline{X}_1 - \overline{X}_2$
δ_0	hypothesized difference between the two population means

Probability plots and boxplots were used to assess the normality and variability of sample distributions as well as to look for outliers. A boxplot shows the median, interquartile range, range, and outliers for each group. Boxplots were created to show the differences between instructors and students for those with a significant difference.

The fifth research question used the data from effectiveness questions for students and instructors but focused on the top box response of “Extremely Effective”. Percentages were calculated for each mechanism and for each technology for students and instructors. The percentages were then sorted from highest to lowest.

The sixth research question studied differences between the preferred feedforward mechanisms and technology between full-time and part-time students. The mechanisms included syllabus, instructions/handout, rubric, criterial sheet, template, textbook, and model/sample. The technology categories included web-based/LMS (Blackboard), video/audio recordings, email/text messages, verbal/lecture, written/paper, and mobile applications. The scale for the question for effectiveness included extremely effective, very effective, moderately effective, slightly effective, not effective at all, or do not use. The data was coded for analysis purposes

with extremely effective at 5, very effective at 4, moderately effective at 3, slightly effective at 2, not effective at all at 1.

The coded data means were calculated for each mechanism and each technology for full-time and part-time students. The t-value for the mean was calculated as well as the p-value from the t-test to address the hypothesis for each mechanism and each technology. If the test finds that at least one group is different, comparisons can be used to identify pairs of groups that are significantly different. Alpha, which is the probability of committing a Type I error, was set to 5%. The data from survey questions were statistically analyzed using the Minitab.

Probability plots and boxplots were used to assess the normality and variability of sample distributions as well as to look for outliers. Boxplots were created to show the differences between full-time and part-time students for those with a significant difference.

The seventh research question was created to review the proposed graphical model of the feedforward mechanisms and technology to convey assignment quality requirements. The Delphi Panel was again utilized to revise the model. The model was based on information collected and analyzed from the previous research questions and adjusted based on Delphi Panel input. The second part of this research question researched the use of the model for a particular assignment.

Summary

The Dephi Panel first set of questions and survey questions are contained in Appendix A and Appendix D, respectively. The survey was developed using Qualtrics and screen shots of each survey question are included. The seven research questions were studied using the Delphi Panel and the survey.

CHAPTER 4

RESULTS

The results chapter includes sections for the three phases of the study. The Delphi Panel results from Phase 1 are described first, followed by the survey results from Phase 2 and finally the Delphi Panel results from Phase 3. The results of this study were derived from the Delphi Panel findings as well as the survey statistical analysis. The outcome of this study is a proposed graphical model of feedforward mechanisms to convey assignment quality requirements.

This study was produced in three phases. The first phase utilized a Delphi Panel to compliment information gathered during the literature review and improve the survey. The second phase of the study used a survey to identify waste, communication preferences, and office hour utilization. The third phase of the study again used the Delphi Panel to review the survey data and adjust the model.

Prior to convening the Delphi Panel, the Delphi Panel questions and the survey were submitted to Indians State's Institutional Review Board (IRB). IRB approval was necessary since this research falls into the category of Psychological, Sociological, or Behavioral Research (Category 7). This type of research involves individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality

assurance methodologies (Indiana State University Institutional Review Board, 2010). IRB approvals were also gained from University of Central Missouri and the University of Kansas. (Appendix E)

Delphi Panel Results for Phase 1

The Delphi Panel was utilized initially to study the first research question, review the research methodology, and improve the survey prior to distribution. The Delphi Panel was convened via a Zoom conference call and consisted of 3 representatives from the University of Kansas and one representative from the University of Central Missouri. The University of Kansas Center for Teaching Excellence, Center for Online and Distance Learning, and the school of Engineering Teaching Fellows had representatives present on the call. The University of Central Missouri Center for Teaching and Learning had a representative present. No representatives from Indiana State participated on the panel. All participants signed the Informed Consent (Appendix C) prior to participating on the conference call. The meetings were not recorded.

For Round 1 of the Delphi Panel, several questions and diagrams were discussed as well as the survey questions (Appendix A and Appendix D). The first questions were related to Figure 6 SIPOC for the Assignment Process. The Delphi Panel was asked "What are the suppliers, inputs, process, outputs, and customers (SIPOC) for the assignment process? Are there any items missing from the SIPOC diagram?" Under 'suppliers' there was discussion about adding the university or school or department as they influence both the instructors and students. Industry might also influence what is needed for that field of study and supply information

needed to create meaningful assignments. The LMS company, publishers, and instructional designers could also be included under ‘suppliers’. The design of the assignment so that it meets accreditation requirements, accessibility needs, and course objectives can also be important and should be included as a part of ‘inputs’. Under ‘outputs’ the discussion focused on the definition of graded. Groupwork and peer reviews are sometimes used to establish the grade for an assignment as well as artificial intelligence associated with automatic grading. Teaching assistants and paid graders also influence the grade a student receives.

The next questions were related to Figure 7 High Level Process Diagram for Assignments. The Delphi Panel discussed the steps of the process flow for assignments. They were asked if any items in the diagram were missing or confusing. The steps are high level and the Delphi Panel noted that there are other sub-steps associated with each part of the process. There is also a previous step of preparing the assignment that is important. How the instructor designs the assignment has an impact on the communication of the assignment and the grading of the assignment. Poorly defined assignments will create issues with communication as well as grading. The conversation again focused on the grading of assignments. There are many items that can influence the grade beyond the student’s work including the information provided by the LMS such as grade notes, attachments, and in-line grading. The LMS may also have auto-grading features that were established by the LMS company, the university’s LMS support staff, or the instructor. People other than the instructor can influence the grading process such as peers associated with peer reviews and teaching assistants.

The next questions focused on Figures 8 and 9 which are fishbone diagrams showing inputs and outputs for the communication of the assignment and the review of the grade. The Delphi Panel was asked to think in terms of feedforward mechanisms and technology then asked

to help identify the inputs and outputs for the first process step which is communicating the assignment. Under mechanisms the Delphi Panel suggested changing the word ‘assessment’ to ‘assignment’ and suggested adding model or sample as instructors often provide students with a model or sample for research papers for formatting purposes. The Delphi Panel focused mostly on technology. Mobile phones are more common in classrooms, so phone apps, texting, and video have become options available for communication. Video conferencing is often used for students to attend class virtually. Remote communication methods such as phone calls, video chats, email, and apps such as Slack are becoming more common especially in master’s degree courses where students are also employed full-time. Gamification or simulation are becoming more common in academic settings.

The Delphi Panel was asked about the last step of the process which is reviewing the grade and identify inputs and outputs. Again, the focus was more on technology than mechanisms. Feedback to students can include audio or video recordings attached to the grade. In face-to-face courses grade review can be a part of class time lecture to help students understand what was expected. In-line grading or mark-ups are also becoming more common as they are readily available in learning management systems. The Delphi Panel noted that the review of the grade may be accomplished via video conferencing or meeting software such as Adobe Connect or Zoom. Face-to-face meetings via inhouse office hours are used less frequently. Texting and email are becoming more common for feedback but may be limited due to potential Family Educational Rights and Privacy Act (FERPA) issues. The Delphi Panel noted that non-university email and text messages are not secure but often preferred by students. For the output of this process step, knowledge gap awareness should be added as students

become more aware of what they don't know or understand from the assignment grading process.

To wrap up the diagrams, the Delphi Panel was asked if any additional diagrams would help explain the assignment process. No other diagrams were created but the SAMR model was discussed. The SAMR model has four categories: Substitution, Augmentation, Modification, and Redefinition (Puentedura, 2010). This framework created by Dr. Ruben Puentedura explains these four degrees of classroom technology integration.

Finally, the Delphi Panel reviewed the survey tool for students and instructors and made suggestions for improvement. The original questions are in Appendix B. For the question about recent assignments, the participants suggested limiting the number of choices for assignment type and not include assessments like quizzes. To improve readability, they suggested using only the word 'instructions' instead of 'assignment instructions' since some people taking the survey might use mobile phones and the question would not show correctly. For technology the terms verbally, paper/handout, and electronically were suggested with an option of 'other'. Using the term 'web-based' or Blackboard as well as LMS might reduce confusion since some taking the survey might not be familiar with the term LMS. All three universities use Blackboard so students would be familiar with that term. The term conveyance might also be confusing, so they suggested rewording this to 'how did you communicate…' For instructors a suggestion of asking about time as well as percentage of time was made to accommodate those with larger classes.

For the questions associated with communication effectiveness, the Delphi Panel suggested changing the wording from "conveying quality requirements for an assignment" to "communication of assignment expectations" and adding model/sample to the list of feedforward

mechanisms. They also suggested using “methods of communication” instead of technology for the technology part of the question. For the technology selections they suggested adding web-based to the LMS item, audio recording to video/recordings, and text messages to email.

Based on Delphi Panel input the first research question (RQ1) can be answered. The feedforward mechanisms used to convey quality requirements for assignments include criteria sheets, instructions, model or sample, rubric, syllabus, template, and textbook. The technology used to convey the requirements include written or paper, web-based or LMS (Blackboard), video or audio recordings, verbal or lecture, mobile applications, and email or text messages. These items were added to the survey for the question regarding student and instructor opinions as to the best mechanisms and technology to convey the quality requirements.

Survey Results from Phase 2

The survey wording was updated based on information from the Delphi Panel. The survey was available via Qualtrics to students and instructors from April 19, 2019 through December 5, 2019 via Qualtrics. The link to the survey was communicated via email and Blackboard announcements. The survey was accessed 81 times with 12 responses from Indiana State University, 30 responses from the University of Central Missouri, and 39 responses from the University of Kansas (Figure 21).

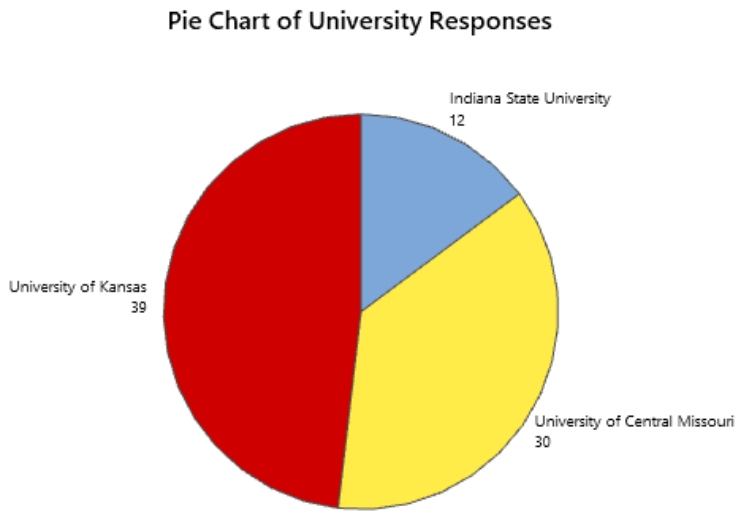

Figure 21. University Survey Participation

The survey was designed so that students and instructors answered questions specifically created for their demographic. The survey was divided into six parts. On average is took participant's 6 minutes to complete the survey. The first part of the survey asked for participant consent (Figure 4). The second part of the survey asked demographic information about university affiliation, participant status, and student status (Figure 11, Figure 12, and Figure 13). Thirty-five students accessed the survey, 27 instructors access the survey, and 19 people selected other. If other was selected, then the survey ended and the respondent was thanked for their participation. Of the 35 students who accessed the survey, 18 identified as full-time students, 11 identified as part-time students, and 7 did not select an answer.

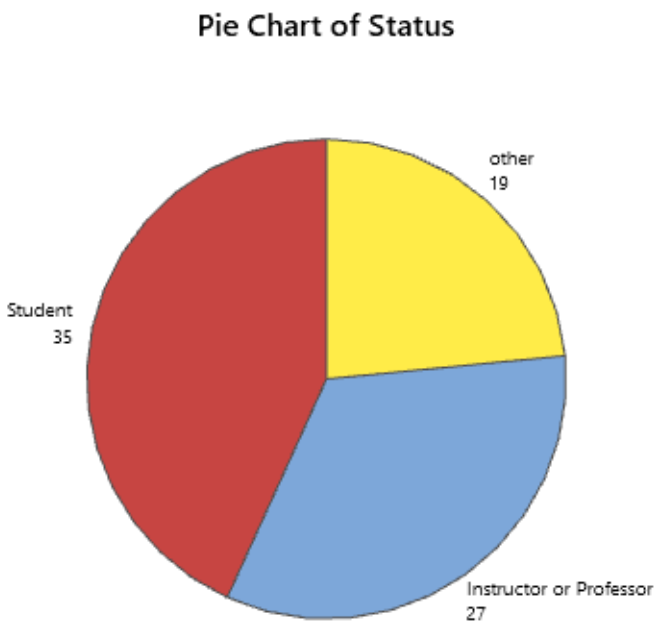

Figure 22. Survey Participant Type

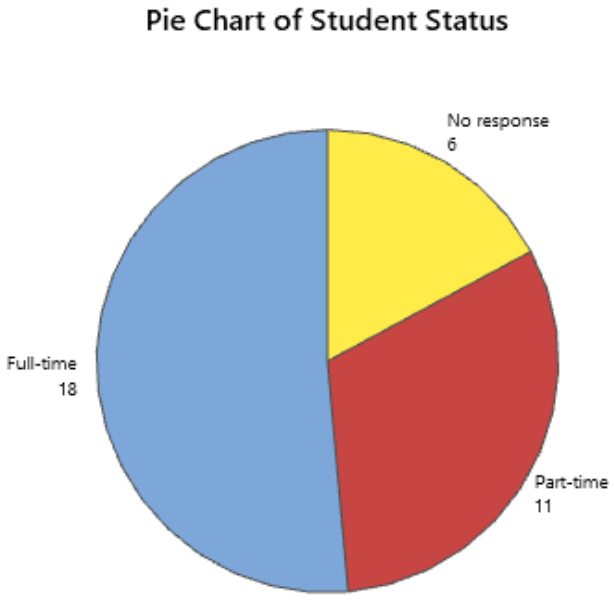

Figure 23. Student Status

The third part of the survey asked for information about specific assignments. This question was worded differently for students and instructors. Students were asked to think about 3 recent assignments. They recorded the assignment type based on a drop-down list that included problem solving, essay, case study, presentation, research paper, and other. For each assignment type selected, students were asked to identify what the instructor used to explain the assignment. The choices were syllabus, instructions, rubric, or other. They could select one item or all that applied. The next part of the question asked how the instructor explained the assignment. The choices were verbally, paper/handout, electronically, or other. They could select one item or all that applied. Students were then asked to record how much time they spent asking the instructor for clarification before submitting the assignment in minutes as well as how much time was spent asking for clarification of the graded assignment in minutes (Figure 14). There were 61 responses that selected instructions, 55 selected syllabus, and 52 selected rubric. The responses for other included in-class and online discussions. The data included one student response for three types of assignments where the numbers did not align with the other data points with times of 120, 240, and 90 (Figure 24). These data points were removed from further analysis and not included in the numbers above.

