AN ABSTRACT OF THE THESIS OF

Allyson Jo Ironside for the degree of Master of Science in Civil Engineering presented on December 6, 2017.

Title: An Exploration of Faculty Sensemaking in the Adoption of Course Social and Cognitive Engagement (CSCE) Surveys.

Abstract approved:

_____

Shane A. Brown

The work of engineering education researchers has resulted in the development of research-based instructional strategies (RBISs) aimed at providing educators with means to increase student learning. Research has shown that there is a disconnect between the development of RBISs and their use by educators. Means to make new practices more accessible to educators include the development of tools that allow educators to assess their progress towards incorporating RBISs in their classroom. The ways in which these tools are developed have shown to play an important role in their usefulness: tools developed with faculty input tend towards greater adoptability.

The work of this thesis focuses on the development of a survey tool intended to assist educators in their assessment of student engagement, with engagement being a foundational principle of RBISs. This work is described in two manuscripts. The first manuscript addresses the first deployment of our survey, presenting thoughts of faculty as they learned about the instrument. The second manuscript employs sensemaking as a means of describing faculty perceptions of student engagement and a survey to measure it. Cumulatively, 24 faculty participated in this study. Each faculty member participated in a semi-structured interview prior to deploying the survey in their course. Interviews were transcribed and coded for analysis.

Our work shows that faculty saw student engagement as important, were willing to implement a survey created by engineering education researchers, and exhibited interest in using a measurement tool to inform their teaching practices. Concerns faculty had regarding the survey were generally regarding length and/or applicability to their classroom. Overall, the ongoing nature of this work played an important role in the continual development and modification of our survey, with the later version of the survey generating more positive faculty perceptions.

An Exploration of Faculty Sensemaking in the Adoption of Course Social and Cognitive Engagement (CSCE) Surveys

by
Allyson Jo Ironside

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Science

Presented December 6, 2017
Commencement June 2018

Master of Science thesis of Allyson Jo Ironside presented on December 6, 2017

APPROVED:

Major Professor, representing Civil Engineering

Head of the School of Civil and Construction Engineering

Dean of the Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

Allyson Jo Ironside, Author

ACKNOWLEDGEMENTS

I would like to express sincere appreciation to my advisor, Dr. Shane Brown, for the significant amount of time, guidance, and support he has provided throughout this process. I also want to thank Dr. Jack Istok, Dr. Kathleen Quardokus Fisher, and Dr. Mike Bailey for serving as my committee members. In addition, I want to acknowledge the following co-authors of these two papers and the entire National Science Foundation PRIME team whose guidance and assistance made this project possible: Shane Brown, Nichole Pitterson, Kathleen Quardokus Fisher, Sean Gestson, Denise Simmons, Olusola Adesope, Natasha Perova-Mello, and Ben Lutz. Another thanks to my friends and fellow engineering education graduate students whose support and encouragement helped motivate me to complete this project. A special shout out to my friend Greta who, despite knowing nothing about engineering education, read the entire thesis. And also to my boyfriend Zach who sat by my side until I finally completed the document. Finally, I would like to thank my family for their motivating me to finish the project.

In addition, this material is based in part upon work supported by the National Science Foundation under grant DGE-1544182. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CONTRIBUTION OF AUTHORS

Allyson Jo Ironside was the primary data collector and analyzer for the work conducted in this research. The majority of the writings in this thesis are her original work. Dr. Shane A. Brown assisted in writing, organizing, and editing of the manuscripts presented in Chapters 2 and 3. Nicole P. Pitterson aided in writing the Introduction, Background, Method, and Results sections of Chapter 2. Kathleen Quardokus Fisher assisted in the review of Chapter 2 and the editing of Chapter 3. Sean Lyle Gestson, Denise Rutledge Simmons, and Olusola Adesope reviewed Chapter 2. Benjamin Lutz and Natasha Perova-Mello provided feedback throughout data analysis and writing for Chapter 3. Brown, Pitterson, Fisher, Simmons, Adesope, and Lutz also all served as members of the PRIME team, providing feedback and direction for the overall project.

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Continued)

LIST OF TABLES

Table Page

CHAPTER 1 — INTRODUCTION

1.1 Research Context

Research-based instructional strategies (RBISs) are one way in which the research of engineering educators intersects with faculty; these strategies are intended to provide faulty with knowledge they can use to shape engineering students towards the type of practitioner the world needs [1]–[3]. Despite their development, the use of RBISs in the classroom has been limited or at best lagging behind the research [4]. One reason posited for this limited and lagging use is the lack of faculty input as RBISs are developed and deployed in classroom contexts [5], [6]. To address this concern, various development models make ways for faculty perspectives and needs to shape innovations.

Innovations, and RBISs as a whole, largely center around student engagement. Research has shown active engagement to be an essential aspect of meaningful learning [7] and a key factor in increasing student performance [8]. While there is widespread agreement on the importance of increasing student engagement through active learning, there is a lack of tools being developed to allow teachers to measure student engagement. A key factor in the development of tools related to engagement is defining what we mean by "engagement". Fredricks, Bloomfield, and Paris conducted foundational work in defining engagement by identifying three engagement types: behavioral, social, and cognitive [9]. Further work has resulted in robust definitions surrounding these types of engagement. Chi and Wylie have done notable work on defining cognitive engagement, developing the ICAP framework to link overt behaviors to cognitive states. [10]. Despite introductory theoretical work by Chi and Wylie and others, tools measuring student engagement remain scarce.

This thesis presents the development of a set of tools for measuring the engagement of students. These tools were developed alongside faculty, with their feedback playing an important role in the evolution of the survey. To guide the collection and interpretation of this feedback throughout the study, a sensemaking framework was used. Sensemaking, as defined by Weick, is creating a set of ideas based in probable

explanation [11]. As individuals experience a shift in the norm or expected, sensemaking helps explain their actions. In this work, the introduction of faculty to the survey measuring engagement and its potential use in their course caused a shift in the expected. Their actions, important for understanding the usability and ultimate adoptability, were understood through sensemaking.

1.2 Project Background

Though the use and adoption of a survey is the focus of the work presented here, it is important to note this study was situated as a part of a larger study seeking to supply faculty with an innovative tool to allow them to understand the behavioral and social engagement of their students. This larger project, TEAM PASS (Collaborative Research: Tool of EngAgement Measurement to Propel Academic Success of Students) remains ongoing. Supporting research for the TEAM PASS project was conducted and managed by the PRIME (Promoting Research and Innovation in Methodologies for Evaluation) team, consisting of approximately eight members. The tools developed to accomplish engagement measurement are known as the CSCE (Course Social and Cognitive Engagement) survey(s).

Several iterations of the CSCE surveys have been developed by the PRIME team, and are the subject of the work presented here. The first version of this survey used in-class cognitive engagement, out-of-class cognitive engagement, in-class social engagement, and out-of-class social engagement as the framework for understanding student engagement. **Chapter 2** addresses faculty perceptions and feedback of this original instrument.

This framework was modified based on the results of **Chapter 2** to use several shorter surveys, with separate surveys targeting in-class cognitive, out-of-class cognitive, and all social engagement. Several shorter surveys aimed to increase student participation by decreasing their time and intellectual demand for a single survey. **Chapter 3** focuses on faculty interpretation of one of these tools, the ICCE (In-Class Cognitive Engagement) survey

1.3 Organization of the Thesis

Chapter 1 of this thesis is intended to introduce the background, context, and purpose of the cumulative effort of two publications. The work presented in the body of this thesis is organized chronologically, with subsequent work building upon the prior. Peer-review is required for both publications. **Chapter 2** is a conference proceedings from the ASEE 2017 Annual Conference [12]. The paper was submitted as a Work-In-Progress to the Engineering Research Methods division. **Chapter 3** is a publication pending submittal to the International Journal of Engineering Education (IJEE). Work in **Chapter 3** incorporates and builds on the work of **Chapter 2**, with a focus solely on in-class engagement. **Chapter 4** concludes this work by positioning findings within the overall project evolution and relevance to future work.

1.4 Purpose of Research

This thesis presents two manuscripts with purposes that build upon one another. The purpose of **Chapter 2** addresses the larger project's aim to develop an instrument that measures students' social and cognitive engagement with a course through the exploration of the sensemaking processes faculty. These sensemaking processes are centered around the choice to adapt and adopt the CSCE survey. Additionally, the purpose is to investigate how engaging faculty in the process of developing and using the survey impacts the overall ability of the instrument to meet the needs of current and future users. In **Chapter 3** the purpose of the study is to explore faculty perceptions surrounding the potential adoption of a research-based survey instrument, the ICCE survey. Sensemaking and its core properties are foundational to accomplishing of this purpose, as they provide the framework in which faculty perceptions on in-class engagement, measurement of student engagement, and the ICCE survey are described. The purpose of **Chapter 2** includes the development CSCE survey(s) into tools useful and adoptable by faculty; **Chapter 3** takes a more nuanced approach, focusing on understanding better the journeys taken by faculty as they are presented with a classroom survey, and how that process might inform survey developers seeking to meet their needs.

In a greater sense, the overarching purpose of this research is twofold: a) develop an adoptable survey which allows faculty to measure the engagement of their students and b) use and document innovative development models that contribute to the literature conversation regarding the adoption of classroom measurement tools that can support the adoption of RBISs into engineering classrooms. To accomplish this, the work presented in this thesis shows an evolution of both a project and a framework. It was observed in **Chapter 2** that faculty sensemaking of the complex original CSCE instrument was often lacking in depth and connectivity. To ensure rich data on faculty sensemaking of both engagement as a construct and the newly-developed ICCE instrument, **Chapter 3** refined the scope to focus on in-class student engagement. Analysis in **Chapter 3** study focused solely on data related to faculty perceptions on in-class engagement of students, and the ability of the ICCE instrument to assess said engagement.

CHAPTER 2 — INCORPORATING FACULTY SENSEMAKING IN THE IMPLEMENTATION AND MODIFICATION OF AN INSTRUMENT TO MEASURE SOCIAL AND COGNITIVE ENGAGEMENT

Allyson Jo Ironside, Nicole P. Pitterson, Shane A. Brown, Kathleen Quardokus Fisher, Sean Lyle Gestson, Denise Rutledge Simmons, Olusola Adesope

2017 ASEE Annual Conference & Exposition, Columbus, Ohio
1818 N Street, N.W., Suite 600
Washington, DC 20036-2479
Published: June 24, 2017

2.1 Abstract

Over the last decade, numerous calls for change in the engineering curriculum and content delivery have been made. Following these recommendations, the field of engineering education saw research on the development and implementation of several learning innovation and instructional practices. However, while there has been extensive research examining barriers and affordances to the adoption of teaching practices and curriculum, much less work has been done on assessment instruments. In addition, research highlights a general resistance on the part of faculty members when it comes to adopting new practices. This resistance often stems from faculty feeling as though their input was not solicited during the development of these innovations.

As part of a larger study to develop an instrument that measures students' social and cognitive engagement with a course, this work seeks to explore the sensemaking processes faculty undertake when they choose to adapt and adopt the aforementioned instrument. In addition, we seek to investigate how engaging faculty in the process of developing and using the instrument impacts the overall ability of the instrument to meet the needs of current and future users.