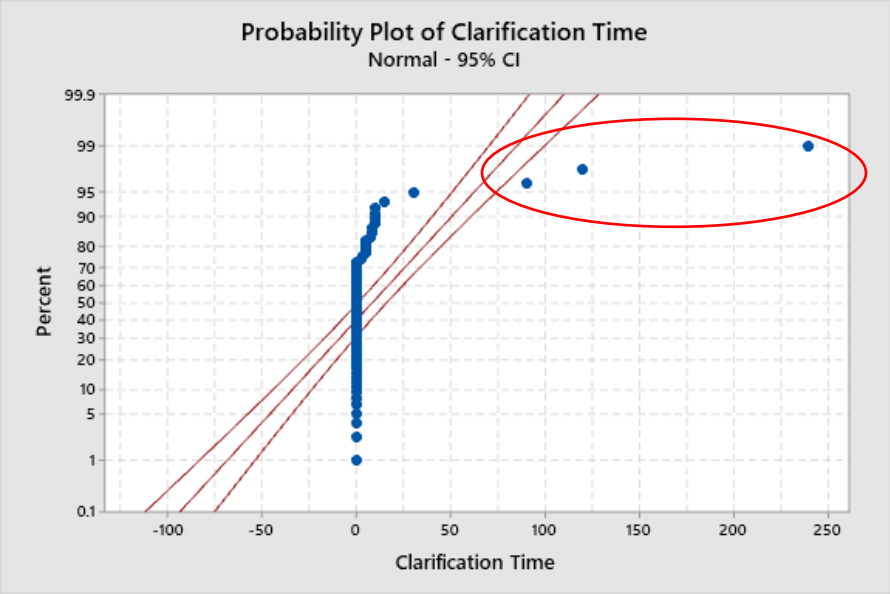

Figure 24. Normal Probability Plot for Student Clarification Time Responses
Note. The data points circled were removed from future data analysis as they shifted the mean from 8.2 to 1.92.

The data for the 61 responses is summarized in the following tables (Table 5 and Table 6). Table 5 summarizes the data from student assignment clarification responses. The most common feedforward mechanism reported was instructions with 61 responses. The technology with the most responses were electronic with 24 responses. The lowest average for assignment clarification was associated with electronic and rubric with a mean of 0.4 minutes.

Table 5

Student Assignment Clarification (average minutes)

		Mechanism			
		Syllabus	Instructions	Rubric	N
Technology	Electronic	2.3	2.4	0.4	24
	Electronic & Verbal	1.7	1.5	1.5	17
	N	55	61	52	

Note. The technology used to clarify the grades included more options, but the number of responses was zero. The cell highlighted had the lowest clarification time.

Table 6 summarizes the data from the grade clarification responses. The most common feedforward mechanism reported was instructions with 61 responses. The technology with the most responses were electronic with 24 responses. A mean of zero was calculated for electronic and verbal conveyance using syllabus, instructions, and/or rubrics.

Table 6

Student Grade Clarification (average minutes)

		Mechanism			
		Syllabus	Instructions	Rubric	N
Technology	Electronic	0.4	0.4	0.7	24
	Electronic & Verbal	0	0	0	17
	N	55	61	47	

Note. The technology used to clarify the grades included more options, but the number of responses was zero.

The instructor responses in the third part of the survey focused on information about specific assignments (Figure 15). Instructors were asked to think about 3 recent assignments. They recorded the assignment type based on a drop-down list that included problem solving, essay, case study, presentation, research paper, and other. For each assignment type selected, instructors were asked to identify what they used to explain the assignment. The choices were syllabus, instructions, rubric, or other. They could select one item or all that applied. The next part of the question asked how they explained the assignment. The choices were verbally, paper/handout, electronically, or other. They could select one item or all that applied. Instructors were then asked to record how much time they spent clarifying the assignment before

submittal in minutes as well as a percentage. They were also asked to record how much time was spent clarifying the graded assignment in minutes as well as a percentage. Instructor data in percentages was not different from the data in minutes.

Forty-eight responses were recorded. Of the 48 responses, instructions were selected 33 times, syllabus was selected 45 times, and rubric was selected 15 times. The data included one response where the data point did not align with the other data points (Figure 25). This data point was removed from further analysis.

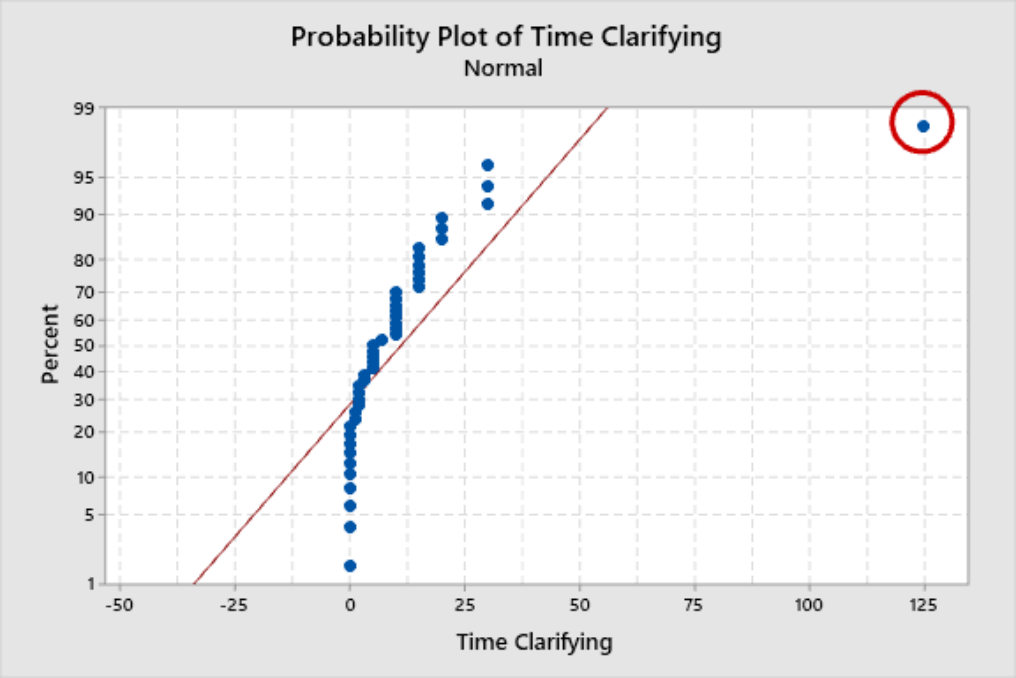

Figure 25. Probability Plots for Instructor Time Clarifying Data Showing the Outlier
Note. The data point circled is the outlier. Removing this data point shifted the mean from 10.96 to 3.38.

Table 7 is a summary of the instructor data from the assignment clarification responses for the two combinations with the most responses. The most common feedforward mechanism reported was instructions with 48 responses. The technology selection with the most responses was electronic and verbal with 18 responses. The lowest average clarification time was associated

with electronic and verbal as technology an rubrics as the mechanism with a mean of 6.5 minutes.

Table 7

Instructor Assignment Clarification (average minutes)

		Mechanism			
		Syllabus	Instructions	Rubric	N
Technology	Electronic & Verbal	7.8	7.4	6.5	18
	Electronic, Verbal, & Written	10.8	10.8	7.5	13
	N	36	48	18	

Note. The technology used to clarify the grades included more options, but the number of responses was zero. The cell highlighted had the lowest clarification time.

Table 8 is a summary of the instructor data from the grade clarification responses. The technology with the most responses were electronic and verbal with 19 responses. The lowest average was rubrics with an average of 0 minutes.

Table 8

Instructor Grade Clarification (average minutes)

		Mechanism			
		Syllabus	Instructions	Rubric	N
Technology	Electronic & Verbal	2.1	1.7	0	19
	Electronic, Verbal, & Written	6.2	6.2	0	13
	N	36	48	18	

Note. The technology used to clarify the grades included more options, but the number of responses was zero.

The data in Tables 5, 6, 7, and 8 contain the information needed to answer the second research question (RQ2). The combinations with the lowest average time were associated with review of the grade. Both students and instructors recorded zero minutes of time reviewing grades when rubrics were used as the mechanism. When reviewing the responses for assignment clarification, rubrics exhibited the lowest amount of time. The responses for technology for both reviewing the assignment and the grade included all three options of electronic, verbal, and written for instructor responses.

The fourth part of the survey asked about office hour use. Students were asked why they attended office hours, if they did. Students could also select that they didn't attend office hours. The potential responses included asking for an explanation of an assignment prior to submission, asking for clarification of a graded assignment, asking for clarification of a graded quiz or exam,

asking about course material, asking about the program or future course, other, and never attended office hours. The most common response was that they never attended office hours (55.9% selected this response). The next most common response was that they were seeking explanations about assignments (Figure 26).

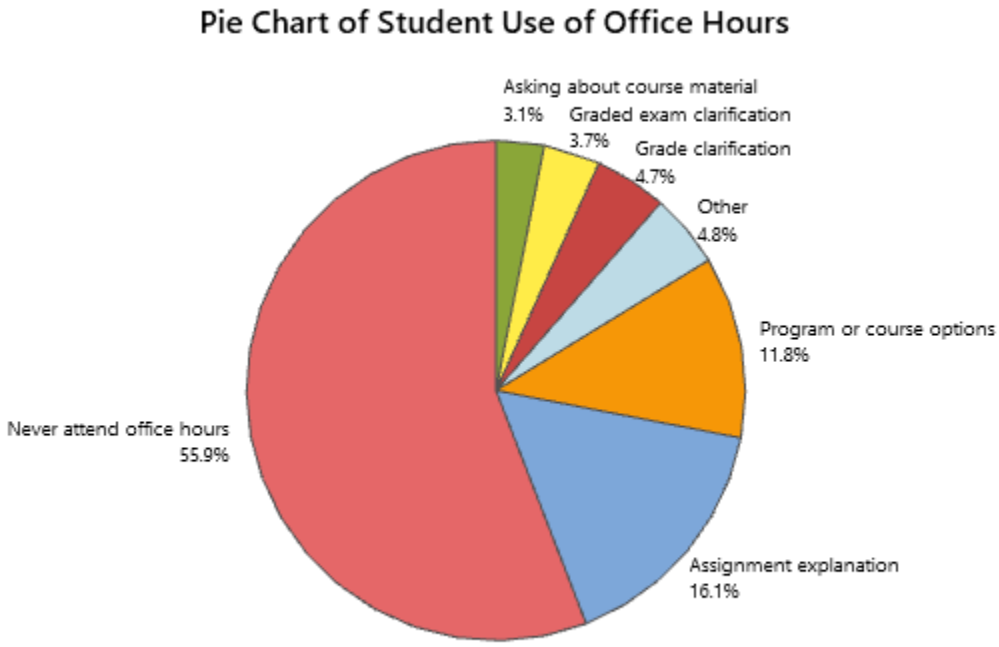

Figure 26. Pie Chart of Student Responses of Office Hour Utilization

The question for instructors about office hours was similar to the student question. The potential responses were clarifying course material, clarifying assignment information, clarifying grades for assignments, clarifying quiz or exam grades, advising current students, answering questions about the program for potential students, or other. The most common responses were associated with clarifying assignments, quizzes, or exams (Figure 27). Instructors noted in the comments that students rarely attend office hours.

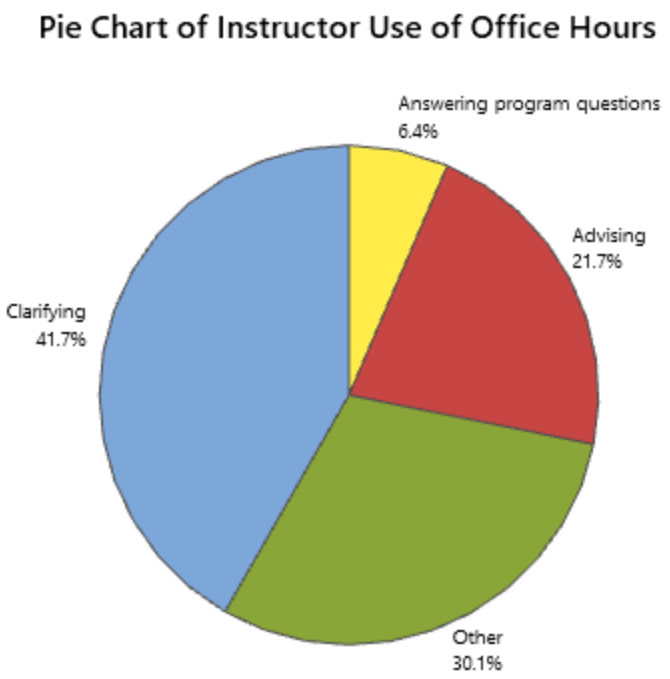

Figure 27. Pie Chart of Instructor Responses of Office Hour Utilization

The two pie charts (Figures 26 and 27) summarize what students and instructors spend their time doing during office hours and answer the third research question (RQ3). Many students do not attend office hours. When students do attend office hours, they are seeking clarification of assignments. Instructors use office hours to clarify items for students associated with course material, assignments or grades.