A group of engineering faculty at a pacific northwest institution participated in this study through interviews and survey implementation in their course. Data were collected through three interviews. First, faculty were interviewed to understand their motivation in using our survey and their perception of its benefits. A second interview followed, using the instrument items as a guide, to determine how faculty made sense of the survey items in relation to their course and their students. In a final interview, faculty were given the opportunity to select results they wished to view thereby eliminating questions from the dataset that they deemed outside of their needs or interests. Faculty were also asked what parts of the survey they would like changed and why.

This study demonstrated how feedback from faculty, as it relates to the usability of the instrument and recommendations for improvement, impacted the evolution of

the social and cognitive engagement instrument. In addition, this approach allowed for an understanding of how the adoption of the instrument emerged through faculty input.

Engaging faculty in the process of developing educational initiatives is an important aspect of fostering change. Most importantly, understanding faculty perspectives can guide current and future development efforts of our instrument. Future research will investigate the role of the instrument and student data on teachers' decisions to modify their teaching practices.

2.1 Introduction

The field of engineering education grew out of the need to increase research scholarship on educational issues specific to engineering. Over the last decade educators and researchers have engaged in the conversation about what it means to be an engineer and what educational and curriculum reformations are necessary to produce the type of engineer the world needs [1]–[3]. To this end, engineering education research has sought to highlight the importance of intentional instructional strategies, educational innovations and their ability to evaluate the effectiveness of these approaches on student learning. This led to increased calls for the use and creation of active learning environments to ensure student engagement and knowledge retention. Active learning researchers [13]–[15] posit that students learn more and are better able to transfer knowledge of key concepts when they are actively involved in the learning process. Based on their recommendations, educators have often felt the need to make significant changes to their courses with the aim of actively engaging students. However, amidst the growth of research on student engagement there is no reliable instrument designed to assess student engagement in an effort to explore how and why students engage with course materials.

The Course Social and Cognitive Engagement (CSCE) survey was designed to assess students' in- and out-of-class cognitive and social engagement while completing learning activities associated with a particular course. In an effort to determine instrument reliability and validity, a pilot study of the instrument was conducted in

partnership with faculty participants. While the overall goal was to have these faculty participants agree to distributing the survey to their students, the researchers saw a fruitful opportunity to engage faculty input beyond just sending their students a link to the survey. Consequently, an adoption study was designed to explore the motivation of faculty members and their perception of the CSCE survey.

Since previous research suggests that simply developing materials and demonstrating their effectiveness will not result in widespread adoption [16], a subset of the research team was dedicated to engage faculty to go beyond the passive role of dissemination and participate in the active role of propagation. To serve as a guide for engagement with faculty, the sensemaking framework was used. Sensemaking is defined broadly as developing a set of ideas based in plausible explanations [11]. Sensemaking is likely to occur when a current state of an initiative is different than the expected state [17]. In this study, a noticeable difference was seen in the current state of faculty evaluation (or lack of evaluation) of student engagement through their own means and the expected state of faculty evaluation of student engagement through the provided survey instrument. With this framework as a guide, the research team sought to involve faculty in the multi-phased sensemaking process of survey adoption. This process included faculty being introduced to the research study, previewing and interpreting survey items before distributing the survey to their students and discussing results with the researchers. This resulted in faculty discussing their initial interest in using the instrument and what perceived benefits educational surveys of this nature can have for their overall professional and personal development. In each interview, the researchers used open-ended, semi-structured interview protocols to highlight areas of faculty sensemaking. While the survey itself was meant to measure students' self-reported levels of cognitive and social engagement, the purpose of this particular study was to explore how and why faculty chose to adapt and adopt versions of this survey to measure engagement in their respective courses. The goal of this pilot study was to provide researchers with valuable information about the usefulness of our survey in measuring the cognitive and social engagement constructs. Additionally, this work was meant to showcase the importance incorporating faculty input in the development of educational innovations.

2.3 Background

Research on the use of evidence-based instructional practices in engineering classrooms and their benefits in promoting learning and student engagement is not a new concept. In 2005, Smith and colleagues reported "in the past twenty years engineering educators have implemented several means of better engaging their undergraduate students" [7]. These authors discussed that "educators, researchers and policy makers have advocated student involvement for some time as an essential aspect of meaningful learning" [7]. On the heels of the critique of traditional approaches to teaching and learning came the movement towards student engagement and active learning in engineering classrooms. Studies focused on approaches such as cooperative learning, problem and project based learning, learning communities and service learning sought to support the idea of increasing student engagement [14], [18]. In addition, engineering educators recommended specific changes be made to the engineering curriculum to reflect the importance of actively engaging students [19]. However, despite various studies on this issue "the engineering curriculum has been slow to respond" [4, p. 286]. Some scholars [20] attributed this slow response in curriculum reform to resistance of change initiatives on the part of faculty and other educational administrators.

One reason change researchers posit that change initiatives are often met with resistance from faculty was because the development and testing of instructional innovations usually occur with little to no faculty input [6], [20], [21]. Yet, it is usually an expectation that faculty should not only be competent in executing these initiatives but should be invested in their success. There often exists built in "assumptions that the faculty will be convinced to use these new instructional materials and strategies once they are shown data demonstrating that these new methods produce improved student learning compared to more traditional instructional approaches" [6].

Consequently, studies that engage future faculty users in the design phase of educational innovations are necessary. To this end, Lattuca [22] suggested the success of educational innovation or curriculum change is often affected by the motivation and instructional decisions of individual faculty members. It is also

faculty members' commitment and reception to the use of innovative instructional approaches to improve their teaching and student learning that fuels their desire to implement these approaches in their classrooms. Therefore, sensemaking is a core concept of interest. Faculty's sensemaking of the CSCE instrument provided researchers and developers with the opportunity to understand why faculty chose to participate in the study as well as their perception of the usefulness of the instrument.

In a nationwide study of the adoption of engineering education innovations, Borrego, Froyd and Hall [23] explored how seven engineering education innovations were used across the US. The seven innovations were student-active pedagogies, artifact dissection, curriculum-based engineering service-learning projects, interdisciplinary capstone design projects, summer bridge programs, learning communities or integrated curricula and design projects in the first-year engineering courses. The purpose of this work was "to understand and make recommendations to promote adoption of engineering education innovations with demonstrated value" [4, p. 186].

The authors surveyed engineering education department heads to assess how aware they were of these practices and how they use them in their respective departments. This study presented key recommendations that may serve as a guide for current and future adoption studies similar to this project. The recommendations were:

1. Adoption levels will be higher in situations where change agents focus on clients' needs over promoting adoption of a specific innovation.
2. Faculty members must be involved in adopting engineering education innovations.
3. Faculty are unmotivated to adopt engineering education innovations when they perceive that teaching innovation is marginalized in promotion and tenure considerations.
4. Faculty attitudes play an important role in peer willingness to adopt new pedagogies including active learning [23, p. 203].

These recommendations solidified the need to include faculty perception in the development and dissemination of educational innovations. In our study, we encouraged faculty to engage in reflection on their practice and on why a survey aimed at evaluating student engagement with their course was important. In addition, since our intent was to get faculty to implement our survey in their courses it was

necessary to first have faculty understand the purpose of the study and what the items on the survey are aimed at assessing. McKenna, Yalvac and Light [24] termed this approach as "collaborative reflection" (p. 17). Collaborative reflection encompasses the process by which researchers work directly with faculty to develop educational materials to improve faculty teaching and student learning by extension. While our survey items were drafted before engaging faculty, the sensemaking process used before and after implementing the survey allowed researchers to gauge faculty perception of the survey. Most importantly, the insights gathered from these faculty interviews helped to shape future modification of the instrument.

2.4 Method

Using a single case study with multiple embedded units design, five engineering faculty members participated in the multi-phase interview process in which their sensemaking of the CSCE survey instrument was studied. For this study, the case was the CSCE instrument with each faculty member serving as an individual unit of analysis. The courses taught by the faculty participants ranged from small (46 students) to large (over 200 students). The course structures were also different and included lectures, laboratories, workshops, and recitations (mandatory group problem solving sessions). In addition, the range of experience between faculty members encompassed first time instructors to others with over five years of teaching at the same institution.

2.4.1 Description of case

The CSCE instrument consists of two major sections. Section one is split into two main categories, in-class and out-of-class activities. In category one, students are expected to answer questions directed at gathering information about their in-class activities. Similarly, in category two, items are focused on students out-class-activities. The in-class and out-of-class items are measured using a descriptive scale based on the work of Beach and colleagues [25]. Additionally, for both categories, students are also asked to rate their level of concentration on a scale of zero to four with none (not thinking at all about the content/activity) being zero to high (intensely thinking about the content/activity) being four. In section two, items are designed to capture students'

social engagement with their instructional team (instructor and/or teaching assistants) and peers both inside and outside of the classroom. The survey was designed using two broad frameworks, section one aimed at measuring cognitive engagement was designed based on the Interactive Constructive Active Passive framework (ICAP) created by Chi [10], [26] while section two aimed at measuring social engagement was guided by the social capital framework [27].

2.4.2 Sensemaking framework

The sensemaking framework used to guide this study, grounded in the work of Weick [11], [17] focuses on how meaning is created based on one's perception. This framework consists of seven core properties:

1. **Identity** –how people view themselves within a given context and how this view shapes how they enact or interpret events in that context.
2. **Retrospection** – a necessary facet of sensemaking in that it is through the process of reflecting on a particular concept or event people make sense of what happened or their role in the event.
3. **Enactmen**t –one's ability to assume responsibility to construct and participate in their environment at the same time.
4. **Social** –sensemaking is an individual as well as social activity. As people interact with their environment, they must navigate their roles and are held accountable for any related action as a result of such.
5. **Ongoing** –sensemaking is a continuous loop that is never ending. There is no beginning nor end. Consequently, each new situation provides a stimulus that challenges or affects the process of making sense.
6. **Extraction of cues** – as people make sense of their actions within a particular context, they also extract necessary information from the context to assist in determining the relevance and appropriateness of the explanation.
7. **Plausibility over accuracy** –people tend to rationalize what they are doing or have done. To this end, sensemaking is focused on, and more receptive to, information that is capable of creating "plausible images that rationalize what people are doing" [17, p. 410]

In this study, the seven properties of sensemaking and the overall framework were used to facilitate the development of the interview protocols. The interviews, discussed next, followed a three-phase process in which faculty were prompted to make sense of the research project, the items on the survey, and finally the survey results.

2.4.2.1 Phase 1 – Sensemaking of research project

In the initial interviews, faculty were asked to describe the structure of their course and how they were selected to be the instructor. Questions were geared towards understanding the sense faculty had made of their potential participation in the study. This initial, loosely structured interview served to build rapport, mark the starting position of faculty prior to interaction with the survey, and establish a time in which the survey instrument could be discussed. The following are examples of questions faculty were asked:

a. When you were asked to participate, what was your understanding of what your participation would look like?
b. What is motivating you to use the survey this term?
c. What are you hoping to get out of implementing our survey?
d. What role do you see this type of survey having in your class?
e. Do you see assessment of student engagement having a purpose or impact on you as an educator?

Interviews were recorded and transcribed, with data gathered informing the second series of interviews.