The fifth part of the survey asked about communication effectiveness of the mechanisms used as well as the technology. The questions were similar for both students and instructors. The mechanisms included syllabus, instructions/handout, rubric, criterial sheet, template, textbook, and model/sample. The technology categories included web-based/LMS (Blackboard), video/audio recordings, email/text messages, verbal/lecture, written/paper, and mobile applications. The scale for both questions for effectiveness included extremely effective, very effective, moderately effective, slightly effective, not effective at all, or do not use. The data

was coded for analysis purposes with extremely effective at 5, very effective at 4, moderately effective at 3, slightly effective at 2, not effective at all at 1.

The number of responses used for this analysis was 42 and the Cronbach's Alpha associated with the coded data was 0.77. The power associated with the sample size, an alpha of 0.05, and the standard deviation for the 2-sample t-test was approximately 94%. Increasing the sample size to over 50 would have improved the power.

Table 9 shows the mean for each mechanism for instructors and students. Instructions/ handout had the highest mean for both students and instructors. Students also rated model/sample and syllabus higher than other mechanisms.

Table 9

Communication Mechanism Effectiveness – Student and Instructor Comparisons

		Mean	
		Instructor	Student
Mechanism	Criteria sheet	2.53	3.82
	Instructions/handout	4.06	4.26
	Model/sample	3.59	4.19
	Rubric	2.65	3.78
	Syllabus	3.41	4.07
	Template	3.24	3.30
	Textbook	2.47	2.96

Note. The scale is from 1 to 5. The means highlighted in green are over 4.0.

Table 10 displays the t-value for the mean as well as the p-value from the t-test. Criteria sheets and rubrics were significantly different between students and instructors with higher

means from student responses. The boxplots (Figure 28 and Figure 29) show the differences between instructors and students for criteria sheets and rubrics.

Table 10

Communication Mechanism Effectiveness Hypothesis Test Results

		T-Test of Mean	P-Value	Hypothesis Result
Mechanism	Criteria sheet	2.67	0.01	Reject H_{OC}
	Instructions/handout	0.09	0.40	Fail to reject H_{OI}
	Model/sample	0.15	0.89	Fail to reject H_{OM}
	Rubric	2.50	0.02	Reject H_{OR}
	Syllabus	1.82	0.08	Fail to reject H_{OS}
	Template	1.44	0.16	Fail to reject H_{OT}
	Textbook	1.21	0.24	Fail to reject H_{OB}

Note. α=0.05. The mechanisms highlighted in green were significantly different between instructors and students.

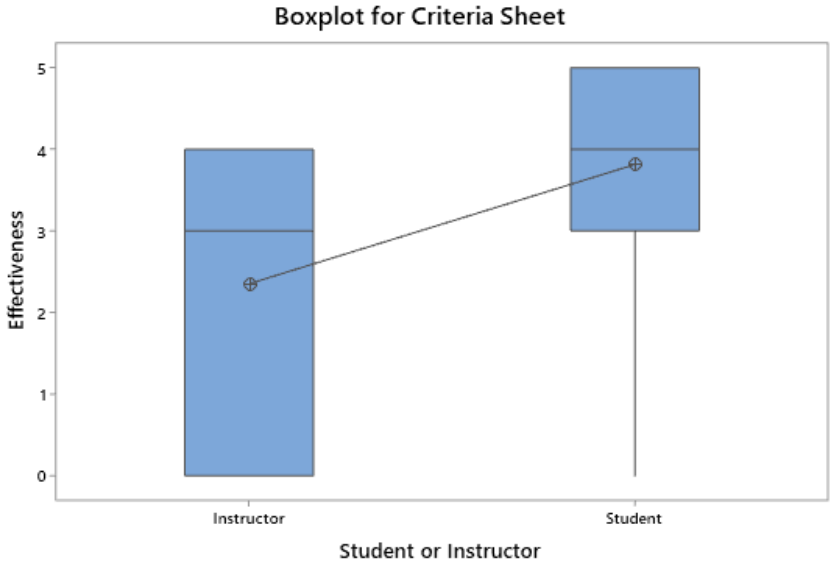

Figure 28. Boxplots for Criteria Sheet

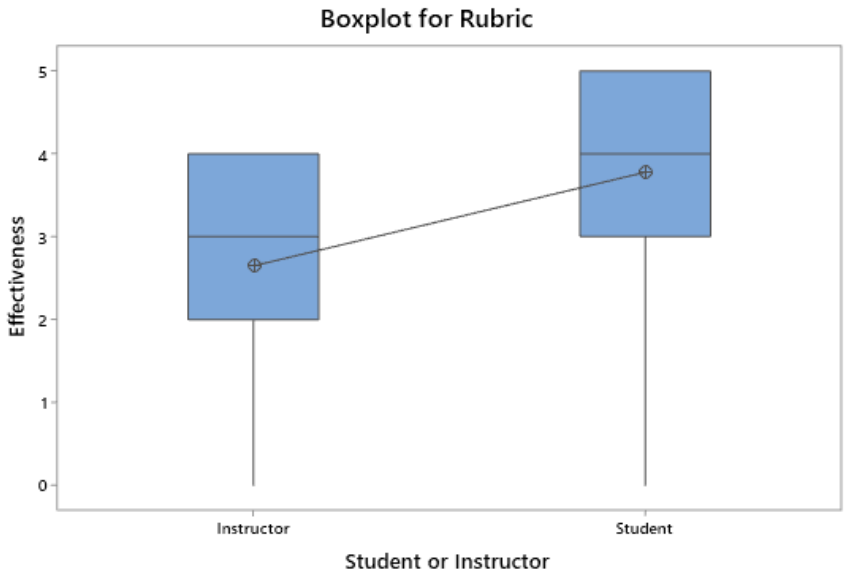

Figure 29. Boxplots for Rubric

Table 11 shows the mean for each technology type for instructors and students. Web-based/LMS (Blackboard) had the highest mean from student data. There were no means over 4 from the instructor data.

Table 11

Technology Effectiveness – Student and Instructor Comparisons

		Mean	
		Instructor	Student
Technology	Email/Text messages	3.588	3.407
	Mobile applications	1.118	2.222
	Verbal/lecture	3.824	3.815
	Video/audio recordings	2.824	3.407
	Web-based/LMS (Black Board)	3.824	4.148
	Written/paper	3.471	3.741

Note. The scale is from 1 to 5. The mean highlighted in green is over 4.0.

Table 12 displays the t-value for the mean as well as the p-value from the t-test for technology. Mobile applications were significantly different between students and instructors with a higher mean from student responses. The boxplot (Figure 30) show the differences between instructors and students for mobile applications.

Table 12

Technology Effectiveness Hypothesis Test Results

		T-Test of Mean	P-Value	Hypothesis Result
Technology	Email/Text messages	-0.62	0.54	Fail to reject H_{OE}
	Mobile applications	2.14	0.04	Reject H_{OA}
	Verbal/lecture	-0.03	0.98	Fail to reject H_{OL}
	Video/audio recordings	1.30	0.21	Fail to reject H_{OV}
	Web-based/LMS	1.01	0.32	Fail to reject H_{OW}
	Written/paper	0.97	0.34	Fail to reject H_{OP}

Note. α=0.05 The p-value highlighted in green was the only technology below the alpha value.

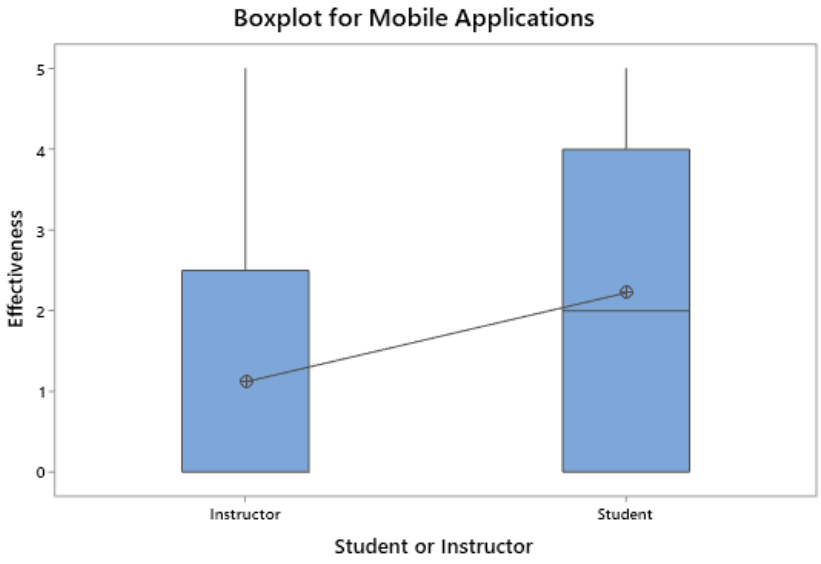

Figure 30. Boxplots for Mobile Applications

The fourth research question (RQ4) investigated differences between students and instructors for preferred feedforward mechanisms and technology. The feedforward mechanisms where the hypothesis was rejected include criteria sheets and rubric. Both mechanisms had higher means from student data than from instructor data. For technology the hypothesis was rejected for mobile applications with the student mean higher than the instructor mean.

A tally of the results for mechanisms rated as "Extremely effective" showed some differences between instructors and students (Table 13). For example, 48% of students rated criteria sheets as extremely effective, but no instructors rated them in that category. Similar results were discovered for rubrics, template, and textbook where students rated the mechanisms as extremely effective, but no instructors used that rating. Other items that were rated as extremely effective were model/sample where 24% of instructors and 63% of students found them extremely effective, instructions/handout where 24% of instructors and 52% of students aligned with the extremely effective category, and syllabus where 18% of instructors and 48% of students found them to be extremely effective.

Table 13

Extremely Effective Response for Feedforward Mechanisms

	Extremely effective	
Mechanism	Students	Instructors
Model/sample	63%	24%
Instructions/handout	52%	24%
Syllabus	48%	18%
Criteria sheet	48%	0%
Rubric	41%	0%
Template	33%	0%
Textbook	11%	0%

A tally of the results for technology rated as "Extremely effective" also displayed some differences between instructors and students (Table 14). For example, 48% of students rated web-based/LMS as extremely effective, but only 24% of instructors selected extremely effective. Verbal/lecture was the only item rated a greater percent by instructors (24%) than by students (22%).

Table 14

Extremely Effective Response for Technology

	Extremely effective	
Technology	Students	Instructors
Web-based/LMS (Black Board)	48%	24%
Verbal/lecture	22%	24%
Video/audio recordings	30%	6%
Email/Text messages	26%	6%
Written/paper	22%	6%
Mobile applications	11%	6%

The response of "Extremely effective" is used to answer the fifth research question (RQ5). The mechanism of model/sample was most commonly responded to as extremely effective by both students and instructor. The technology noted as extremely effective by both students and instructors was web-based/LMS.

The student data results were analyzed to determine if there were any differences between full-time and part-time master's degree students as to the preferred feedforward mechanisms used to convey quality requirements for assignments. Table 15 displays the mechanisms along with the mean for full-time and part-time students. The highest averages were associated with criteria sheet, instructions/handout, model/sample, and syllabus.

Table 15

Part-time and Full-time Student Mechanism Average Effectiveness

		Mean	
		Full-time	Part-time
Mechanism	Criteria sheet	4.00	3.45
	Instructions/handout	4.30	4.10
	Model/sample	4.10	4.27
	Rubric	3.60	3.90
	Syllabus	4.30	3.73
	Template	2.80	3.80
	Textbook	2.90	2.82

Note. The values highlighted in green were greater than or equal to 4 on a scale from 1 to 5.

Using the means from full-time and part-time students, t-test values and p-values were calculated. The t-test and p-values show that there were no significant differences between full and part-time students for each mechanism (Table 16).

Table 16

Full-time and Part-time Mechanism Effectiveness Hypothesis Test Results

		T-Test of Mean	P-Value	Hypothesis Result
Mechanism	Criteria sheet	0.81	0.43	Fail to reject H_{1C}
	Instructions/handout	0.68	0.50	Fail to reject H_{1I}
	Model/sample	-0.35	0.73	Fail to reject H_{1M}
	Rubric	-0.61	0.55	Fail to reject H_{1R}
	Syllabus	1.37	0.18	Fail to reject H_{1S}
	Template	-1.50	0.14	Fail to reject H_{1T}
	Textbook	0.33	0.75	Fail to reject H_{1B}

Note. α=0.05

Table 17 displays technology effectiveness means for full-time and part-time students. The highest means were associated with web-based/LMS, verbal/lecture, and video/audio recordings.

Table 17

Part-time and Full-time Student Technology Average Effectiveness

		Mean	
		Full-time	Part-time
Technology	Web-based/LMS (Black Board)	3.87	4.46
	Verbal/lecture	4.00	3.45
	Video/audio recordings	2.67	4.27
	Email/Text messages	3.50	3.20
	Written/paper	3.60	3.80
	Mobile applications	2.40	1.73

Table 18 shows the t-test and p-values for each technology based on results from full-time and part-time students. There was a significant difference between full-time and part-time students for video/audio recordings. Part-time students had an average of 4.27 while full-time students had an average of 2.67. The P-value was .004.

Table 18

Full-time and Part-time Technology Effectiveness Hypothesis Test Results

		T-Test of Mean	P-Value	Hypothesis Result
Technology	Web-based/LMS (Black Board)	-1.54	0.14	Fail to reject H_{1W}
	Verbal/lecture	1.25	0.23	Fail to reject H_{1L}
	Video/audio recordings	-3.30	0.004	Reject H_{1V}
	Email/Text messages	0.55	0.59	Fail to reject H_{1E}
	Written/paper	-0.55	0.59	Fail to reject H_{1P}
	Mobile applications	0.97	0.34	Fail to reject H_{1A}

Note. α=0.05 The p-value highlighted in green is significant as it is less than the alpha value.