2.4.2.2 Phase 2 – Sensemaking of survey items

In the second set of interviews, which occurred approximately a week later in most instances, faculty members were presented with a preview version of the survey. The preview version was electronically formatted in Qualtrics and was the exact version of the survey their students would be given following the interview. In most instances the interviewer presented and progressed through the survey on a laptop while the faculty member observed. The survey was approximated by the research team to take 35 minutes for students to complete. However, faculty spent significantly less time in going through the survey, often not taking time to read individual questions presented within question banks, as well as eliminating self-evaluation time necessary for student response. Various functional elements of the survey were brought to the attention of the faculty including the survey's skip function when particular questions were answered negatively and items requiring free response. The format of the interview followed that of cognitive interviewing in which faculty were encouraged to explain their understanding of each item. Cognitive interviewing is an important

step in survey development as this type of interviewing helps researchers to evaluate participants' interpretation of the quality of survey items and their ability to measure the intended construct(s). In keeping with the sensemaking framework, this phase of interviewing was aimed at validating the items on the survey from the perspective of faculty who would be future implementers of the instrument. Also, using the cognitive interviewing approach along with probing questions to explore faculty sensemaking played a vital role in ensuring our survey was adaptable to the needs of the current participants. Faculty were asked to give overall impressions of the survey, with follow up probing targeted at understanding perceptions of individual questions. Methods of survey distribution and promotion were discussed, finally faculty were asked to provide their students with the link to the survey in the coming week. The following are examples of questions faculty were asked:

a. What aspects of the survey stand out to you?
b. For what question(s) in the survey are you most interested in student response(s)?
c. Are there aspects of the survey that you think are more important or relevant to you/the way you teach/your course content?
d. Do you have any reservations about using this survey in your class?
e. Do you foresee students using this survey in a way that will provide useful feedback to you?

2.4.2.3 Phase 3 – Sensemaking of survey results

Due to low survey completion, the third interview was modified to incorporate assisting faculty to understand specifically the information they hoped to gain from the survey as was discussed in the first interview. This is discussed later in the results section. The interview was aimed at the generation of a specialized version of results for each faculty member. Towards this end, each faculty member was presented with a new print version of the survey. The print version of the survey presented each question in a condensed fashion (answer options were not present and questions using multiple scales were presented only once). Faculty were asked to look through each individual question bank and to select which results they would be interested in seeing.

Questions were targeted at understanding not just results of the current survey, but

how the survey could be implemented again in a future section of their course. This involved the potential removal of questions faculty deemed irrelevant or inapplicable to their classroom. The following are examples of questions faculty were asked:

a. After using this survey, do you think there is purpose or impact in assessing of student engagement having on you as an educator?
b. Would you share anything you learned through this survey with coworkers or others?
c. Would you recommend the survey to coworkers? Why or why not?
d. What questions remain for you about engagement of your students?
e. If you could change this survey, what changes would you make?

2.5 Results and Discussion

One hundred sixty-two (162) students participated in the study, of which only 47 completed the survey. The limited number of students participating in the study and the large volume of questions in the survey generated difficulty in presenting results through traditional practices such as distribution graphs and summary statistics. Consequently, response data were limited in spread across a large volume of questions. Based on interactions in previous interviews, it was concluded that it was unlikely faculty would want to see results for each question on the survey—some had more relevance to their course structure, their beliefs on their role in generating engagement, etc.—and would likely forgo sensemaking of a large body of results.

2.5.1 Faculty perception of research project

All five faculty members expressed an interest in the survey and were eager to implement within their courses. The main reason given for their interest in using the survey, even though all admitted they have never used an educational survey before, was being able to reach their students and by extension do a better job at teaching. Some faculty also discussed at length their desire to "mix things up a bit" in their class hence their interest in being able to assess student engagement. The following are quotes from the five participants when asked why they were interested in implementing the survey in their courses (pseudonyms assigned by researchers):

> *I think this will be a great term to use something like this because I feel like I'm doing the worst job I've ever done at teaching this class, so it'll probably be a good one…Usually I feel pretty good. This has just not been a good quarter. I don't know if I've got too much going on or what's happened, and then I had a family emergency…I just haven't been able to get caught up, and so I don't feel like I'm doing a very good job with engagement or with anything, because I don't feel like my normal self this quarter – Janet*

> *I'm really interested in learning more about how my students learn. What works for them, what doesn't. Selfish really. But if they do well on the tests, I get to have a weekend. It's true, unfortunately. I care deeply about their learning, too, but that's a nice benefit – Kevin*

> *I am an instructor by choice, and I say that because it's an interesting thing ... Well, whatever. Rather than going there, I want to teach. I like to teach, and I would be happy to be better at it – Kurt*

> *In general, I'm happy to help advance engineering education in any way that I can, as long as it doesn't take too much of my time right now since that's not my main function – Nancy*

> *I don't have a lot of experience teaching. I am interested in learning how to become more effective at teaching and making it more effective for the students to learn. I've gone to some workshops. I'm really interested in trying to embrace and implement some of these new ideas. You know effective active learning or just new teaching pedagogies. How to take the same material, but deliver it in a different way or maybe get the students more engaged. I just want learn – Thomas*

Based on their desire to assess student engagement, faculty members expressed interest in particular portions of the survey both when discussing survey implementation and results. In the second interview faculty members spoke at length about most of the questions and based on the design of their course, decided what items were not of interest to them. For example, in the quote below, Nancy discussed the lack of exams in her course hence the questions related to exams would not be relevant to her students.

> *I mean in some ways for this course you can take out the exam part. I mean I give them two quizzes but there's not like exams, there not as technically hard or long or any of that – Nancy*

In similar fashion, Kurt highlighted, on a printed version of the survey that was

returned to the researchers, all the items that he believed would not be applicable to his students and represented activities he was not interested in learning about. On this same issue, some faculty members differed on whether the in the in-class or out of class items of the survey would be most beneficial to their developments as teachers.

> *The in-class stuff maybe isn't so interesting to me. The out of class, what they're actually doing to study, is really relevant, but I'm not sure about the in-class stuff for my particular class. I wouldn't say it's not useful, but for me it's probably not so helpful –Kevin*

> *Okay. Yeah. I'm very curious about the in class. That's most important to me is what is meaningful to them in class. I have no idea if anything I'm doing is getting through to them. I don't know – Thomas.*

When discussing the implementation, some faculty members expressed their desire that the survey be modified to use language representative of their course.

> *The only other thing is some of these to me, I guess what you're getting at is thinking about ... Because when I work on lab projects in a group moderate, thinking about the course content. This just seems kind of confusing on what it's asking me to answer within those on the Likert scale. That was the only other thing that I'm kind of going, I don't know what I would select – Janet*

Others expressed confusion about the relevance of certain questions or entire sections of the survey to their ability to increase engagement in their classroom. On the flip side, one faculty member raised the point of how group work might be perceived differently in her course. She felt that because there is the perception on the part of the student that they would be penalized for cheating if their codes were too similar this restricted how students engaged in a group.

> *You know what's interesting, I don't see anything on here ... with the working in groups, something that might be kind of interesting to ask them if they ... I don't see anything about cheating. I encourage them to talk to their peers, but they can't code it right beside their peers or do things like that because then I'm going to flag them for cheating because if their program is more than 70% alike from what somebody else's is in the class, I report them – Janet*

The lack of faculty sensemaking before the development of the survey calls for a

modification of the entire instrument. To allow for sensemaking of the entire instrument being implemented, we pose working with instructors to allow them to select portions of the survey they wished to use for their own purposes and further giving them the ability to make edits to individual questions. An instrument modified individually by instructors would work to ensure sensemaking occurs before implementation. This modification would also serve to advance sensemaking when instructors view results. It was observed instructors often were undergoing sensemaking of the instrument, detracting from sensemaking of the results with which they were being presented.

2.5.2 Faculty interest in survey benefit to students

Faculty sensemaking of the survey resulted in their seeing the potential benefit for both them as an educator and participating students. Faculty spoke of their interest in the survey not only providing feedback on classroom engagement, but for use as a tool to compel students towards engagement.

> *I'm very curious to know what the students do. I knew what I was like when I was a student and I know what I was like, I'm curious to see where my mode of operation fallson the spectrum of what students like to do. I wish I had a sensor... I figure there's a lot of students that like to do their homework as a group. They come together and are like, "Let's do the homework together." As a student I hated that – Thomas*

One faculty member wished to use the survey to gather data on the success of students who exhibited engagement in the course. This faculty member sought to replace folkloric stories linking engagement to success with actual data. As this was not part of its original intent, significant modification would be required of the instrument to meet this need. However, each faculty member was asked to provide questions they had about engagement and student success, so the viability of incorporating them in a future version of the survey could be addressed.

2.5.3 Faculty perception of survey items

Low response rates, with even lower completion rates, echoed a primary concern of faculty members—the approximate 35-minute response time of the survey would

deter students from taking and completing the survey.

> *I'm worried when you're talking about freshman and they see they have to do something for 35 minutes, they're going to be like, I'm not doing this. A 10-minute survey I could see them participating in, but a 35-minute survey, this seems very long and many of them don't even do evaluations and things and there's not nearly this amount of questions on there, right? – Janet*
>
> *35 minutes is like, that is a lot of time. They've been pretty much working all day, or they have a job. If you can get that to 10 minutes – Thomas*
>
> *I think you'd get a lot better response rate. That's one of the reasons I wanted to see how many responses you've got. I'm curious if anyone's even done it, much less if it's 10 minutes, or 5, or 20 – Kevin*
>
> *No, that seems long. 35 minutes seems like a long time – Nancy*

Faculty likewise expressed concern over incomplete representation of student cognitive and social engagement in the classroom. It was of primary concern to many faculty members that the survey be representative of their class constituents. In addition, faculty members discussed the pros and cons of offering some form of incentive for the survey; pros included increased data while cons included the discounting of those voices not motivated by the incentive. It became evident that as faculty made sense of the survey, they believed it appealed primarily to a particular constituent of students (those compelled to go to great lengths to help others or those with great dissatisfaction in the course). The survey length was clearly foundational to this concern, so modifying the items on the survey to make the completion time shorter would coincide with faculty desires.

2.5.4 Current and future research

The third stage of interviews is still ongoing. So far one complete interview that has been conducted with Kurt whose sophomore-level course had the highest number of participants (86). Using a printed summary version of the survey, Kurt was able to eliminate several blocks of questions that were deemed irrelevant to his course. Questions eliminated included activities he does not enact in his course delivery as well as those perceived to be potentially ambiguous to his students. For example,

Kurt was uninterested almost entirely in the social engagement portion of the survey, stating its application to generating a more engaged classroom unclear. The only items related to social engagement he was interested in were students' social engagement with their instructor and teaching assistant. Kurt was also concerned about how the divide between lecture and recitation would be maintained. For instance, some items on the survey pertained to in-class activities, which are common for lecture periods, while some items labelled as out-of-class activities could, in Kurt's course, be interpreted as activities students would engage in during the recitation portion of the class. One prime example is a survey item that asks about students solving homework problems alone and/or in a group. Kurt discussed this as something his students often do during recitation which would still be interpreted as "in-class". This raised a very important and insightful issue for the developers of the survey. How will the survey adapt to courses that have paired lecture and recitation and/or lab portions as opposed to those courses that have lectures or lab sections only? This case demonstrates the importance of adoption studies during survey development.

The data for the other four faculty members are still pending distribution. Survey results are still being generated and will be presented in graphical format for the requested questions. For faculty who have data available, a follow-up interview will occur in which faculty can express the clarity of the results presented. Continued iterations of how results are presented are occurring.