Tables 16 and 18 support the evaluation of the sixth research question (RQ6). There were no differences between full-time and part-time students for feedforward mechanisms. One technology option, video/audio recordings, did show a difference between full-time and part-time students. Part-time students had an average of 4.27 while full-time students had an average of 2.67. The P-value was .004.

Delphi Panel Results for Phase 3

The University of Kansas Center for Teaching Excellence, Center for Online and Distance Learning, and the school of Engineering Teaching Fellows had representatives present on a Delphi Panel call. The University of Central Missouri Center for Teaching and Learning had four representatives present at a meeting. No representatives from Indiana State participated

on the panel. All participants signed the Informed Consent (Appendix C) prior to participating on the conference call. The meetings were not recorded. At the Delphi Panel meetings, the survey data results were reviewed as well as a new model created from the first Delphi round and the survey (Figure 31). The conversation started with feedforward mechanisms. Textbooks were included in the survey, but some on the Delphi Panel talked about current issues with text books including pirated copies sold in web-based stores, online versions of the textbook that do not match the print version, and issues with cost and students just not purchasing textbooks. The panel noted that models or samples are often used for papers but there can be issues with students just copying the material provided instead of creating their own material. Accessibility or the ability for all students to access the assignment information is critical. Paper copies are difficult for blind students to use. Audio recordings are difficult for hearing impaired students to use unless they are close captioned.

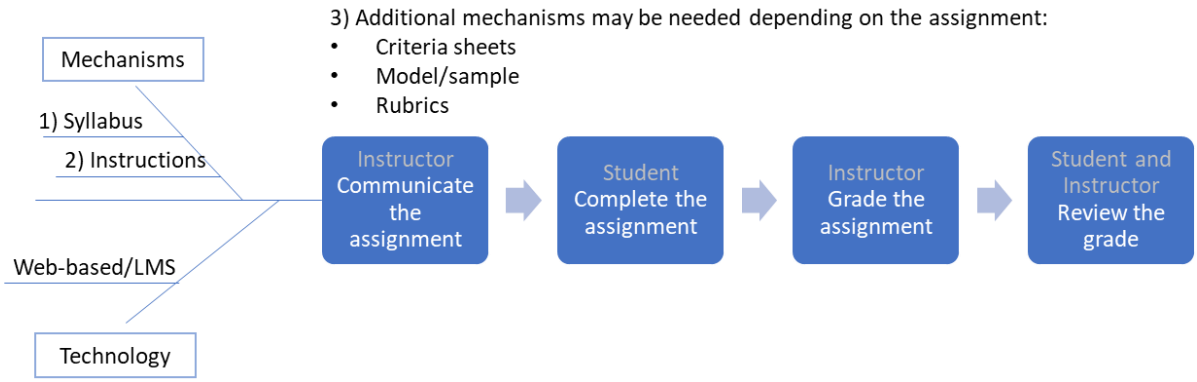

Figure 31. Preliminary Model for Assignment Quality Conveyance

Creativity, critical thinking, and innovation may be difficult to develop criteria or models for. Instructors need to think about what is important as it relates to the assignment. The students should get something out the assignment in terms of new knowledge or practice of a skill. The

panel noted that it is important for instructors to think about the assignment and how much information students need to learn or practice as well as develop definitions for grades. Authentic assignments and meaningful applications were suggested by the Delphi Panel in order for students to obtain the knowledge and skills needed.

The Delphi Panel suggested that there is a tiered rollout of assignment instructions. The first tier is the syllabus. The syllabus is often the first item most students see when joining a class. The syllabus is often posted on the LMS and available to the students early in the semester. The second tier is assignment instructions associated with the specific assignment. These instructions can be added to the LMS or conveyed via a handout. The third tier includes models, samples, criteria sheets, and rubrics. These items are tied to the specific assignment and may be available via the LMS or handed out in class. Rubrics can be tied to the assignment in the LMS and used for grading.

The panel also noted that by defining the assignment and grading criteria, assignments can be graded more consistently and in a timely manner. Consistent due dates are helpful to students and help instructors manage time. This becomes more important if class sizes are large and graders or teaching assistants support the grading process. The panel suggested that students need individualized feedback in order to improve. Digital feedback is becoming more common as more instructors use the LMS grading options or technical solutions such as video or audio apps. Rubrics were noted as a common approach to providing feedback as well as creating grading consistency. The drawback of rubrics as noted by the panel is the potential lack of individualized feedback due to poor rubric development.

The graphical models were revised based on responses from the Delphi Panel and the survey. Figure 7 which was the High-Level Process Diagram for Assignments did not change.

Figures 32, 33, 34, and 35 were developed to explain the quality requirements for the assignment process and answer part of the seventh research question (RQ7). Figure 6 had additional suppliers and inputs added and evolved into Figure 32. The university, industry, LMS company, and publishers were added under suppliers. Under inputs "methods" was changed to "mechanisms" to match the terminology recommended by the Delphi Panel. Design method and accreditation were added under inputs as they often impact the assignment design (Figure 32).

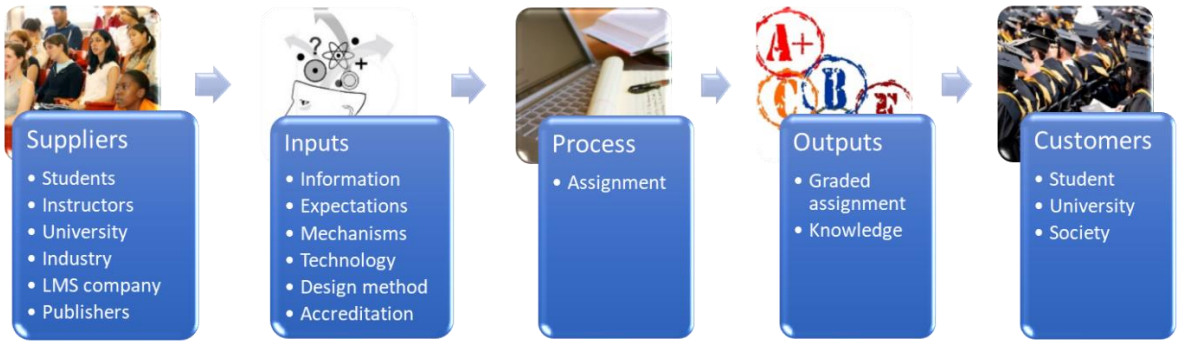

Figure 32. Revised SIPOC for the Assignment Process
Note. SIPOC is the abbreviation for suppliers, inputs, process, outputs, and customers.

The original figure for inputs for the process step of communicating the assignment (Figure 8) was revised. Assessment was changed to assignment. Textbooks and model/samples were added to mechanisms. Technology is constantly evolving so several items were added to this part of the fishbone diagram. Audio was added to video recording as some instructors record audio clips to explain assignments. Web-based was added to LMS to signify that the LMS is online. Lecture was added to verbal as that is often the means of verbal communication. Text was added to email since both are commonly used on mobile phones. Mobile apps and simulation/gamification were added as both are becoming more common (Figure 33).

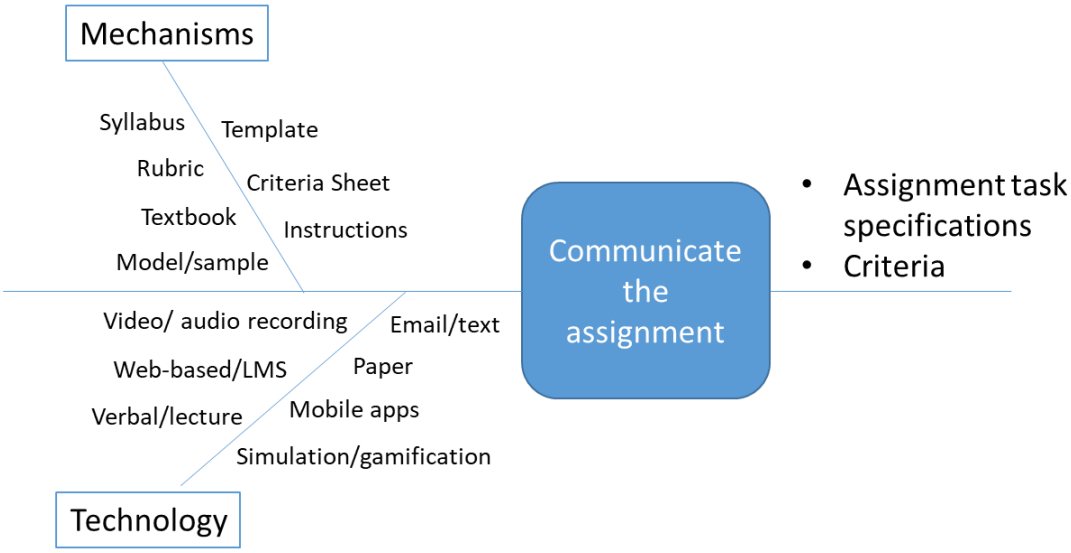

Figure 33. Revised inputs/outputs for the process step of communicating the assignment

The original figure for inputs for the process step of reviewing the grade (Figure 9) was revised. The inputs were revised to match the inputs of the previous fishbone (Figure 34). Knowledge gap awareness was added as an output based on feedback from the Delphi Panel.

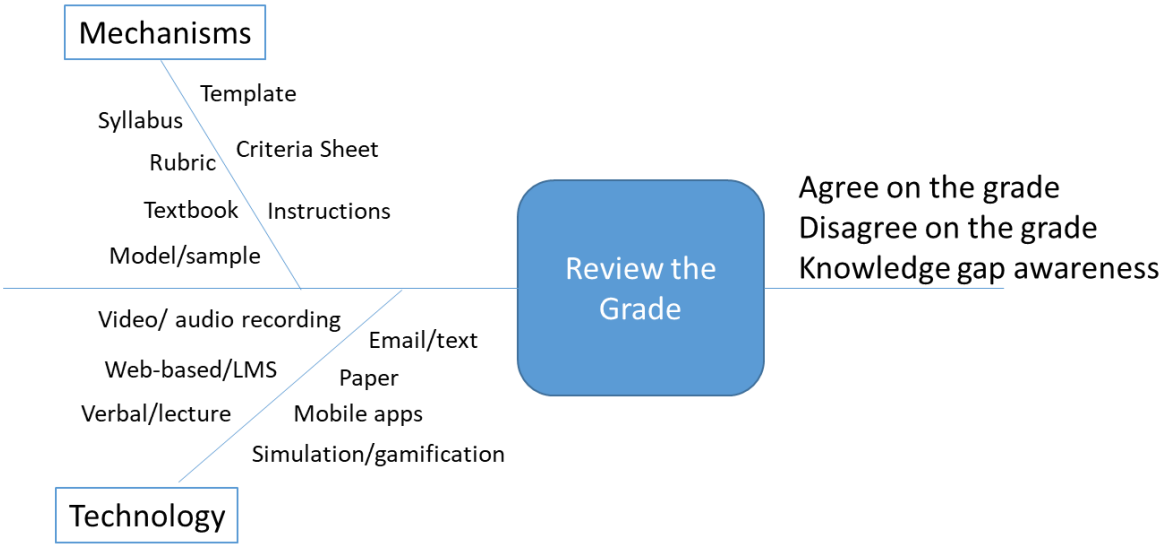

Figure 34. Inputs/outputs for the process step of reviewing the grade

Combining the information from the Delphi Panel, survey, and the above figures, an overall diagram model was created (Figure 35). This model suggests using a syllabus and instructions as mechanisms to convey quality requirements for assignments. For some assignments it might be important to also include a rubric, criteria sheet, or model/sample to clarify requirements. Using the web-based learning management system allows students to access information outside of the classroom and at any time. The LMS can contain written as well as video or audio recordings of assignment information. Grade information can also be in written or as a video or audio recording. Consistency and timeliness are important in conveyance of both the assignment and the grade. Consistent due dates and times as well as timely grading were noted by the Delphi Panel as important parts of the process.

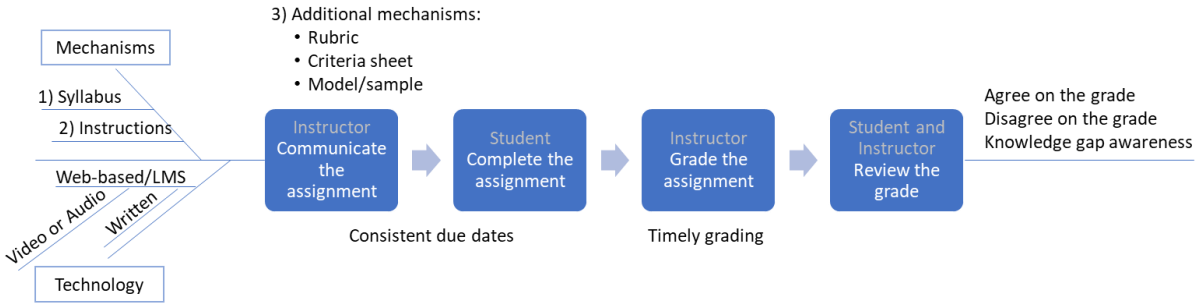

Figure 35. Final model for conveying quality requirements for assignments

The second part of the seventh research question (RQ7) focused on how the model could be used to improve course assignments. Using a course from the Project Management Program the current process was reviewed and improvements were suggested. Project Management Fundamentals 2 (PMGT817) is taught in three formats: face-to-face 16 week, face-to-face 8 week, and online 8 week. A template for the course is available for instructors including part-time lecturers via Blackboard.

One assignment in the template was reviewed for improvements starting with mechanisms. PMGT817 uses the syllabus and instructions for homework assignment information. Figure 36 displays the information in the syllabus. The information in the syllabus does not include any information related to assignment quality and does not reference the rubric.

Homework (Exercises and Case Study)

Each student is required submit answers to the questions in the assigned homework and case studies.

- Pinto Exercises 9.1 and 9.3
- Pinto Exercises 10.1-4
- Pinto Case Study 8.2
- Pinto Problem 13.7-8

The answers to the questions are to be developed independently. Each student will submit their assignments as assigned via Blackboard™.