In addition, interviews discussing survey results remain ongoing. From the one in-depth interview, mentioned earlier, the importance of working with instructors not only to modify the data they will receive from the survey in the previous term, but to develop a version of the survey that uniquely addresses their interests in engagement was discussed. For instructors who do not have significant data to view, this will be the sole focus of the third interview. Based on faculty suggestions, multiple versions of the survey will be created to only reflect the areas faculty are interested in studying about their particular course and/or students prior to survey distribution. Finally, as the project progresses, our goal is to increase the number of faculty cohorts and number of participating institutions.

CHAPTER 3 — AN ADOPTION STUDY OF THE COURSE SOCIAL AND COGNITIVE ENGAGEMENT (CSCE) SURVEYS: FACULTY SENSEMAKING OF STUDENT IN-CLASS ENGAGEMENT PRINCIPLES

Allyson Jo Ironside, Benjamin J. Lutz, Natasha Perova-Mello, Kathleen Quardokus Fisher, Shane A. Brown

International Journal of Engineering Education (IJEE)

Anticipated Submission: December 2017

3.1 Abstract

Engineering education researchers have developed research-based instructional strategies (RBISs) to increase teaching effectiveness and thereby student learning. To accomplish this, RBISs often try to improve student engagement in classroom activities through active learning. Concerns have been raised regarding the low and delayed rates at which RBISs are adopted. As implementations of RBISs require adaptations given the unique context of a classroom, various methods of developing RBISs work to mitigate adoption concerns. This study employs a unique, faculty-inclusive model in the development of a tool to measure the modes of student engagement foundational to RBISs. This tool, the In-Class Cognitive Engagement (ICCE) survey, offers educators insight on the engagement of students in their course.

This study addresses propagation of a survey instrument by allowing faculty perspective to inform the ongoing development and dissemination of the ICCE. Sensemaking was employed as the framework to engage faculty and better understand their unique classroom contexts. The purpose of this study is to explore faculty perceptions surrounding the potential adoption of a research-based survey instrument. To that end, we pose the question: *How are sensemaking's core properties described by faculty as they interact with the ICCE survey?*

We conducted interviews with faculty, who were presented the potential items and responses on the ICCE survey. Interviews were semi-structured and guided by the core properties of the sensemaking framework. Interview data were analyzed using these core properties to interpret how faculty perceived the ICCE survey.

Results were categorized by emergent themes in each of the sensemaking core properties. We found that as we interacted with faculty as co-developers, in forming their opinions of the ICCE survey, faculty tended to rely on a few of the sensemaking core properties. Faculty who relied on social, identity, enactment, and ongoing sensemaking properties often formed positive perceptions of the ICCE survey, and wished to implement it in their class as a result. Conversely, faculty that relied on other properties (retrospection, extraction of cues, and plausibility over accuracy) tended to

form negative perceptions of the ICCE survey and their willingness to implement it was limited.

These findings suggest that future research-based survey developers can utilize social, identity, and enactment core properties of sensemaking framework in their work to their advantage during propagation efforts. Developers should be mindful of how faculty retrospection (previous failing of a similar survey), extracted cues (language believed to have little meaning in a particular course context), etc., may influence faculty decision making. The inclusion of faculty as stakeholders in development was shown to be formative to their perceptions of an instrument related to RBISs. As faculty are expected to understand and implement RBISs, future work may wish to continue co-developing tools for measuring classroom environments alongside faculty.

Keywords: Adoption, Sensemaking Framework, Engagement

3.1 Introduction

There are a multitude of research-based instructional strategies (RBISs) that have been established in STEM Education. Some notable examples include active learning, classroom formative assessment, and project-based learning. And while significant effort has been expended to develop further and to implement RBISs in broad educational contexts, there remains a gap between the availability of RBISs and their implementation by engineering faculty in postsecondary classrooms [4]. Faculty must not only be competent in using educational innovations, but should be invested in their propagation to improve engineering education. However, research suggests faculty and educational administrators are often sources of resistance to change, in part because they are rarely included in the development process and testing phase of educational innovations [5], [6], [21]. Additionally, faculty as a whole cannot be seen as a homogenous decision-making group: Lattuca [22] suggests it is often faculty's *individual* motivations, decision-making processes, commitments, and reception surrounding innovations that propels them to make changes in their classes. Therefore, to understand faculty input, motivation, and decision-making, studies including

individualized faculty perceptions in the design phase of educational innovations are necessary.

Foundational to work regarding RBISs is the considerable attention to the design of interventions to enhance students' classroom engagement. In 2005, Smith et al. stated "in the past twenty years engineering educators have implemented several means of better engaging their undergraduate students", going on to say "educators, researchers and policy makers have advocated student involvement for some time as an essential aspect of meaningful learning" [7, p. 87]. In a study comparing traditional lecture classes to those including newer active-learning strategies, Freeman et al. found that "active learning increases examination performance by just under half a standard deviation and that lecturing increased failure rates by 55%" [8, p. 8412]. Beyond student performance, Chi and Wylie posit that the in-class behavior of students is indicative of their cognitive engagement, and thereby complex understanding of the material [10]. The critique of traditional approaches to teaching and learning motivated movement towards student engagement and active learning in engineering classrooms. This movement is evident in studies of cooperative learning, problem and project based learning, service learning, and learning communities, emphasizing the importance of active engagement [14], [18].

The importance of active engagement by students to the effectiveness of RBISs has been well-established in the literature, yet both education and research communities lack tools to measure student engagement. Researchers Chi and Wylie suggest engagement can be operationalized in terms of overt behaviors in the classroom. They developed the ICAP framework as a means of defining the concept of "active" engagement. ICAP references four modes of engagement: Interactive, Constructive, Active, and Passive. This model predicts that higher levels of learning occur with higher modes on the hierarchical scale, i.e., Interactive > Constructive > Active > Passive [10]. A significant advantage of the ICAP framework, in particular, is that it links overt behaviors to unobservable cognitive states of engagement, thereby offering a more objective, empirically valid measure of student cognitive engagement. To date, however, the framework has been used primarily to advance discussions of theory.

Consequently, there are limited student survey-based methods to measure or distinguish between different levels of engagement in a classroom setting. To address these concerns, we have leveraged the ICAP framework to develop a set of survey instruments to measure modes of engagement.

This work is part of a larger project investigating the engagement of college students along cognitive and social dimensions, both in and out of class [12]. The study presented here focuses on the In-Class Cognitive Engagement (ICCE) survey. The goal of the ICCE instrument development process is to produce an instrument that is both valid and reliable, and, perhaps most importantly, adoptable by STEM faculty. Here, an adoptable survey is defined as a survey that faculty interpret as both *useable* given their classroom context and *useful* for understanding the cognitive engagement of their students. To address concerns of adoptability, faculty were actively involved in the development process of the instrument. Faculty participants were considered both stakeholders and co-creators, recruited not only to implement the ICCE survey in their courses, but also to discuss engagement and its measurement by using a survey of student cognitive engagement.

This study investigates experiences of individual faculty as both stakeholders and co-creators of the ICCE survey. A lens of sensemaking framework guided the interpretation of faculty perceptions. Broadly defined as developing a set of ideas based in plausible explanations [11], sensemaking occurs when a current experienced state is different than the expected state [17]. This discontinuity between the expected state and the current state is known as a *disruption*. In this study, the introduction of faculty to the ICCE survey served as a disruption to the expected state of their course. For example, faculty do not normally systematically consider how students are engaged in the classroom. In this case, the *expected state* is that classroom practice does not include measurement of student engagement. Participation in the ICCE survey development asked faculty to consider student engagement systematically. The *current state* causing *disruption* is the invitation and opportunity to measure student engagement in classroom practice. This discontinuity required faculty to make sense of the atypical experience. The seven core sensemaking properties, as defined by Weick, were used to

interpret the experiences of faculty with the ICCE survey and to offer insight into their perceptions related to its implementation in their course.

This study was designed to symbiotically meet the needs of researchers studying STEM education and faculty teaching in STEM classrooms. For researchers, identifying key factors related to the adoption of RBISs will help promote innovative and effective tool development techniques. For educators, understanding cognitive engagement of students is important to creating a more engaged classroom. In this case, the more educators know about their students, their classroom, and themselves, the more power they have to make positive shifts towards engagement and RBIS implementation. The purpose of this study is to explore faculty perceptions surrounding the potential adoption of a research-based survey instrument.

3.2 Literature Review

Central to this study is work surrounding both faculty adoption of RBISs and the lens of sensemaking framework. First, faculty adoption literature is discussed, including the current limitations of RBISs to transform undergraduate education that point to a need for faculty involvement in the development of tools for classroom use. Next, sensemaking is defined using seven core properties. The ways in which sensemaking has been used in the past as well as its applicability to the current study are presented.

3.2.1 Adoption

3.2.1.1 Adoption and Instructional Change

Faculty adoption of RBISs is a key component of positive educational change and innovation, yet remains a consistent challenge for researchers and educators. Recall that an *adoptable* instrument was defined as being both *useable* given classroom context and *useful* for understanding of students. Two bodies of literature inform the adoption of student measurement instruments. First, the field of change research investigates the dissemination of RBISs in postsecondary education. This body of literature has identified methods for developing an innovation that faculty will adopt within their context. In addition, classroom measurements researchers have studied faculty perceptions of previously developed student measurement tools (such as end-

of-term student evaluations). This body of literature explores the aspects of instruments that faculty find to be informative.

3.2.1.2 Adoption and Faculty Involvement

Henderson and Dancy claim "the biggest barrier to improving undergraduate STEM education is that we lack knowledge about how to effectively spread the use of currently available and tested research-based instructional ideas and strategies" [28]. These authors study the implementation of RBIS in STEM education contexts. Results of this work show that instructors are aware of RBISs, will claim to implement these strategies in their classroom, and generally show interest in incorporating RBISs into their teaching [29]. Despite knowledge, interest, and claims of implementation, additional work by Henderson and Dancy [30], [31] shows that this does not necessarily translate to effective use of these strategies. That is, faculty can be motivated to implement changes, but might not have the tools or skills needed to most effectively initiate and sustain those changes.

The most prevalent way of developing RBISs for classroom use employ a "one-size-fits-all" model, where all faculty are presumed to adopt practices in the same way. But at the same time, Hutchinson and Huberman suggest it is impossible to avoid the individualization of an instructional practice [32]. Bearing these concerns in mind, it is essential that instructors bear the knowledge, skill, and confidence to customize an RBIS to their own environment. Given that student engagement is often a core feature of these RBISs, the use of a student engagement measurement tool can help faculty assess the effectiveness of the customization of practices. Faculty can use this measurement to guide their implementations towards greater student engagement. Research efforts are needed to expand the use of existing RBISs through empowering faculty to make sense of them in their own context—including measurement of student engagement.

Work in STEM education supports user participation in the development process. For instance, Khatri and colleagues studied models of development for instructional strategies in physics. Their findings identify three key features of moving innovations towards sustained use: working alongside faculty in an iterative manner of

development, disseminating innovations in a way that allows for feedback, and providing support to those adopting innovations [16]. Additionally, Borrego, Froyd and Hall [33] explored key factors related to the successful adoption of education innovations in engineering. Their findings suggest adoption levels will be higher in situations where clients' needs are emphasized over promotion of a specific innovation. Such findings and others suggest faculty members must be involved in adopting engineering education innovations and their attitudes play an important role in peer willingness to adopt new pedagogies [33]. Particularly poignant for developers seeking to increase adoption is the importance of discovering and meeting faculty needs and including them in the development process. Faculty-centered development and implementation techniques can promote sustained use of instructional strategies. Furthermore, student measurement tool development can build upon these techniques for sustained use.

3.2.1.3 Adoption and Faculty Beliefs

RBIS adoption literature examined specifically the spread of innovations among faculty. Thus, to understand adoption of student measurement instruments, it is also important to consider how faculty interpret classroom surveys. While current research remains relatively sparse, it is nevertheless important to understand faculty response to student feedback measures currently used in their classrooms. Some work has been done in the realm of faculty's perception of student self-report reflections, primarily centered around Student Evaluations of Teaching (SETs). Findings indicate that faculty show a general concern over the reliability and validity of SETs [34]. SETs are seen by some as biased measures of teaching effectiveness, as faculty and student perspectives on what constitutes effective teaching may be different. Beyond faculty and student discrepancy, a lack of consensus seems apparent among developers as to the meaning of SET results [35], [36]. Faculty will be hesitant to make use of the feedback from students if they do not perceive the instrument as a valid measurement tool, in other words, as *useful* [37].

If faculty do attempt to measure student feedback and interpret it, without guidance on how to constructively make sense of the results, they are prone to misinterpretation

[38]. In the development of future student measurement instruments, it is important that similar pitfalls are avoided. Student measurement instruments need to be coherently designed, results made sense of alongside developers, and growth emphasized over performance and evaluation.

The inclusion of faculty in development of tools related to instructional strategies is an important model in need of further research. Research on change in instructional practices in STEM education have thus far focused on the response of educators to research on instructional strategies. Various alternative models of dissemination/propagation (proposed by Khatri and others) and successful adoption stories (seen with Borrego, Froyd and Hall) can be found in the literature. Yet, research is needed on the effectiveness of different models of educational development—that include faculty as stakeholders—of tools to measure RBISs in the classroom are generated.

3.2.2 Sensemaking

Karl E. Weick and Kathleen M. Sutcliffe present sensemaking as a means of understanding how individuals adjust to their ever-changing surroundings [17]. Organizations are the site of these authors' studies and the environment in which sensemakers are said to be situated. For this context, *organizations* are defined as the order and structure brought to human through negotiating particular meanings and rules [39]. The process of sensemaking is said to be ongoing and occurring continuously; as a sensemaker experiences the current state of the world to be different than the expected state of the world, or a way in which to engage the world is not obvious they are compelled to explain their actions [17]. The propelling force towards action is the dissonance between expectation and reality, a *disruption* for the sensemaker.

Importantly, individuals in an organization are said to undergo sensemaking on behalf of the larger unit, situating individual sensemakers as both actor and storyteller of events shifting an organization [11]. For example, consider a faculty member who is beginning to wonder how use of measurement tools in her classroom can inform her teaching. She may begin by considering how SETs can inform improvement in her

teaching strategies. In the past, her normal state was considering SETs as an evaluation that she reported to the department chair. Her normal is disturbed, and she begins to consider what parts of SETs can be used to change her teaching, and also begins to discuss SETs in this manner to her colleagues. In this way, she is both is undergoing sensemaking and telling others about her new perceptions. Her actions, set in the organization of the university, are representative of this unique climate.

Sensemaking relies on the premise that "action is always just a tiny bit ahead of cognition, meaning that we act our way into belated understanding" [11]. In other words, perhaps the disruption to the faculty of the above story was her chair deciding to question her on how she was going to change her teaching based on the feedback from last semester's SETs. She had not thought of them in this way before, instead she just was going to turn them in and forget about them. The chair's question took her off guard, and her response was to incorporate more example problems to address a common concern held by students. When asked why she made such changes, the faculty member might cite her chair's questioning, her desire for improvement in her teaching, and interest in incorporating student feedback. She could only come to an understanding after having taken action; a different action would have resulted in a different cognitive understanding.

To help describe the belated understanding resultant from action, Weick's sensemaking framework is broken into seven core properties: *identity, retrospection, enactment, social, ongoing, extraction of cues, and plausibility* [11]. **Table 1** summarizes the definitions of the core properties based on Weick's work.

Table 1. Definitions of the Sensemaking Core Properties

Core Property	*Operational Definition*
Identity	The utilization of relevant pieces of self, allowing one to bring to prominence an appropriate self to face the challenges of an environment.
Retrospection	The recollection and likening of past events to present circumstance. Seeing the past as causal and correlated to present outcomes and actions taken.
Enactment	The simultaneous construction and response of one to the environment. Shaping the environment to which they respond; the environment pushes back on the response of individuals.
Social	The negotiation of one's role in an environment based on the predicted, perceived, and physical response of others to their action.
Ongoing	The continuous, never ending loop of sensemaking with no beginning or end, resulting in each new situation acting as a stimulus that challenges or affects the process of making sense.
Extraction of Cues	The selection of pieces of information as the most meaningful in a given context, pointing towards a rational set of responses that give meaning to the larger whole.
Plausibility	The tendency of sensemakers to be less likely to follow a call to accuracy than a call to action that will lead more directly, quickly, or simply to a desirable outcome.

Core properties categorize the ways in which sensemakers make meaning of the action they themselves take. Continuing the example from above, we can see that respect for authority and improvement in teaching might be part of the faculty's identity. She may have used retrospection when she selected example problems as the means of addressing students' concerns; perhaps she recalled an event where she had tried to completely restructure her course and it had failed, but modifying small portions had been successful. Enactment showed up as she shaped her classroom environment, and then addressed the feedback resulting from this newly formed classroom. In her modified classroom environment, students seem to be lacking in theoretical background and it is resulting in lower test scores and poor SETs. She then makes changes based on this new environment she herself formed. The discussion that the faculty began with her colleagues helps explain her own actions. Maybe in her social work spheres there is a general value on betterment of teaching, and she wishes to conform to this value. She certainly did not make the decision on how to restructure her course based on an isolated feedback, rather the thoughts on how she structured her course in the past and how she hopes for it to be structured in the future remain ongoing. She extracted cues from her SETs that focused on example problems to help make

sense of her action to change that about her course. Finally, she really cannot be sure that these changes will result in higher SET scores or appease her chair, but this is deemed plausible and is therefore reason enough for her to take action even if her assumptions are inaccurate.

Though actions may be observable, it is the seven core properties that help describe the understanding of a sensemaker that leads to the observable actions. The application of the sensemaking framework is therefore particularly useful in settings where the understanding in support of action is of interest. Gonzales applied the sensemaking framework to understand faculty perceptions on mission creep of universities, specifically the shift in focus from a teaching institution to a "Tier One" research university [40]. The university's shifting goals provided a disruption, and Gonzales noted the stories of individual faculty's sensemaking. The results are useful for telling the story behind the observable action taken by faculty.

Though literature exists on the observable actions faculty take to make changes in their instructional practices, little is known about how they as individuals explain their actions. Sensemaking is an appropriate and fruitful framework to begin building knowledge of faculty perception and understanding of their actions. Being asked to think about the classroom in a new way is a disruption to normal faculty behavior, and sensemaking allows researchers to understand how faculty arrive at their new normal. Additionally, research related to changes in instructional practices showed that faculty must be involved and create a shared meaning of classroom innovations, while also building an understanding of these instruments and their usefulness. Faculty sensemaking of tools being developed for student measurement is important for understanding how faculty take a new idea and interpret an instrument as a tool they could use and adopt.

3.3 Methods

The purpose of this study is to explore faculty perceptions surrounding the potential adoption of a research-based survey instrument (i.e., the ICCE). The study is qualitative, to allow for the stories of individuals to emerge in the results. To guide us

to such an end, the following research question was asked: *How are sensemaking's core properties described by faculty as they interact with the ICCE survey?*

This study emerged out of the need to understand better the journey faculty undergo when asked to adopt a survey tool to operationalize in-class student engagement. Here, we use the seven core properties of sensemaking to describe the journey of faculty as they take action (agree to participate in our study and change their classroom norm) and make meaning (what the measurement of in-class engagement means in their context). Though adoption is the ultimate goal of the instrument development, it is important to note this study focuses on faculty sensemaking *leading up to adoption*. This was part of a larger study seeking to supply faculty with an innovative survey tool to allow them to understand better the cognitive and social engagement of their students, that can be used to assess RBIS. Though there are many different kinds and modes of engagement (e.g., cognitive, social, in-class, out-of-class), the present work is focused on cognitive engagement behaviors within classroom settings.

3.3.1 Engagement

Instruments informing faculty on student engagement in their classrooms, and thereby their success of RBIS implementation, rarely emerge from the research community. Foundational to tool development is an operational definition of what engagement means in the classroom. In seeking to develop a definition, the ICAP framework references four modes of engagement: *interactive, constructive, active, passive*. The framework is hierarchical, meaning interactive engagement is evidence of higher-oreder engagement and therefore deeper understanding than constructive engagement and so-on.

The framework is based on the overt behavior of students in classrooms of various domains. In the conclusion of their work, Chi and Wylie leave questions remaining on the cognitive engagement of students unaccounted for by overt behavior observations. Though the framework has been instrumental in advancing theoretical discussions surrounding student behaviors and resulting cognitive engagement, its application in empirical settings to date remains limited.

To address this limitation, the ICCE survey used in our study employed the ICAP framework to define modes of in-class cognitive engagement. Several questions were designed to address each mode of engagement. Each question was paired with a 5-point Likert scale ranging from "not at all descriptive of my in-class activity" to "very descriptive of my in-class activity". **Table 2** below provides examples of questions intended to correlate to a particular mode of engagement.

Table 2. Sample Survey Questions and Mapping to ICAP Framework

Mode of engagement	Sample Questions
I(nteractive)	I discuss my position with others regarding the course content.
	I evaluate alternatives with others when discussing course content.
C(onstructive)	I add my own notes to the notes provided by the lecturer.
	I compare and contrast lecture concepts to concepts from other courses.
A(ctive)	I copy solution steps verbatim.
	I apply current concepts being taught to previous course content.
P(assive)	I listen to what the teacher is saying and do not do anything else
	I think about current concepts covered in this course.

3.3.2 Data Collection

3.3.2.1 Sampling

Participants were initially targeted based on the large enrollment size of their course, frequently teaching lower-division required, or capstone-required courses. Utilizing convenience sampling, the majority of faculty initially recruited were known by the research team, either by personal encounter in a professional setting or work on a prior project. Snowball sampling [41] followed in subsequent rounds of recruitment. Snowball sampling provided the research team with additional access to faculty potentially open or interested in the measurement of student cognitive engagement, advancing both the adoption study and instrument validation. Recruitment occurred over three terms (one academic year). Initial contact was made with participants via email or in-person which included a request for faculty to distribute the ICCE to their current class(es) and participate in an interview. In this way participants played both the role of user (implementing the survey in their course) and developer (agreeing to

an interview in which they gave feedback on the instrument and the construct it was measuring). All participants who agreed to implement the survey also participated in the interview.

Sixteen of the 24 faculty participants had traditional classrooms consisting of lecture, lab and/or recitation periods. Recitation periods consisted primarily of small-group problem solving sessions while labs focused on application of course principles. Additionally, eight faculty described their courses as "flipped classrooms", meaning lecture periods consisting of problem solving sessions, and information transfer occurred outside of the classroom. Courses ranged in credit from 3 to 5 quarter-credit hours. Though our recruitment strategy intentionally targeted faculty in large-enrollment courses, snowball sampling introduced courses that were more varied in nature, including one low-enrollment graduate course.