Figure 36. PMGT817 Syllabus Screen Shot

Figure 37 displays the instructions in Blackboard for one of the assignments, the case study. The instructions include some information on what to use to complete the exercise and mentions the rubric.

Pinto Case Study 8.2

Read the case study titled "Boston's Central Artery/Tunnel Project" and answer the 3 questions at the end (pages 288-290). Create a Word document with your answers and submit it in Blackboard. Review the rubric for grading criteria.

Instructions for submitting your Case Study in Blackboard:

1. Review the Assignment Information, then go to the section Assignment Submission.
2. Click **Browse My Computer**
3. Select the document file you created for this assignment.
4. Click **Submit**

Figure 37. PMGT817 Blackboard instructions for the case study assignment

This assignment utilizes a rubric. The rubric has four levels: unacceptable, acceptable, good, and excellent. There are four criteria including completeness, understanding, analysis and application, and writing mechanics (Figure 38). The rubric is the quality criteria for this assignment.

	Unacceptable (Below Standards)	Acceptable (Meets Standards)	Good (Sometimes Exceeds)	Excellent (Exceeds Standards)
Completeness	**7.5** (15.00%) Incomplete in most respects; does not reflect requirements.	**9.375** (18.75%) Incomplete in many respects; reflects few requirements.	**11.25** (22.50%) Complete in most respects; reflects most requirements.	**12.5** (25.00%) Complete in all respects; reflects all requirements.
Understanding	**7.5** (15.00%) Demonstrates an inadequate understanding of the topic(s) and issue(s).	**9.375** (18.75%) Demonstrates an acceptable understanding of the topic(s) and issue(s).	**11.25** (22.50%) Demonstrates an accomplished understanding of the topic(s) and issue(s).	**12.5** (25.00%) Demonstrates a sophisticated understanding of the topic(s) and issue(s).
Analysis and Application	**12** (24.00%) Presents an incomplete analysis of the issues identified. Makes little or no connection between the issues identified and the strategic concepts studied in the reading.Supports diagnosis and opinions with few reasons and little evidence; argument is one-sided and not objective.	**15** (30.00%) Presents an acceptable analysis of the issues identified. Makes some connection between the issues identified and the strategic concepts studied in the reading. Supports diagnosis and opinions with some reasons and evidence.	**18** (36.00%) Presents an effective analysis of all questions. Makes appropriate connections between the case featured and the strategic concepts studied in the reading.	**20** (40.00%) Presents an insightful and thorough analysis of all questions. Makes appropriate and powerful connections between the case featured and the concepts studied in the reading.
Writing Mechanics	**3** (6.00%) Big problems in sentence structure, grammar, and diction. Frequent major errors in citation style, punctuation, and/or spelling. May have many run-on sentences and commas splices. Does not conform to format requirements.	**3.75** (7.50%) Problems is sentence structure, grammar, and diction (usually not major). Some errors in punctuation, citation style, and/or spelling. May have some run-on sentences or comma splices. Conforms in almost every way to format requirements.	**4.5** (9.00%) Sentence structure, grammar, and diction strong despite occasional lapses; punctuation and citation style often used correctly. Some (minor) spelling errors; may have one run-on sentence or comma splice. Conforms in every way to format requirements.	**5** (10.00%) Sentence structure, grammar, and diction excellent; correct use of punctuation and citation style; minimal to no spelling errors; absolutely no run-on sentences or comma splices. Conforms in every way to format requirements.

Name:**Case Study**

Exit

Figure 38. PMGT817 Rubric for the case study assignment

The syllabus, assignment instructions, and rubric are available on Blackboard. The syllabus is a written document attached in Blackboard. The assignment instructions and rubric are Blackboard components. Information on the assignment is included in a video based on what is available in written form.

Other items included in the model were consistent due dates and timely grading. The PMGT817 assignment due date is Tuesday at 11:30PM Central time (Figure 39). The syllabus also contains a statement on timely grading (Figure 40).

> **Assignment Due Dates and Times**
> All assignments in this course will be due on Tuesdays at 11:30PM Central Daylight Time. Specific due dates are provided for each assignment in Blackboard.

Figure 39. PMGT817 Assignment due dates and times in the syllabus

> **Feedback on Grades**
>
> Your grade status will be reported to you via BlackBoard. Your instructor will make every effort to have your grade reported on BlackBoard by the next module. To check your scores, go to My Grades in the BlackBoard course menu.

Figure 40. PMGT817 Timely grading statement in the syllabus

Based on the model, an improvement should be made to this case study assignment. Since the information in the syllabus does not include anything related to assignment quality, a statement should be added as well as a reference to the rubric. The other assignments in this course should also be reviewed for possible improvements.

CHAPTER 5

SUMMARY, DISCUSSION, and RECOMMENDATIONS

A summary of the research, discussion of the findings, and recommendations for the use of this study as well as future studies are included in this chapter. In the summary, the problem statement, purpose of the study, and research questions are revisited. The discussion section includes information from the Delphi Panel regarding mechanisms and technology as well as conclusions. In recommendations, further use of the model as well as future studies are discussed.

Summary

This research focused on quality requirement conveyance for assignments in technology and engineering master's degree programs. Quality requirements should be the specific criteria as to what is required for the student to receive a specific grade. Assignments should be aligned with the goals and objectives of the course (Svinicki & McKeachie, 2014). The specific objectives create the basis for the definition of quality.

The assignment should also be appropriately communicated to students. In higher education, defining quality requirements and communicating those requirements to students may be accomplished through a variety of mechanisms such as a syllabus, assignment instructions, and/or rubric. Although students receive some information, they still may not know what it takes to get a good grade on an assignment. Students may have to wait for an instructor to clarify the

assignment quality requirements. The lack of effective feedforward mechanisms cause waste in the assignment process such as increased waiting and rework culminating in increased office hours and unexpectedly low grades.

This study was conducted because students and instructors may have different opinions as to which forms of feedforward and what technology are best to convey assignment requirements. Master-degree seeking students and instructors as well as university resources from teaching excellence programs from three universities were utilized in this study. The purpose of this study was to determine effective feedforward mechanisms as well as the technology used to convey quality requirements for assignments. This study was produced in three phases. The first phase utilized a Delphi Panel to compliment information gathered during the literature review and improve the survey. The second phase of the study used a survey to identify waste, communication preferences, and office hour utilization. The third phase of the study again used the Delphi Panel to review the survey data and adjust the model. The research questions and hypotheses studied were:

RQ1: What feedforward mechanisms and technology are utilized to convey quality requirements for assignments?

RQ2: What combinations of feedforward mechanisms and technology used to convey quality requirements for assignments resulted in the average lowest amount of time being clarified?

RQ3: What activities do students and instructors use office hours for?

RQ4: Are there differences between students (S) and instructors (I) among the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) and technology (email/text messages, mobile

applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments?

H_O: There is no statistically significant difference between students (S) and instructors (I) as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between students (S) and instructors (I) as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each preferred feedforward mechanism:

Mechanism	Null Hypothesis	Alternative Hypothesis
Criteria sheet (C)	$H_{OC}: \mu_{CS}=\mu_{CI}$	$H_{AC}: \mu_{CS}\neq\mu_{CI}$
Instructions/handout (I)	$H_{OI}: \mu_{IS}=\mu_{II}$	$H_{AI}: \mu_{IS}\neq\mu_{II}$
Model/sample (M)	$H_{OM}: \mu_{MS}=\mu_{MI}$	$H_{AM}: \mu_{MS}\neq\mu_{MI}$
Rubric (R)	$H_{OR}: \mu_{RS}=\mu_{RI}$	$H_{AR}: \mu_{RS}\neq\mu_{RI}$
Syllabus (S)	$H_{OS}: \mu_{SS}=\mu_{SI}$	$H_{AS}: \mu_{SS}\neq\mu_{SI}$
Template (T)	$H_{OT}: \mu_{TS}=\mu_{TI}$	$H_{AT}: \mu_{TS}\neq\mu_{TI}$
Textbook (B)	$H_{OB}: \mu_{BS}=\mu_{BI}$	$H_{AB}: \mu_{BS}\neq\mu_{BI}$

H_O: There is no statistically significant difference between students (S) and instructors (I) as to the technology (email/text messages, mobile applications, verbal/lecture,

video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between students (S) and instructors (I) as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each technology:

Technology	Null Hypothesis	Alternative Hypothesis
Email/Text messages (E)	$H_{OE}: \mu_{ES}=\mu_{EI}$	$H_{AE}: \mu_{ES}\neq\mu_{EI}$
Mobile applications (A)	$H_{OA}: \mu_{AS}=\mu_{AI}$	$H_{AA}: \mu_{AS}\neq\mu_{AI}$
Verbal/lecture (L)	$H_{OL}: \mu_{LS}=\mu_{LI}$	$H_{AL}: \mu_{LS}\neq\mu_{LI}$
Video/audio recordings (V)	$H_{OV}: \mu_{VS}=\mu_{VI}$	$H_{AV}: \mu_{VS}\neq\mu_{VI}$
Web-based/LMS (Black Board) (W)	$H_{OW}: \mu_{WS}=\mu_{WI}$	$H_{AW}: \mu_{WS}\neq\mu_{WI}$
Written/paper (P)	$H_{OP}: \mu_{PS}=\mu_{PI}$	$H_{AP}: \mu_{PS}\neq\mu_{PI}$

RQ5: Using the top box response of "Extremely Effective", what mechanisms and technology are rated extremely effective most often (percentages of responses)?

RQ6: Are there significant differences between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms and technology used to convey quality requirements for assignments?

H_O: There is no statistically significant difference between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms (criteria sheet,

instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each preferred feedforward mechanism:

Mechanism	Null Hypothesis	Alternative Hypothesis
Criteria sheet (C)	$H_{1C}: \mu_{CF}=\mu_{CP}$	$H_{2C}: \mu_{CF}\neq\mu_{CP}$
Instructions/handout (I)	$H_{1I}: \mu_{IF}=\mu_{IP}$	$H_{2I}: \mu_{IF}\neq\mu_{IP}$
Model/sample (M)	$H_{1M}: \mu_{MF}=\mu_{MP}$	$H_{2M}: \mu_{MF}\neq\mu_{MP}$
Rubric (R)	$H_{1R}: \mu_{RF}=\mu_{RP}$	$H_{2R}: \mu_{RF}\neq\mu_{RP}$
Syllabus (S)	$H_{1S}: \mu_{SF}=\mu_{SP}$	$H_{2S}: \mu_{SF}\neq\mu_{SP}$
Template (T)	$H_{1T}: \mu_{TF}=\mu_{TP}$	$H_{2T}: \mu_{TF}\neq\mu_{TP}$
Textbook (B)	$H_{1B}: \mu_{BF}=\mu_{BP}$	$H_{2B}: \mu_{BF}\neq\mu_{BP}$

H_O: There is no statistically significant difference between full-time (F) and part-time (P) master's degree students as to the technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

H_A: There is a statistically significant difference between full-time (F) and part-time (P) master's degree students as to the technology (email/text messages, mobile

applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments.

The following is a list of the null and alternative hypotheses for each technology:

Technology	Null Hypothesis	Alternative Hypothesis
Email/Text messages (E)	$H_{1E}: \mu_{EF}=\mu_{EP}$	$H_{2E}: \mu_{EF}\neq\mu_{EP}$
Mobile applications (A)	$H_{1A}: \mu_{AF}=\mu_{AP}$	$H_{2A}: \mu_{AF}\neq\mu_{AP}$
Verbal/lecture (L)	$H_{1L}: \mu_{LF}=\mu_{LP}$	$H_{2L}: \mu_{LF}\neq\mu_{LP}$
Video/audio recordings (V)	$H_{1V}: \mu_{VF}=\mu_{VP}$	$H_{2V}: \mu_{VF}\neq\mu_{VP}$
Web-based/LMS (Black Board) (W)	$H_{1W}: \mu_{WF}=\mu_{WP}$	$H_{2W}: \mu_{WF}\neq\mu_{WP}$
Written/paper (P)	$H_{1P}: \mu_{PF}=\mu_{PP}$	$H_{2P}: \mu_{PF}\neq\mu_{PP}$

RQ7: What graphical models help explain the quality requirements for the assignment process and how could the model be used to improve course assignments?

A Delphi Panel was utilized to identify feedforward mechanisms as well as technology currently used. The Delphi Panel as well as the survey were used to investigate the first research question. The first research question was to determine feedforward mechanisms and technology are utilized to convey quality requirements for assignments. The feedforward mechanisms used to convey quality requirements for assignments include criteria sheets, instructions, model or sample, rubric, syllabus, template, and textbook. The technology used to convey the requirements include written or paper, web-based or LMS (Blackboard), video or audio recordings, verbal or lecture, mobile applications, and email or text messages.

Research question 2 studied the combinations of mechanisms and technology with the lowest average time being clarified. The lowest averages were associated with review of the

grade. Both students and instructors recorded zero minutes of time reviewing grades when rubrics were used as the mechanism. When reviewing the responses for assignment clarification, rubrics exhibited the lowest amount of time. The responses for technology for both reviewing the assignment and the grade included all three options of electronic, verbal, and written for instructor responses.

The activities students and instructors participated in for office hours were investigated for the third research question. One finding was that many students do not attend office hours. When students do attend office hours, they are seeking clarification of assignments. Another finding is that instructors use office hours to clarify items for students associated with course material, assignments or grades.

Research question 4 investigated the differences between students (S) and instructors (I) among the preferred feedforward mechanisms (criteria sheet, instructions/handout, model/sample, rubric, syllabus, template, and textbook) and technology (email/text messages, mobile applications, verbal/lecture, video/audio recordings, web-based/LMS (Blackboard), and written/paper) used to convey quality requirements for assignments. A hypothesis was created for each mechanism and for each type of technology studied. T-tests were used to determine if there was a difference between students and instructors as to what feedforward mechanisms or combinations of feedforward mechanisms are preferred to effectively convey quality requirements. The feedforward mechanisms where the hypothesis was rejected include criteria sheets and rubric. Both mechanisms had higher means from student data than from instructor data. For technology the hypothesis was rejected for mobile applications with the student mean higher than the instructor mean.