In total, 24 faculty participated in the study, 18 of which chose to implement the survey in their course. One faculty implemented the survey all three terms of the study's duration, while two faculty implemented over two terms. One faculty member initially declined to implement the survey, but elected to implement it the following term based on modifications to the survey. Courses were taught by both instructors, whose primary institutional role is teaching, and research faculty, whose role spans teaching and research. Seventeen faculty taught at 4-year research institutions, four at 4-year teaching institutions, and three at 2-year teaching institutions. Faculty participated from all areas of STEM: eight from General Engineering; four from both Chemistry and Biology; three from Chemical Engineering; and one each from Computer Science, Civil Engineering, Environmental Engineering, Mathematics, and Physics.

3.3.2.2 Interview

Interviews were semi-structured, with structure ensuring faculty had the opportunity to discuss each core property and openness allowing for deeper inquiry into core properties relied upon by faculty for sensemaking. The semi-structured interview had two distinct topics of discussion. The interview occurred shortly after participants agreed to the study. In the first portion of the interview, faculty discussed the structure

of their course, their journey to teaching that course, and the roll of engagement in their teaching philosophy. The purpose of this phase was to gather information about the course while marking faculty's *expected state* as related to engagement.

After discussing engagement in general terms, the interview shifted to discuss engagement in terms of the ICCE instrument and its use in their course. To make this transition, the interviewer presented faculty with the ICAP framework as a means of discussing engagement in the classroom. Faculty were provided a brief overview of what the framework was and how it might be useful for understanding engagement in their classroom. Knowledge of the ICAP framework provided faculty with a foundational understanding of how the survey was developed and allowed them to provide meaningful input and feedback.

Following the discussion of the framework, faculty were shown the PDF version of the survey their students would take in Qualtrics [42]. When presented with the instrument, faculty were told how each mode of ICAP was addressed in four to ten questions. Questions prompted faculty to discuss what stood out to them and their overall perceptions of the instrument. Faculty directed their way through the survey, spending as little or as much time as they desired reading through individual questions. After faculty read through the survey, the interviewer asked questions to target both positive and negative perceptions of the survey and its usefulness to them as an educator. Interviews lasted between 20-45 minutes. The seven core properties of the sensemaking framework guided the analysis of the interviews. **Table 3** provides sample interview questions for each of the core properties.

Table 3. Sample Interview Questions and Mapping to Sensemaking Core Properties

Sensemaking Core Property	Sample Interview Question(s)
Identity ***(utilization of self)***	How did you come to teach the course this survey will be used in? What impact do you see the assessment of student engagement having on you as an educator?
Retrospection ***(connecting past to present)***	What was your motivation in agreeing to use the survey? Have you used an educational survey or participated in educational research before?
Enactment ***(interaction with environment)***	Are there aspects of the survey that you think are more important or relevant to you/the way you teach/your course content?
Social ***(interplay of self with others)***	What kind of communications have you had with coworkers or others regarding your decision to use the survey?
Ongoing ***(endless loop of making sense)***	What role do you see this type of survey having in your class?
Extraction of Cues ***(selection of information bits)***	What aspects of the survey stand out to you?
Plausibility ***(preference of action to accuracy)***	What are you hoping to get out of implementing our survey? Do you foresee students using this survey in a way that will provide useful feedback to you?

3.3.4 Data Analysis

In this study, faculty sensemaking was in the context of the academic institution. As educators made choices that led to their understanding of how student engagement and its measurement impacted them, sensemaking was used to capture the change in thought patterns. The site of sensemaking observation was interactions between faculty, researchers, and the survey instrument. The seven properties of sensemaking were used to develop data collection and analysis protocols.

All interviews were conducted by the lead author, and transcribed by a third party. Transcriptions were coded using Dedoose [43]. Deductive coding was used in the first phase of data analysis [44], with an applied codebook that used each sensemaking core property as a code. In the second phase of data analysis, the coded interviews were analyzed for emergent themes in each of the sensemaking core properties. These themes were intended to highlight salient aspects of faculty's sensemaking of the ICCE survey and student engagement in their classroom. Emergent themes allowed us to tell

the stories of many faculty and highlight organizational-wide perceptions while keeping individual nuances intact.

Data presented here do not include feedback on specific survey items, with the exception of *extraction of cues* findings. The stepped-back resolution allows for the presentation of broader findings that have a greater impact on shaping the overall trajectory of survey instrument development on other topics with different stakeholders, as opposed to the refinement of the specific ICCE instrument. Extraction of cues was an exception because the bits of information faculty identified were at fine-grained resolution, meaning they were directly related to the ICCE survey. This information was not only helpful in survey development, but is worth presenting as a representation of the types of cues a faculty may pick up on to form their perception of an instrument.

3.3.5 Credibility and Trustworthiness

Credibility is defined as the degree to which the findings provide an accurate representation of a phenomenon, and whether that representation is consistent with participants' experiences of it [45]. To this end, I, the lead author, worked extensively with the data to develop robust representations of participant's experience, and conducted research alongside a team of engineering education researchers who validated my methodology, results, and findings throughout the study. Faculty interviews were initially conducted with two engineering researchers. Following the interviews, researchers discussed key takeaways. Interview data were then coded in two phases. Two peer debriefing sessions [46] were held in each coding phase with researchers/coauthors who questioned methods, meanings, and interpretations until consensus was reached.

Trustworthiness is defined as the degree to which findings are represented honestly and evidence for such findings is sufficiently documented [44]. Important to this study was the way in which sensemaking's core properties honestly represented faculty's perceptions of engagement and the ICCE survey. To achieve this, definitions of the core properties were reformatted and operationalized for clarity and bounded meaning.

In peer debriefing sessions [46], coauthors reviewed and questioned the ways in which participant excerpts were used and explained throughout the results. Concerns were addressed and reviewed to ensure clarity and integrity of the findings.

3.4 Results

Results show faculty sensemaking process as related to the seven core properties by describing their perceptions of engagement and the use of the ICCE survey in their classroom. Results are presented by discussing how the seven core properties of sensemaking framework provide interpretation of faculty interactions with the instrument (their evaluation and adoption). The discussion of core properties is followed by an outlining of the most influential factors in faculty adoption.

3.4.1 Sensemaking Processes

An important aspect of this study is the development of an understanding of faculty perceptions leading them towards or away from implementation of the ICCE survey. Such an understanding will inform the potential for adoption of future instruments. By discussing each of the seven core sensemaking properties in turn, the following sections illustrate how faculty embark on a journey of sensemaking in response to the potential adoption of the ICCE survey. We present examples relating to each property, highlighting both the range of sensemaking processes faculty underwent and the salient factors influencing faculty perceptions and willingness to implement the instrument.

3.4.1.1 Identity (utilization of self)

Faculty focused on their involvement in STEM education and their research background when discussing their identity as it related to engagement. They frequently referenced their previous research, be it STEM education research or otherwise, when discussing their thoughts on the ICCE survey. For faculty with a STEM education research background, adoption of the instrument was seemingly a natural continuation of either contribution to the field or personal development as an educator. For those faculty who did not have a background in education research, a general interest in education research was seen:

> *Avery: I have **almost no experience with educational surveys and engineering education**. This is my third year to teach engineering. I've done some reading, and **I'm trying to learn about that field**, but it isn't my field.*

Avery notes that while she may not have had previous experience in the field, her desire was to further her understanding, in part through the adoption of the ICCE survey. Motivation to begin or continue to understand the field of STEM education and the best practices associated with it was driven by faculty identity as a teacher of students. Faculty felt that their work identity included the engagement of students in the classroom, and a willingness to learn what engagement might look like in their specific classroom. Riley stated "*I just see it as part of my job***"** when discussing embracing new pedagogies and surveying for student feedback.

Faculty communicated that the ability to teach, to understand their students, and to facilitate engagement, were all parts of their identity as an educator. Regardless of background, faculty expressed a desire to continue to improve their teaching. Faculty saw engagement as a pathway to improved teaching and had integrated engagement into their identity prior to interaction with the ICCE survey. Faculty were willing to look to those conducting STEM education research as a resource for tools to measure engagement and to their students as a resource for feedback on engagement.

3.4.1.2 Retrospection (connecting past to present)

Retrospection was expressed in faculty primarily through their recollection of past questions posed to students and past usage of class surveys. Faculty tended to recall events that illuminated how students made sense of words, phrases, or ideas. This retrospective process influenced how faculty believed students would interpret, and therefore respond, to different ICCE survey items. Retrospection often followed an extraction of a cue, bringing to mind a story or instance likened to the ICCE survey. As seen below, stories recalled often centered around mistakes or misinterpretations faculty hoped to avoid when adopting the ICCE survey in their classroom:

> *Kerry: It's a really minor thing, but the instructions, the wording... I don't know how to say it better, but I know that particularly students*

> *learning English as they go have a hard time understanding that…* ***I just thought of that because the final I just gave had some wording like that, and there was a line of people like, "What does this mean?"***

In the quote above, Kerry is referencing the language used in the survey instruction to students that indicated that all questions might not apply to them. Kerry likens the language used in the survey to a past event in which many of his students lacked comprehension due to language barriers. Of particular concern to Kerry was the potential limitation to those learning English. Sensemaking of the ICCE survey was influenced by this retrospective event, as concerns from the past incident were brought into the new context. Past concerns were brought to light through retrospection associated not just with wording used in the ICCE survey, but also usage of surveys as a whole:

> *Peyton: My understanding is that typically when we do these surveys* ***the students that we really most want to hear from are the ones that we very rarely do****, because they're often the ones that opt out on these surveys.* ***That's certainly been my experience as well***

Peyton brings up a concern from an experience with surveys in general, stating that the students most desired for feedback rarely provide it. In Peyton's mind, the results of the survey will come from the students from whom he does not need feedback. Concerns around survey usage, particularly associated with the constituent of students responding, was commonly observed, yet faculty concluded that on the whole students would use the survey in a way that would be useful to them.

Retrospection was influential in the sensemaking of the ICCE survey for faculty, particular in its tendency to generate negative perceptions. Past text presented to students in various coursework and past surveys used by students constituted the majority of retrospective occurrences in faculty. It was retrospection that brought clarity to both concerns and motivation faculty found in the adoption of the ICCE survey.

3.4.1.3 Enactment (interaction with environment)

Sensemaking through enactment occurred as faculty perceived students both as the environment and the stimulus for change. Faculty sought to understand their class, admitting to having little knowledge of what students thought. Faculty desired the ICCE survey not only to have an impact on their educational strategies, but to benefit their students through the survey process.

Faculty sought to understand their class as a means of change. Change was often targeted at improvement, be it through the incorporation of new educational strategies or removal of past unsuccessful ones:

> *Jaime: **I want to know what works**. What* particular *teaching practices work. **I know what the research says works**, but I really get the impression that every class is its own personality and what works in one classroom may not work well in another. So I'd really like to know **what bits of what I'm doing are working and what bits I really need to focus on fixing**. That's what interests me about doing this.*

Jaime speaks of a theme common among many faculty—wanting to know what works. As stated, both research and personal experience were seen as valid sources of knowledge for educational strategies. As Jaime enacted different educational strategies in the classroom environment, the perceived response of the class played a role in future decisions, including the decision to adopt the ICCE survey. Faculty were motivated to get this feedback to enable change, as the commonly held belief that their knowledge of students' perception was limited. This limitation acted as stimuli for faculty to adopt the ICCE survey as a means of response.

The feedback loop between faculty and students was closed, in that faculty hoped that the environment itself would be shifted by the ICCE survey. Reese noted, "*if you volunteer with stuff you get stuff out of it too.*" Reese speaks of enactment related to the ICCE survey: wishing that not only he would be shaped by its use, but his students (the environment) would likewise be shaped. Such feedback was common among faculty, many of whom suggested that course success, demographics, or other data be collected

alongside the ICCE survey as a means to impact students directly through their participation.

Enactment was observed in faculty as they oscillated from looking to student as the source of knowledge, seeking to shape students and their experience, and returning to the changed students as the environment to which they must respond. This shaping and being shaped interplay aided in developing positive perceptions of the ICCE survey; faculty saw the ICCE as a tool with which they could both receive and impart change on their classroom environment.

3.4.1.4 Social (interplay of self with others)

Sensemaking theory suggests that no decision is made in isolation, and faculty perceptions echoed such claims surrounding the adoption of the ICCE survey. For participants here, an authority often engaged with faculty to assist in sensemaking. However, authority frequently took the form of respected education researchers. For some, that authority of the researcher was the primary point of sensemaking:

> *Blair: [Research team member] said, "Hey can you do this?" Without knowing too much about it, I looked through the questions, but I see that you guys just need volunteers who are willing to do this.* ***I'll pretty much just play along****. If you give me a survey to send out, I'll send it out but that* ***I don't really have any purpose or a goal myself, necessarily****.*

Blair does not take specifics of the ICCE survey or its use in the classroom as primary factors in sensemaking of the instrument. Instead, as the quote suggests, Blair focuses sensemaking efforts on the work of the researcher associated with the ICCE survey. This allows the instrument to have meaning in Blair's context, despite his claim to not have any "*purpose or goal*" himself. Furthermore, Blair went on to generate perceptions of the survey based on his interactions with the research team, suggesting that the interaction between researcher and faculty was important to sensemaking.

Interaction with educational researchers was the primary point of social sensemaking; nearly all faculty indicated they had not spoken with coworkers regarding their decision to adopt the ICCE survey. Notable exceptions included faculty who co-taught or taught

the same course in the same term. Carey, the lead instructor in a series of biology courses, indicated that she first informed the two other instructors of the course, then asked if they would be interested in participating. In many ways, Carey was seen as an authority on education practices, as she had begun to make radical shifts in the overall course structuring to increase the engagement of the large-enrollment, co-taught class. As Carey looked to an educational researcher on how to improve engagement, her co-instructors looked to her as a resource of educational best practices.

While faculty did indicate that best practices such as engagement were discussed among coworkers, many operated outside peer influence when making decisions surrounding how engagement might be implemented in the classroom. Important to social sensemaking was the perceived knowledge of educational practices of the individual or team suggesting the use of the ICCE survey.

3.4.1.5 Ongoing (endless loop of making sense)

Sensemaking is a process that has no beginning and no end, meaning sensemaking that occurred long before faculty saw the ICCE survey influenced their perceptions of it, and were influenced by the future they projected surrounding its adoption. For example, the ways in which faculty collected student feedback in the past influenced their perception of the ICCE survey, and the way they predicted adopting the ICCE survey would influence their teaching. In this way, the ongoing nature of sensemaking allowed faculty to make steps towards adoption without extensive knowledge about the ICCE survey or its use in their classroom.

Of consistent importance to faculty was the ability to create a continual feedback loop between the ever-changing classroom environment they create and their students:

> *Kerry: Yeah, when it's good, when you feel confident in it,* ***I would like to use it at least every time I change something****. Which, judging by the past will be every term. Then maybe if I could even more a shorter version, just to get quick feedback…* ***I'm constantly trying to assess what they're thinking****,* ***if they're thinking about the right things****. I don't have a lot of tools to do that so this would tell me what type of thinking they're doing,* ***which would really help****.*

Kerry sees the ICCE survey as a tool which could "*really help*" as the classroom structure changes. This use is pending not only the survey's effectiveness ("*when it's good, when you feel confident in it*"), but also its ability to provide insight into Kerry's understanding of what students are thinking ("*I'm constantly trying to assess what they're thinking*"). Collectively, faculty spoke of lacking tools to assist them in understanding student perspective; sensemaking of the ICCE was ongoing as faculty gathered information about its usefulness as a tool.

Faculty sensemaking of the ICCE survey started before exposure to the instrument and continues beyond their interaction with it. The first decision towards adoption (agreeing to participate in an interview to discuss the survey and its use) was made with little knowledge of the survey itself; some sensemaking pathways (i.e., social or identity) led faculty to continue onto sensemaking of the ICCE survey, and even onto the predicted future of how results would influence their educational practices. The sensemaking tied to future events or results informed the faculty's decisions in the present—it was often the preconceived notions or the sense made of events yet to unfold that proved to be the strongest motivators in faculty adoption.

3.4.1.6 Extraction of Cues (selection of information bits)

When looking at the survey questions on the ICCE survey, faculty extracted cues that informed their sense made of the survey as a whole. A singular or few extracted cues were enough to inform faculty whether the ICCE survey was relevant to their classroom. The cues extracted frequently centered around language faculty believed would be unclear to their students. Of additional concern was the use of language that faculty believed led to content not present in their class:

> *Peyton:* ***When I hear example problems I think that's a math problem****. There's variables. There's addition.* ***There's never going to be that in my class****, so what do we mean by example problems when you ask these questions?*

Peyton saw *example problem* to relate strictly to math content, not to the biology course she instructed. Indicating that example problems will never be present in their classroom led to the questioning of what was indeed meant by *example problem*.

Language that faculty believed could not relate to their course created negative perceptions of the survey, as they believed certain questions prevented students from providing a holistically accurate picture of engagement in the course. A similar phenomenon was observed when faculty believed their course structure diverged from the course structure implicitly suggested in the survey: For example, when students were asked about writing notes in class, suggesting a course structure that included a time to take notes, some faculty stated that they do not do notes in the classroom. Faculty remained interested in students' perception of how content is communicated, but in their flipped classroom content is not communicated through the lecture/notes model. Yet, there was another subset of faculty that found the items of concern to those with flipped classrooms to be useful and beneficial:

> *Kerry: These are cool.* ***The ones about note taking and relating concepts are really interesting to me.***

Kerry speaks for the majority of more traditionally structured classes. These faculty frequently identify feedback on notes as an area of high interest. The ways in which students were engaged through notetaking was an area in which faculty desired student feedback. Nearly universally, faculty with more traditional classrooms saw notes as a way they could gain useful feedback from students through use of the ICCE survey.

Extracted cues allowed faculty to play out how students would interpret and respond to specific survey items. Overwhelmingly, notetaking was the most commonly extracted cue, whether faculty saw the question to be relevant or irrelevant. In conjunction with faculty concerns related to unclear language, it was relevancy and clarity that nearly all cues were extracted around.

3.4.1.7 Plausibility (preference of action to accuracy)

As the outcome of implementing the ICCE survey remained unknown by faculty, they utilized plausibility over accuracy to streamline their adoption process. Plausibility took the form of assuming that students would respond with honest, useful feedback. Faculty willingly admitted that honesty was not guaranteed, yet they still displayed excitement over the outcome of the survey. Plausibility was utilized when faculty

believed students would respond to the ICCE as they had responded to surveys in the past:

> *Carey: I feel like I get a range of responses where I can see the students… generally it seems like they're not just clicking to click, I guess.* ***So I think they would use it in a way that would be good data for us.***

Though there is no evidence to back Carey's claim in relation to the ICCE survey, she indicates that students will respond without just "*clicking to click*". It is this belief that supports her confidence that the data gained from ICCE survey will provide good data to faculty. Not all plausibility led to belief in the results of the ICCE survey. Some faculty used plausibility as a means to discount the results prior to students ever engaging with the instrument:

> *Avery: I hope enough of them take it that it's useful.* ***If there's only like twenty, then you can assume that 15% of those are the top people that do everything*** *... Go getters. In some ways, it's better to have the feedback spread among the class. I'm hoping 85% or more, but we'll see.*

Avery indicates that survey results, pending a small response rate, are from the top 15% of the class. Though this may not be an accurate statement, Avery relies on the plausibility to allow her to make sense of the potential outcome of the ICCE survey.

Plausibility over accuracy resulted in simplified sensemaking of the instrument. Faculty were willing to believe that students would use the survey with accuracy, respond to a survey on engagement in accordance with how they had responded to other surveys, and that various response rates were correlated to different constituents of students responding. This acceptance of the plausible led to simplified adoption and potential interpretation of the survey results.

3.4.2 Summary of Results

The seven core properties of sensemaking provided a framework for understanding faculty perceptions of engagement and the ICCE survey's intent to measure student engagement in their classrooms. The following is a brief summary of each core

property as it was observed in faculty; these results are also summarized in Table 4 of the discussion. Engagement was valued in faculty's *identity* regardless of their background in teaching and researching. The desire to continue to increase student in-class engagement likewise part of their identity. Faculty used *retrospection* to recall past work with surveys to inform how they saw students using the ICCE survey and how they planned to interpret the results. *Enactment* took the form of faculty looking to their students to get feedback, seeking to change the students in response to feedback, and then looking at the modified classroom as the new environment in which feedback was needed. To obtain this feedback, faculty turned to their *social* interaction with researchers, in which those perceived to be a resource of knowledge on education best practices were accepted as meaningful sources to explore. *Ongoing* sensemaking allowed faculty accept or reject the ICCE instrument into their present based on their previous knowledge and their predicted future outcomes. Specifics of the survey, especially notes, were *extracted cues* from which faculty used as an important basis to determine the ICCE survey's relevance in their course. In the end, faculty were willing to accept or discount the offerings the ICCE survey could provide to them based on *plausibility*. The actions faculty took in relation to the ICCE survey and the perceptions they formed surrounding it were informed by the cumulative effect of sensemaking's core properties.

3.5 Discussion

In studying how sensemaking's framework core properties were described by faculty as they interacted with the ICCE survey, the emergent themes were similar to those found in the literature. Though not discussed in terms of sensemaking, the faculty embodiment of the core properties was consistent with previous work on change in instructional practices. For example, Hutchinson and Huberman suggest it is impossible to avoid the individualization of an instructional practice [32]. Faculty in this study were concerned with individualization of the ICCE survey to meet their needs. They relied on extracted cues to describe the ways in which a generalized survey limited the relevance or applicability of the results. Indeed, we believe the likelihood

of long-term survey adoption would decrease without individualization based on these findings.

According to Borrego, Froyd and Hall, faculty members must be involved in adopting engineering education innovations [33]. For faculty in this study, the primary way the ICCE survey had relevance to them was through their interaction with the research team. We believe if we had simply asked them to distribute the survey, even if they agreed, they would not be invested or particularly interested in the results; it was their involvement in providing feedback to the researchers that involved them and propelled them toward adoption.