The fifth research question used the top box response of "Extremely Effective" to evaluate mechanisms and technology. The mechanism of model/sample was most commonly responded to as extremely effective by both students and instructor. The technology noted as extremely effective by both students and instructors was web-based/LMS.

Research question 6 investigated the differences between full-time (F) and part-time (P) master's degree students as to the preferred feedforward mechanisms and technology used to convey quality requirements for assignments. T-tests of the mean were used for each mechanism and technology. There were no differences between full-time and part-time students for feedforward mechanisms. One technology option, video/audio recordings, did show a difference between full-time and part-time students. Part-time students had an average of 4.27 while full-time students had an average of 2.67.

The seventh research question used a model developed from the study. The graphical model developed (Figure 36) can be used to improve course assignments as demonstrated in the Results section. This study as well as the model will be used as a guide to develop or revise feedforward to convey quality criteria for assignments to enhance learning effectiveness, reduce waste, and help facilitate change in the assignment communication process.

Discussion

The results of this study may lead to improvements in the development of effective feedforward mechanisms to convey quality requirements for assignments in master's degree courses. The final graphical summary (Figure 34) shows that a variety of mechanisms help convey the quality criteria for assignments based on results from the Delphi Panel and the survey. The Delphi Panel recommended a tier or phased rollout of mechanisms. The first tier is

the syllabus. The syllabus is often the first item most students see when joining a class. The syllabus is often posted on the LMS and available to the students early in the semester. The second tier is assignment instructions associated with the specific assignment. These instructions can be added to the LMS or conveyed via a handout. The third tier includes models, samples, criteria sheets, and rubrics. These items are tied to the specific assignment and may not be needed for all assignments. Rubrics can be tied to the assignment in the LMS and used for grading. The technology recommended in the model is the web-based learning management system. Within the LMS the syllabus, instructions, models, samples, criteria sheets, and rubrics are readily available in either written form or as a video or audio recording.

The panel also noted that by defining the assignment and grading criteria, assignments can be graded more consistently and in a timely manner. Consistent due dates are helpful to students and help instructors manage time. This becomes more important if class sizes are large and graders or teaching assistants support the grading process. The panel suggested that students need individualized feedback in order to improve. Digital feedback is becoming more common as more instructors use the LMS grading options or technical solutions such as video or audio apps. Rubrics were noted as a common approach to providing feedback as well as creating grading consistency. The drawback of rubrics as noted by the panel is the potential lack of individualized feedback due to poor rubric development.

As an instructor the results of this study may help me as well as other instructors become more consistent in utilizing appropriate means to convey quality requirements plus improve grading consistency and feedback to students. To demonstrate the possible use of the model, a course from the Project Management Program the current process was reviewed and improvements were suggested. One assignment was reviewed for improvements starting with

mechanisms. PMGT817 uses the syllabus and instructions for homework assignment information. The syllabus, assignment instructions, and rubric are available on Blackboard. The syllabus is a written document attached in Blackboard. The assignment instructions and rubric are Blackboard components. Information on the assignment is included in a video based on what is available in written form.

The information in the syllabus does not include any information related to assignment quality and does not reference the rubric. The instructions in Blackboard include some information on what to use to complete the exercise and mentions the rubric. This assignment utilizes a rubric. The rubric has four levels: unacceptable, acceptable, good, and excellent. There are four criteria including completeness, understanding, analysis and application, and writing mechanics. The rubric is the quality criteria for this assignment.

Other items included in the model were consistent due dates and timely grading. The PMGT817 assignment due date is Tuesday at 11:30PM Central time. The syllabus also contains a statement on timely grading. Based on the model, an improvement should be made to this case study assignment. Since the information in the syllabus does not include anything related to assignment quality, a statement should be added and a reference the rubric should be added. The other assignments in this course should also be reviewed for possible improvements. This study could be used to encourage other instructors to control and standardize quality requirements for assignments in their courses.

Recommendations

As an instructor the results of this study may help me as well as other instructors become more consistent in utilizing appropriate means to convey quality requirements plus improve

grading consistency and feedback to students. This study will be used as a guide to develop or revise feedforward to convey quality criteria for assignments and help facilitate change in the assignment communication process.

The model can be used by the university's Center for Teaching Excellence and the Center for Online and Distance Learning. This study should be used to encourage instructors to control and standardize quality requirements for assignments in their courses. Effective feedforward mechanisms could reduce waste in the assignment process such as waiting and rework resulting in more effective use of office hours and students receiving the grade they expected.

Future studies could focus on the type of course to determine if there are differences between face-to-face courses and online courses. Online courses need clear instructions as students rely on electronic means to gather information on assignments. Face-to-face students have the opportunity to ask clarifying questions in class. The differences between graduate and undergraduate students could also be studied. Undergraduate classes are often larger and grading time and consistency may be more important.

Another study of interest could look at the development of rubrics. The drawback of rubrics as noted by the Delphi Panel is the potential lack of individualized feedback due to poor rubric development. When rubrics are created, they must align with the assignment quality requirements. Rubrics also need to allow for creativity and innovation. A common complaint the Delphi Panel articulated was that rubrics are sometimes prescriptive and do not allow for creativity. As was noted in the model, rubrics must be appropriate for the assignment.

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APPENDIX A

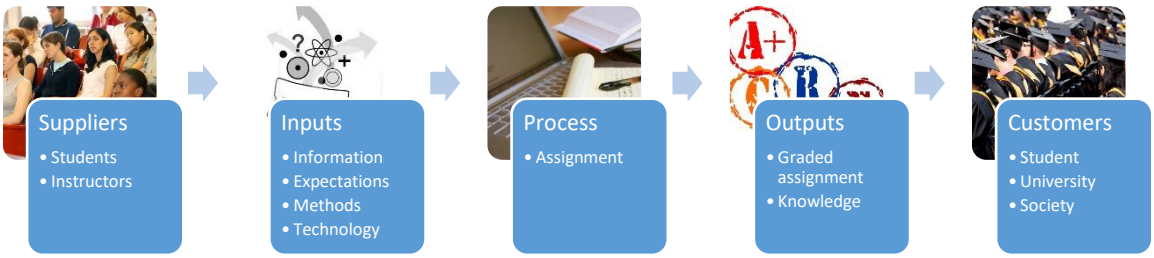
DELPHI PANEL QUESTIONS

Round 1

Delphi Panel participants will review the following diagrams, comment and add to the diagrams. They will also be asked to review the survey questions. The following questions will be discussed:

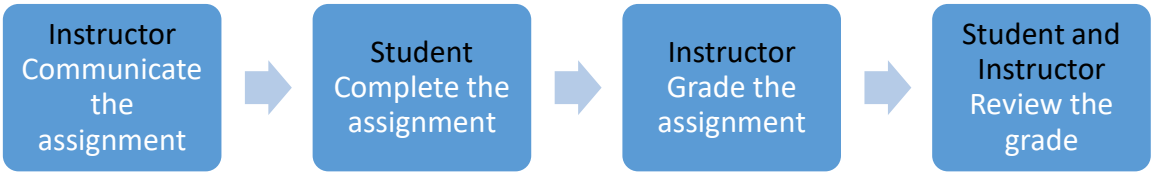
1. What are the suppliers, inputs, process, outputs, and customers (SIPOC) for the assignment process? Are there any items missing from the SIPOC diagram shown below?

SIPOC



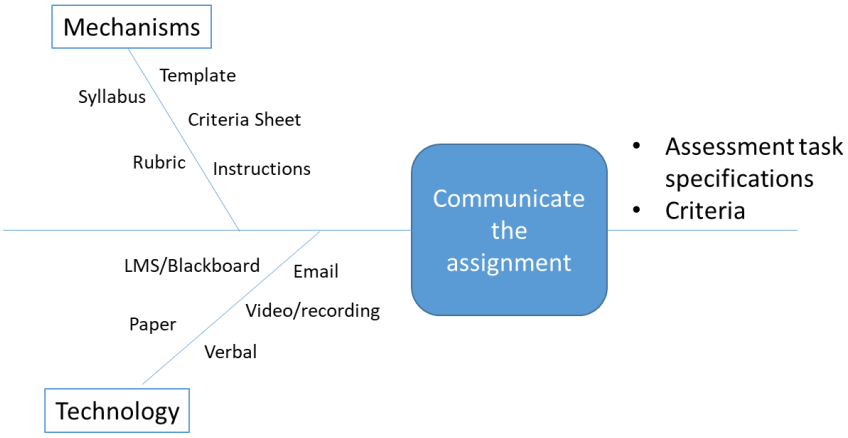
2. What are the steps of the process flow for assignments? Are there any items in the diagram below that are missing or confusing?

Process Flow for Assignments



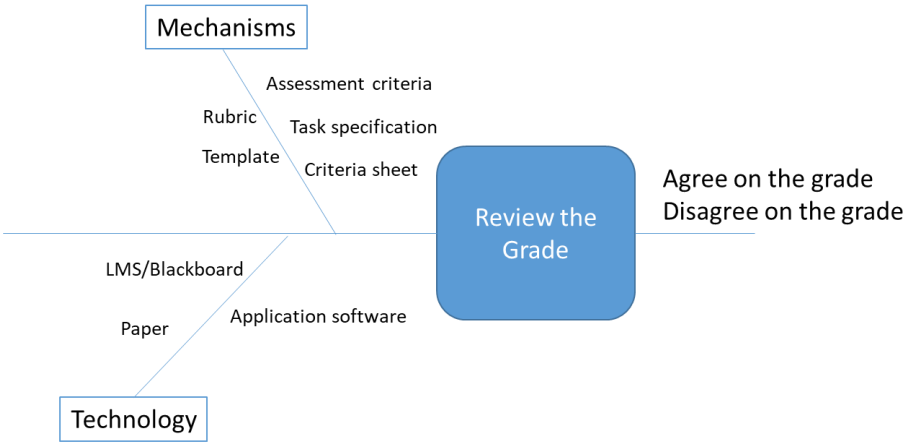
3. Thinking in terms of mechanisms and technology, what are the inputs for the first process step of communicating the assignment? What are the outputs of this step?

Communicate the assignment



4. Thinking in terms of mechanisms and technology, what are the inputs for the last process step of reviewing the grade? What are the outputs of this step?

Review the grade



5. Are there any additional diagrams that help explain the assignment process?
6. After reviewing the survey tool for students and instructors, do you have any suggestions for improvement?

Round 2

Based on results from the survey and answers from the first Delphi Panel meeting, the diagrams and model were edited. The data from the survey was shared with the panel. The questions for the Delphi Panel are:

1. What do you think are the best items to convey quality requirements (mechanisms)?
2. What are the best ways to convey the quality requirements (technology)?
3. Do you think this model will help reduce waste in the assignment process? Why or why not?

Delphi Panel comments were used to update the graphical model.

APPENDIX B

ORIGINAL SURVEY QUESTIONS

Questions for Instructors

1. Think about 3 specific assignments from the last 12 months.
    - Assignment Type:
        - Problem solving
        - Essay
        - Case study
        - Quiz/test
        - Presentation
        - Research paper
        - Project
    - What was used to convey the quality requirements for the assignment (choose all that apply along with the conveyance method)?

Syllabus	LMS/Blackboard
Assignment instructions	Verbal/lecture
Rubric	Written/paper

    - Did any students ask for clarification before submitting?
        - If yes, how much time did you spend on average per student clarifying the requirements (minutes)?
    - Did any students ask for clarification after grading?
        - If yes, how much time did you spend on average per student clarifying the requirements and grade (minutes)?
2. Overall what percent of time during office hours do you spend answering questions about or clarifying assignments?

    __ % of office hours spent on assignment clarification
3. Of the items you use (choose "N/A" if you do not use the item), rate them using (1) least effective (2) somewhat effective (4) very effective (5) superior for conveying quality requirements for an assignment.
    - Syllabus
    - Textbook
    - Assignment instructions
    - Template
    - Criteria sheet
    - Rubric

4. Of the technology you use (choose "N/A" if you do not use this technology), rate them using (1) least effective (2) somewhat effective (4) very effective (5) superior for conveying quality requirements for an assignment.
    - LMS/Blackboard
    - Video/recordings
    - Email
    - Verbal/lecture
    - Written/paper

Questions for Students

1. Think about 3 specific assignments from the last 12 months.
    - Assignment Type:
        - Problem solving
        - Essay
        - Case study
        - Quiz/test
        - Presentation
        - Research paper
        - Project
        - Other (specify)
    - What was used to convey the quality requirements for the assignment (choose all that apply along with the conveyance method)?

Syllabus	LMS/Blackboard
Assignment instructions	Verbal/lecture
Rubric	Written/paper

    - Did you ask for clarification before submitting the assignment?
        - If yes, how much time did you spend clarifying the requirements (minutes)?
    - Did you ask for clarification after grading?
        - If yes, how much time did you spend clarifying the requirements and grade (minutes)?
2. Overall, what percent of your time when you attend office hours is to ask questions about or clarify assignments?

    __ % of office hours spent on assignment clarification

3. Of the items you use (choose "N/A" if you do not use the item), rate them using (1) least effective (2) somewhat effective (4) very effective (5) superior for conveying quality requirements for an assignment.
    - Syllabus
    - Textbook
    - Assignment instructions
    - Template
    - Criteria sheet
    - Rubric

4. Of the technology you use (choose "N/A" if you do not use this technology), rate them using (1) least effective (2) somewhat effective (4) very effective (5) superior for conveying quality requirements for an assignment.
    - LMS/Blackboard
    - Video/recordings
    - Email
    - Verbal/lecture
    - Written/paper

APPENDIX C

INFORMED CONSENT FORM

INTRODUCTION

Indiana State University, the University of Central Missouri, and the University of Kansas support the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this researcher or affect any future study participation.

PURPOSE OF THE STUDY

The purpose of this study is to determine possible feedforward mechanisms as well as the technology used to convey quality requirements with minimal waste for assignments. Once the feedforward mechanisms and technology are identified, there may be a difference between students and instructors as to what feedforward methods or combination of feedforward methods are preferred to effectively convey quality requirements. The study involves Master-degree seeking students and instructors as well as university resources from teaching excellence programs from three different universities. The outcome of this study is a proposed graphical model of feedforward mechanisms to convey assignment quality requirements. This study will be used as a guide to develop or revise feedforward to convey quality criteria for assignments and help facilitate change in the assignment communication process.

PROCEDURES

During this study, you will be asked to participate in an online session where participants will identify feedforward mechanisms as well as the technology used to convey quality requirements for assignments. At the beginning of the session the researcher will present on findings from a literature review. Participants will then be asked to add to the information from the initial review as well as review survey questions for students and instructors. The online session will take a maximum of one hour and will be recorded. The recording will not be distributed and will only be used by the researcher to add to the proposed model.

RISKS

There are no risks or discomforts anticipated.

BENEFITS

There are no specific benefits to you, but we do expect the project to assist faculty members and academic leaders in improving instruction and student learning.

PAYMENT TO PARTICIPANTS
There is no payment for participating in the survey.

PARTICIPANT CONFIDENTIALITY
Your name will not be associated in any way with the information collected about you or with the research findings from this study. The researcher will not share any information about you unless required by law or unless you provide written permission. It is possible, however, with internet communications, that through intent or accident someone other than the intended recipient may see your response. Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing his form you give permission for the use and disclosure of your information for purposes of this study at anytime in the future.

REFUSAL TO SIGN CONSENT AND AUTHORIZATION
You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from University or to participate in any programs or events at the university. However, if you refuse to sign, you cannot participate in this study.

CANCELLING THIS CONSENT AND AUTHORIZATION
You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose information collected about you, in writing, at any time, by sending your written request to the researcher listed below. If you cancel permission the researcher may use and disclose information that was gathered before the receipt of cancellation.

QUESTIONS ABOUT PARTICIPATION
Questions about procedures should be directed to the researcher listed at the end of this consent form.

PARTICIPANT CERTIFICATION
I have read this Consent and Authorization form. I have had the opportunity to ask, and I have received answers to, any questions I had regarding the study. I understand that if I have any additional question about my rights as a research participant, I may call, email, or write:

Office of Sponsored Programs
Holmstedt Hall 272
Indiana State University
(812) 237-3088
Fax: (812) 237-3092
research@indstate.edu

I agree to take part in this study as a research participant. By responding 'Yes' I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

- Yes
- No

Researcher Contact Information:

Heather McCain
PhD Candidate
Indiana State University
11830 S Pine St.
Olathe, KS 66061
913-302-9350
Hmccain1@sycamores.indstate.edu

APPENDIX D

Qualtrics Survey Questions

The first question asks for consent to participate in the survey. The following wording was included in the survey as well as a decision box for consent.

INTRODUCTION
Indiana State University, the University of Central Missouri, and the University of Kansas support the practice of protection for human subjects participating in research. The following information is provided for you to decide whether you wish to participate in the present study. You may refuse to sign this form and not participate in this study. You should be aware that even if you agree to participate, you are free to withdraw at any time. If you do withdraw from this study, it will not affect your relationship with this researcher or affect any future study participation.

PURPOSE OF THE STUDY
The purpose of this study is to determine possible feedforward mechanisms as well as the technology used to convey quality requirements with minimal waste for assignments. Once the feedforward mechanisms and technology are identified, there may be a difference between students and instructors as to what feedforward methods or combination of feedforward methods are preferred to effectively convey quality requirements. The study involves Master-degree seeking students and instructors as well as university resources from teaching excellence programs from three different universities. The outcome of this study is a proposed graphical model of feedforward mechanisms to convey assignment quality requirements. This study will be used as a guide to develop or revise feedforward to convey quality criteria for assignments and help facilitate change in the assignment communication process.

PROCEDURES
During this study, you will be asked to complete an online survey that asks you to report on feedforward mechanisms as well as the technology used to convey quality requirements for assignments. The survey also includes questions about your personal characteristics (e.g. instructor or student, full/part-time status). Most people complete this survey in 10 minutes or less, but sometimes people take up to 30 minutes if they are unsure of their answers or give great attention to certain items.

RISKS
There are no risks or discomforts anticipated.

BENEFITS
There are no specific benefits to you, but we do expect the project to assist faculty members and academic leaders in improving instruction and student learning.

PAYMENT TO PARTICIPANTS
There is no payment for participating in the survey.

PARTICIPANT CONFIDENTIALITY
Your name will not be associated in any way with the information collected about you or with the research findings from this study. The principal investigator will replace your name with an identification number, and only the PI will have access to the master file linking your name with your identification number. The researcher will not share any information about you unless required by law or unless you provide written permission. It is possible, however, with internet communications, that through intent or accident someone other than the intended recipient may see your response. Permission granted on this date to use and disclose your information remains in effect indefinitely. By signing his form, you give permission for the use and disclosure of your information for purposes of this study at any time in the future.

REFUSAL TO SIGN CONSENT AND AUTHORIZATION
You are not required to sign this Consent and Authorization form and you may refuse to do so without affecting your right to any services you are receiving or may receive from University or to participate in any programs or events at the university. However, if you refuse to sign, you cannot participate in this study.

CANCELLING THIS CONSENT AND AUTHORIZATION
You may withdraw your consent to participate in this study at any time. You also have the right to cancel your permission to use and disclose information collected about you, in writing, at any time, by sending your written request to the researcher listed below. If you cancel permission the researcher may use and disclose information that was gathered before the receipt of cancellation.

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Questions about procedures should be directed to the researcher listed on this consent form.

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Office of Sponsored Programs
Holmstedt Hall 272
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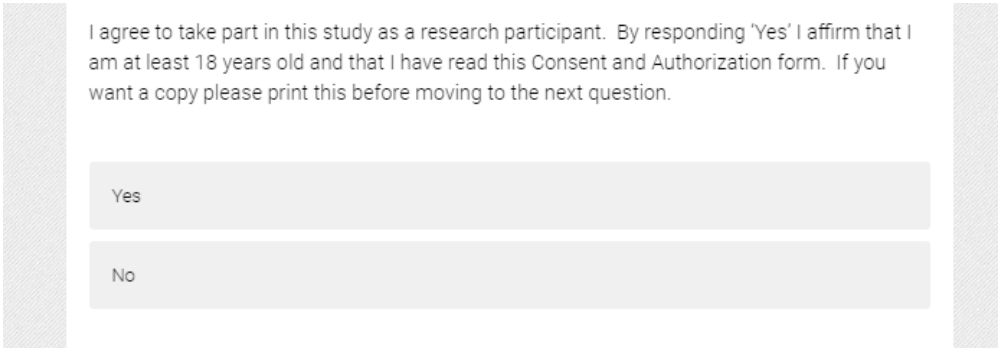
Fax: (812) 237-3092
research@indstate.edu

I agree to take part in this study as a research participant. By responding 'Yes' I affirm that I am at least 18 years old and that I have received a copy of this Consent and Authorization form.

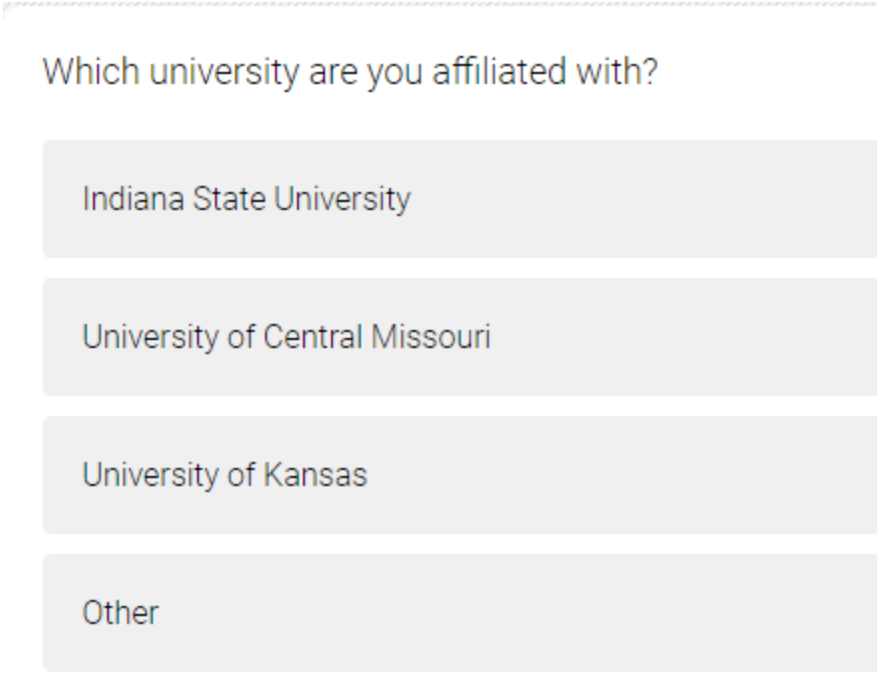
- Yes
- No

Researcher Contact Information:

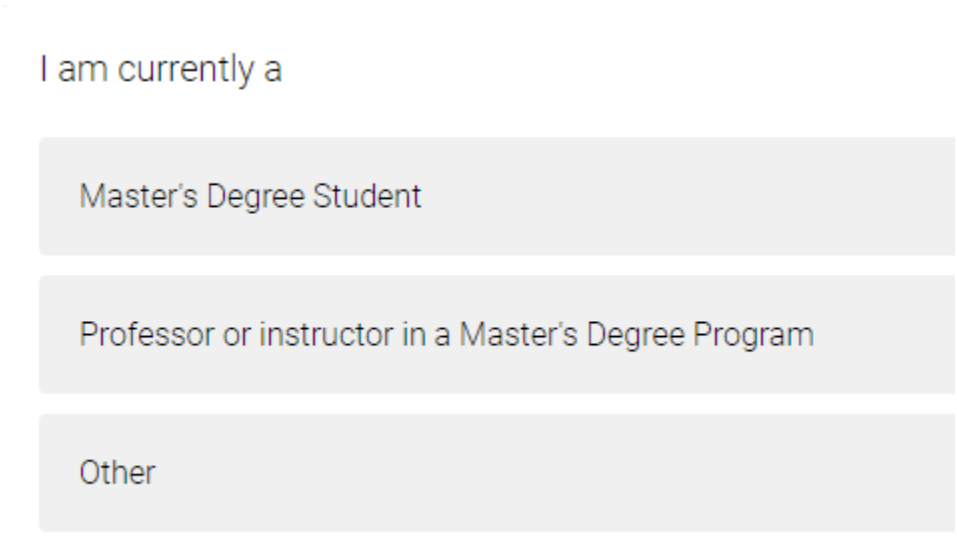
Heather McCain
PhD Candidate
Indiana State University
11830 S Pine St.
Olathe, KS 66061
913-302-9350
Hmccain1@sycamores.indstate.edu



The next questions asked what school the person is affiliated with. If 'Other' is selected, the survey ends. The survey participants must be from Indiana State University, University of Central Missouri, or the University of Kansas.

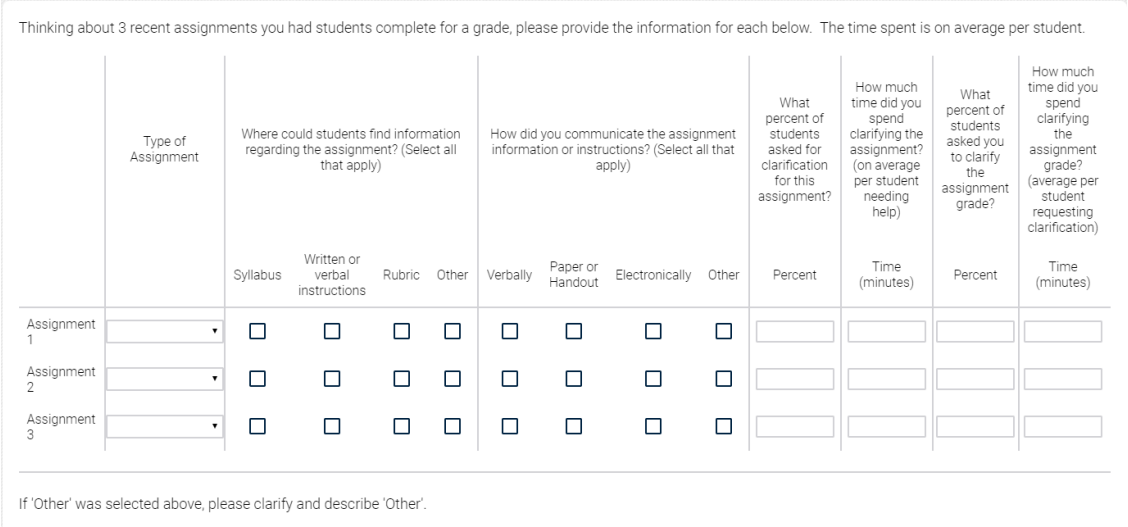


The second question is used to drive participants to the part of the survey associated with whether they are a student or an instructor. If 'Other' is selected, the survey ends. Participants must be either a student or an instructor.



If "Professor or instructor in a master's degree program is selected, the next question asks about recent assignments. The participant must provide information on the type of assignment (problem solving, essay, case study, quiz/test, presentation, research paper, or project), select all

that apply as to how the assignment was explained (syllabus, textbook, instructions, template, criteria sheet, or rubric), select all that apply as to how the assignment was conveyed (verbal, paper, email, video, or LMS/Blackboard), how much time was spent on clarifying the assignment, and how much time was spent clarifying the grade.