Furthermore, pitfalls observed in this study with the ICCE were similar to faculty perceptions surrounding the use of student evaluation (SET). For SETs, these pitfalls include a general concern over reliability and validity [34] and a lack of consensus as to the meaning of results [35], [36]. In this study, the similarity of the concerns held by faculty may have been in part due to retrospection. Faculty readily compared and contrasted the ICCE survey to SETs, with similarities including students "judging" the effectiveness of teaching and differences in the potential for feedback related specifically to engagement. As a result, new surveys, including the ICCE, must contend with the limitations encountered by faculty in previous soliciting of student feedback.

In support of this discussion, the following section will focus on how the sensemaking framework core properties and their emergent themes are related to adoption potential. The section will conclude with the limitations of the research and suggested future work

3.5.1 Discussion of Adoption Potential

The results showed that faculty underwent sensemaking of the ICCE survey and the idea of a tool informing them of in-class student engagement. While all seven sensemaking core properties informed the overall sensemaking, they played different roles. That is to say, though faculty will have sensemaking in each core property, they likely relied most heavily on one or two to explain their actions. Foundational to sensemaking as a framework is the individual stories. In this sense, both the general

trends and the exceptions are equally informative. Faculty who relied heavily on social, identity, enactment, and ongoing sensemaking to explain their action response to the ICCE survey frequently were explaining their adoption process. Conversely, faculty who relied heavily on retrospection, extraction of cues and plausibility over accuracy in the end did not undergo sensemaking that led them to the act of adoption. Positive and negative adoption potential was determined by delving into the sensemaking of faculty who did and did not adopt respectively. For example, by understanding how Peyton was influenced by her extraction of cues related to the language of *example problem* not relating to her students, negative adoption potential was seen. In the case of Peyton, she may have had some positive perception of the ICCE survey (i.e. when considering the part of her identity that sought to engage students), but did not rely on such core properties when explaining her action. Therefore, reliance on a particular core property of sensemaking was seen to be associated with a particular action. A summary of the core properties, the emergent themes of this study, and their relation to adoption potential are located in **Table 4**. The following discussion uses the sensemaking framework to explain poignant examples or patterns related to adoption and how the ICCE survey might be modified to better meet the needs of faculty.

Table 4. Themes of each core property and their relationship to adoption potential

Core Property	Emergent Themes	Adoption Potential
Identity ***(utilization of self)***	• Faculty are willing to learn about engineering education and related research • Faculty will seek to engage their students	*Positive*
Retrospection ***(connecting past to present)***	• Word choice will influence student interpretation • Feedback provided by students will be limited	*Negative*
Enactment ***(interaction with environment)***	• Survey will provide a feedback loop between changes to instructional practices and student perceptions	*Positive*
Social ***(interplay of self with others)***	• Interactions with researchers are useful for faculty making meaning of the survey	*Positive*
Ongoing ***(endless loop of making sense)***	• Usefulness of the survey will be determined after its use • Repeated use of the survey will provide useful feedback on changes to instructional practices	*Positive*
Extraction of Cues ***(selection of information bits)***	• Survey language used is not applicable to every classroom context • Questions on notetaking will provide useful feedback, if interpreted correctly by students	*Negative*
Plausibility ***(preference of action to accuracy)***	• Students will report honestly • Survey will reach only a subset of students	*Negative*

The majority of the faculty in this study chose to implement the ICCE survey in the course they were teaching during the term they were interviewed. These faculty often used similar sensemaking pathways in their understanding of engagement and the ICCE survey. Even though the data suggests that faculty valued in-class engagement, there is a range of exposure and experience with education best practices within STEM faculty that must be addressed. Some survey implementers had classrooms in which value of engagement led them to make regular changes to their courses, while others simply sought initial feedback. Both needs led faculty to adopt the ICCE survey, yet sustained adoption would likely be influenced by the meaningfulness of the results. Feedback from results points to how faculty used enactment to make sense of the ICCE survey: faculty were looking to adopt an instrument that would supply them with feedback, allow them to make changes, then use the instrument again to measure these changed. Faculty generally perceived the ICCE survey to be such an instrument, aiding in its adoptability.

Derived from the social property of sensemaking, it is worth noting that adopters of the ICCE survey in many cases were motivated simply because they were asked by a researcher. The nature and degree of the relationship between researcher and adopter was varied, with most being little more than acquaintances. The association of a name and researcher with an innovation was a motivating factor in its use. This exemplifies the action taken by faculty preceded their sensemaking of the survey instrument; they made sense of contributing to the research community at large and interacting with engineering education, and followed by making sense of the ICCE survey alongside researchers. Faculty perceived that effective instruments came from effective researchers and research communities. Faculty cared about the "big idea" and were willing to trust the researchers' means to explore an idea like engagement. This necessarily poses a concern for sustained adoption, as eventually social interactions with researchers will decrease. The goal of this work is to develop a survey that is self-sustaining (faculty are motivated enough by benefits that they will continue adoption on their own accord) or valued among enough of a community that faculty will continue to use social sensemaking as a pathway to adoption.

The pre-existing beliefs on engagement held by faculty played an important role in faculty choice to adopt. Through the sensemaking framework, it became clear that in-class engagement was an ongoing concern for faculty—they were ready for a tool that allowed them to measure their students' in-class engagement. This aided in the successful adoption of the ICCE survey. For the implementation of RBISs lacking in an established foundation among faculty, the findings here suggest a key first step is convincing faculty to incorporate a best practice into their identity. Ongoing sensemaking allows faculty to bridge the gap between what they have valued in the past and what perceive themselves valuing in the future.

3.5.2 Discussion of Adoption Limitations

Conversely, faculty who did highlighted themes of retrospection, extraction of cues, and plausibility were less likely to express an interest in long-term adoption. Retrospection brought to faculty's mind the failings of previous surveys, and were

applied to the ICCE survey. To mitigate these concerns, evidence would likely be needed to convince faculty that the ICCE survey would perform differently. Faculty were particularly concerned with the applicability of the survey to their class. A challenge is posed in a climate in which STEM classes can vary widely in structure. Flipped classrooms, for example, intentionally engage students differently than traditional lecture-based class. The ICCE survey would need to be modified to make it useful to both classroom types, perhaps separately.

Faculty who extracted cues related to language they believed did not apply to their course were resistant to adopt the survey. Even if the majority of survey content was applicable, faculty could be dissuaded by a single word usage. As the ICCE survey seeks to measure in engagement in various STEM classes, it is important to use generalized language that is widely applicable, or develop a set of questions unique to different disciplines. Faculty were concerned with not only how students might interpret specific words, but generally the accuracy with which students can report on things such as their in-class engagement. Regardless of how accurate self-report is, some faculty will hold to their beliefs as the highest truth in the classroom simply because it is both plausible and efficient. It must be made plausible to these faculty that students hold additional truth worth accessing, and that it is accessible through a certain tool.

3.5.3 Limitations

The convenience sampling procedure inherently biased the results by favoring a particular institution, and group within the institution. Though both traditional lecture-based and flipped classes participated in this study, the ICCE survey was designed primarily for courses with an in-class lecture components. Those with flipped classrooms were limited in the ways in which they could interpret questions based on their context. There was a lack of participant knowledge about cognitive engagement and other foundational components of the study such as ICAP. Participants were not limited by their interest or enthusiasm for engagement, rather they lacked a research-based, common definition.

This study focused on a survey instrument related to in-class engagement. The iterative nature of the survey development caused early faculty participants to encounter a less straightforward instrument than later participants. The number of items may have confused or overwhelmed early participants. To fully understand the long-term adoption of the ICCE survey and resultant changes from its use, a longitudinal study would be beneficial.

3.5.4 Conclusions and Future Work

It is the systematic study and exploration of the reform process that offers promise for effective large-scale, research-based change. In this study, we used the sensemaking framework to describe faculty perspectives as they moved towards reform centered around cognitive engagement. As reform efforts continue, it is important to consider these findings in light of future activities, instruments, and RBISs. Faculty must be sought after in their own contexts, so as to offer meaningful feedback during development of measurement tools for their classrooms. Researchers developing instruments for the whole of STEM ought to be aware of using generalized language, and the resistance such language may generate among faculty; the flexibility of the survey used in this research resulted in positive perceptions of its adoption.

When interacting with potential faculty adopters, researchers should try to trigger sensemaking properties of identify, enactment, social, and ongoing, as this was found to correlate positively with adoption potential. One way in which this could be accomplished is through recruitment materials or initial introduction to an innovation. Alternatively, researchers should try to mitigate the expressions of their innovation that can trigger retrospection, extraction of cues, and plausibility. Perhaps this could be accomplished by preparing to mitigate faculty concerns, for example explaining how a new measurement tool is different than the SETs and will not recreate the poor experiences highlighted through retrospection. It is important to be aware and seek to meet the individualized needs of faculty, lest they see the instrument as research with little benefit to them. Our aim is to have contributed positively to the innovative development model movement that will allow for the creation of useful tools to

understand better RBISs in the classroom, resulting in greater uptake of RBISs by educators.

3.5.5 Acknowledgement

This material is based in part upon work supported by the National Science Foundation under grant DGE-1544182. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

CHAPTER 4 — CONCLUSIONS

4.1 General Discussion

The focus of this thesis has been the measurement of student engagement as a means to provide faculty with feedback on their courses. This feedback assists in faculty evaluating their success in implementing RBISs. This study started in **Chapter 2** with developing a single survey (CSCE) to measure in and out of class cognitive and social engagement. In **Chapter 3**, the focus shifted to a set of CSCE surveys, one of which was the ICCE survey focusing on in-class engagement. Findings in **Chapter 2** indicated that in-class engagement generated the most interest among faculty, and was therefore selected as the focus for **Chapter 3**.

The surveys in both **Chapters 2 and 3** were in the process of being statistically validated. Instead of engaging with faculty following the statistical validation of the instrument, this study sought to interact with faculty using "collaborative reflection" [24]. The purpose of collaborative reflection was to use the process of researcher and faculty working together to develop a survey that had user validity. Since we believe user validity is of equal importance to statistical validity in the overall usefulness of the final instrument, we underwent these processes simultaneously. The purpose of faculty and researcher engaging over the survey was not only to observe faculty sensemaking of the instrument for research, but to seek to improve the instrument during each round of implementation.

Though faculty provided the research team with many comments and concerns, they were not dissuaded by ongoing development in their use of the survey instruments. Faculty frequently asked to continue to be a part of the project the following year when they would again be teaching the course the survey had been implemented. Faculty who were teaching a course in the next term frequently offered to implement the survey a second time. This indication towards sustained use points towards the ultimate aim of the project—to develop an instrument useful and adoptable by faculty.

4.2 Key Findings

While individual conclusions were drawn in **Chapters 2 and 3**, findings based on the cumulative work of this thesis contribute to the body of knowledge on measurement of student engagement and the use of sensemaking as a framework for adoption studies. Throughout this work, faculty were interested in discussing engagement. This interest carried over into a desire to understand their course and how students experience it. Faculty claimed to regularly make changes in their courses, and expressed interest in feedback on the effectiveness of these changes. Faculty generally perceived the CSCE surveys as reasonable means of measuring student engagement, and hoped that students taking the survey would be prompted to reflect on the ways in which they engaged in the class. When asked how the CSCE surveys could be more useful to them, faculty suggested collecting data on the correlation of engagement to student success in their particular course. Faculty wished to pass correlation data on to their students as a means of encouraging engagement in their course.

Faculty argued that engagement in their course context was unique, and wished to have