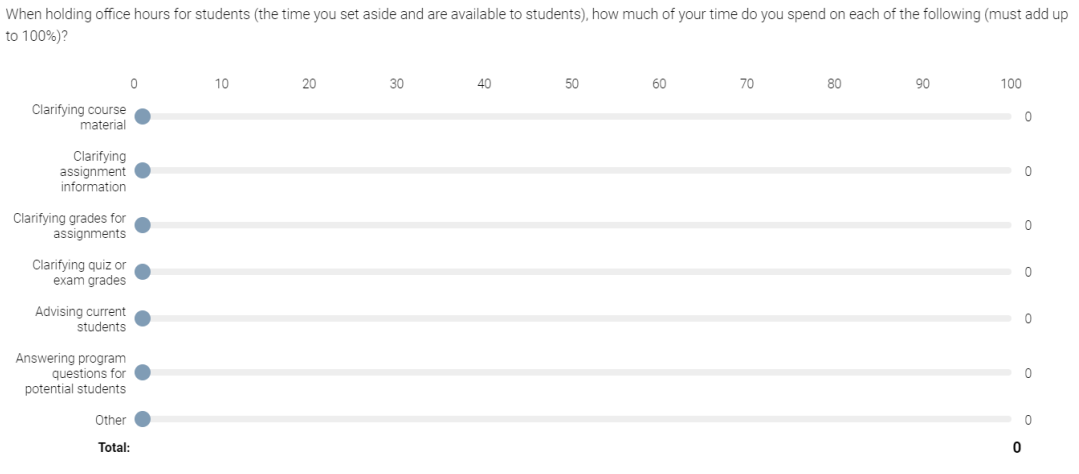


Thinking about 3 recent assignments you had students complete for a grade, please provide the information for each below. The time spent is on average per student.

	Type of Assignment	Where could students find information regarding the assignment? (Select all that apply)				How did you communicate the assignment information or instructions? (Select all that apply)				What percent of students asked for clarification for this assignment?	How much time did you spend clarifying the assignment? (on average per student needing help)	What percent of students asked you to clarify the assignment grade?	How much time did you spend clarifying the assignment grade? (average per student requesting clarification)
		Syllabus	Written or verbal instructions	Rubric	Other	Verbally	Paper or Handout	Electronically	Other	Percent	Time (minutes)	Percent	Time (minutes)
Assignment 1		☐	☐	☐	☐	☐	☐	☐	☐				
Assignment 2		☐	☐	☐	☐	☐	☐	☐	☐				
Assignment 3		☐	☐	☐	☐	☐	☐	☐	☐				

If 'Other' was selected above, please clarify and describe 'Other'.

The next question asks about the percent of time spent during office hours on the explanation of assignments, answering program questions, advising students, or other. The percentages are on sliding scales and the total must add up to 100%.



When holding office hours for students (the time you set aside and are available to students), how much of your time do you spend on each of the following (must add up to 100%)?

0 10 20 30 40 50 60 70 80 90 100

Clarifying course material 0

Clarifying assignment information 0

Clarifying grades for assignments 0

Clarifying quiz or exam grades 0

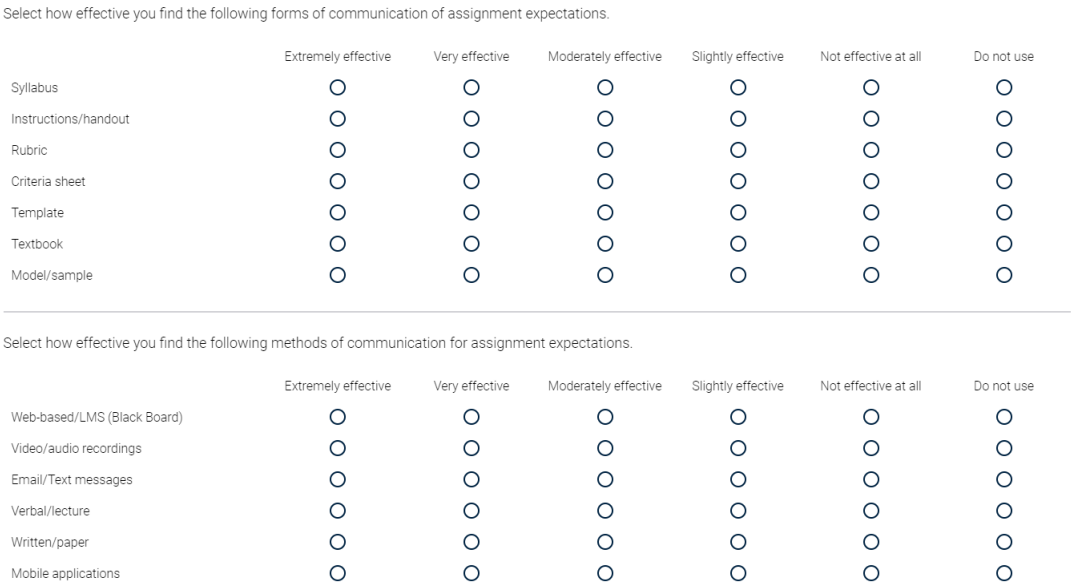
Advising current students 0

Answering program questions for potential students 0

Other 0

Total: **0**

A radio button type of question was used for determining the effectiveness for conveying quality requirements. This question is included in both the student and instructor questions in the survey. Items (syllabus, instructions/handout, rubric, criteria sheet, template, textbook, and model/sample) are listed as well as effectiveness (extremely, very, moderately, slightly, not effective at all, and no not use). The effectiveness of the methods (web-based/LMS, Video/audio recordings, email/text messages, verbal/lecture, written/paper, and mobile applications) was also asked using radio buttons. The same effectiveness scale was used.



Select how effective you find the following forms of communication of assignment expectations.

	Extremely effective	Very effective	Moderately effective	Slightly effective	Not effective at all	Do not use
Syllabus	○	○	○	○	○	○
Instructions/handout	○	○	○	○	○	○
Rubric	○	○	○	○	○	○
Criteria sheet	○	○	○	○	○	○
Template	○	○	○	○	○	○
Textbook	○	○	○	○	○	○
Model/sample	○	○	○	○	○	○

Select how effective you find the following methods of communication for assignment expectations.

	Extremely effective	Very effective	Moderately effective	Slightly effective	Not effective at all	Do not use
Web-based/LMS (Black Board)	○	○	○	○	○	○
Video/audio recordings	○	○	○	○	○	○
Email/Text messages	○	○	○	○	○	○
Verbal/lecture	○	○	○	○	○	○
Written/paper	○	○	○	○	○	○
Mobile applications	○	○	○	○	○	○

If ‘Master’s Degree Student’ is selected, the first question asks whether the student is a full-time or part-time student.

I am currently a

Full-time Student

Part-time Student

The next question is similar to the question for instructors but is written for students. The participant must provide information on the type of assignment (problem solving, essay, case study, quiz/test, presentation, research paper, or project), select all that apply as to how the assignment was explained (syllabus, textbook, instructions, template, criteria sheet, or rubric), select all that apply as to how the assignment was conveyed (verbal, paper, email, video, or LMS/Blackboard), how much time was spent on clarifying the assignment before it was submitted, and how much time was spent clarifying the grade.

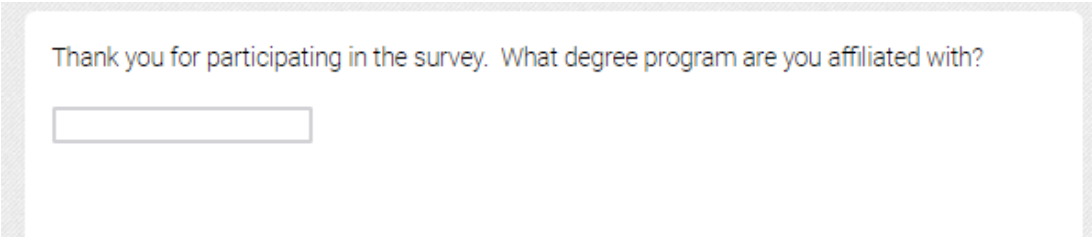
Thinking about 3 recent assignments, please provide the information for each below:

	Type of Assignment	What did the instructor use to explain the assignment? (select all that apply)				How did the instructor explain the assignment? (select all that apply)				How much time did you spend asking the instructor for clarification before submitting this assignment (if you didn't need clarification, use 0)?	How much time did you spend asking for clarification of the assignment grade (if you didn't need grade clarification, use 0)?
		Syllabus	Instructions	Rubric	Other	Verbally	Paper/handout	Electronically	Other	Time (minutes)	Time (minutes)
Assignment 1	▾	☐	☐	☐	☐	☐	☐	☐	☐		
Assignment 2	▾	☐	☐	☐	☐	☐	☐	☐	☐		
Assignment 3	▾	☐	☐	☐	☐	☐	☐	☐	☐		

If 'Other' was selected above, please clarify and describe 'Other'.

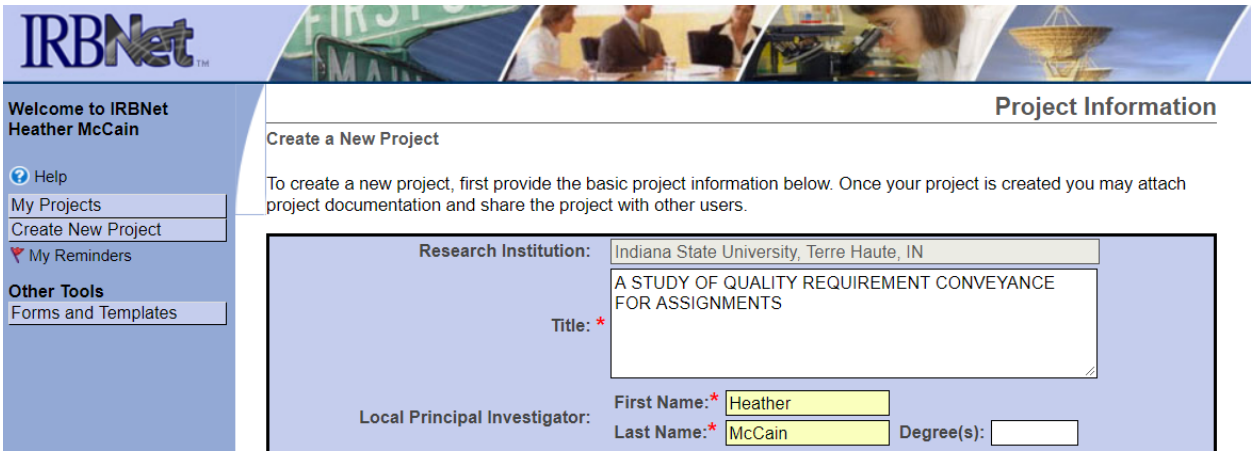
The next student question focuses on how the student spends time with a professor during office hours (asking for assignment explanation, program questions, or advisement). The total must add up to 100%.

The last question asks what program the participant is associated with. This is not required and will be used as information only.



APPENDIX E

IRB APPROVALS



Indiana State University
More. From day one.

Institutional Review Board

Terre Haute, Indiana 47809
812-237-3088
Fax 812-237-3092

DATE:	April 19, 2019
TO:	Heather McCain
FROM:	Indiana State University Institutional Review Board
STUDY TITLE:	[1259798-4] A STUDY OF QUALITY REQUIREMENT CONVEYANCE FOR ASSIGNMENTS IN TECHNOLOGY AND ENGINEERING MASTER'S DEGREE PROGRAMS
SUBMISSION TYPE:	Continuing Review/Progress Report
ACTION:	APPROVED
APPROVAL DATE:	April 19, 2019
EXPIRATION DATE:	April 21, 2022
REVIEW TYPE:	Expedited Review
REVIEW CATEGORY:	Expedited review category # 6, 7

Thank you for your submission of Continuing Review/Progress Report materials for this research study. The Indiana State University Institutional Review Board has APPROVED your submission. The approval for this study expires on **April 21, 2022**.

Prior to the approval expiration date, if you plan to continue this study you will need to submit a continuation request (Form E) for review and approval by the IRB. Additionally, once you complete your study, you will need to submit the Completion of Activities report (Form G).

This approval is based on an appropriate risk/benefit ratio and a study design wherein the risks have been minimized. All research must be conducted in accordance with this approved submission.

This submission has received Expedited Review based on the applicable federal regulation.

Informed Consent: Please remember that informed consent is a process beginning with a description of the study and insurance of participant understanding followed by a signed consent form. Informed consent must continue throughout the study via a dialogue between the researcher and research participant. **NOTE: You must use the electronically stamped informed consent document that has been uploaded into IRBNet.**

Reporting of Problems: All SERIOUS and UNEXPECTED adverse events must be reported. Any problems involving risk to subjects or others, injury or other adverse effects experienced by subjects, and incidents of noncompliance must be reported to the IRB Chairperson or Vice Chairperson via phone or e-mail immediately. Additionally, you must submit Form F electronically to the IRB through IRBNet within 5 working days after first awareness of the problem.

Please note that any revision to previously approved materials must be approved by the IRB prior to initiation. Please use the appropriate revision forms for this procedure.

Modifications: Any modifications to this proposed study or to the informed consent form will need to be submitted using Form D for review and approval by the IRB prior to implementation.

Please note that all research records must be retained for a minimum of three years. If those research records involve health information, those records must be retained for a minimum of six years.

If you have any questions, please contact Dr. Anne Foster within IRBNet by clicking on the study title on the "My Projects" screen and the "Send Project Mail" button on the left side of the "New Project Message" screen. I wish you well in completing your study.

UCM Approval

UNIVERSITY OF CENTRAL MISSOURI

Approved 4/16/2019
Expiration 4/16/2020

Human Subjects Committee
Warrensburg, MO 64093
ResearchReview@ucmo.edu
(660) 543-8562

KU Approval

Active

Entered IRB: 4/19/2019 3:56 PM
Initial approval: 4/19/2019
Initial effective: 4/19/2019
Effective: 4/19/2019
Approval end: 4/21/2022
Last updated: 4/19/2019 4:10 PM

SITE00000449: Assignment Quality Conveyance

Principal investigator: Heather McCain
Submission type: IRB Site
Primary contact: Heather McCain
PI proxies:
Institution: Indiana State University

IRB office: KU Lawrence
IRB coordinator: Alyssa Haase
External study ID: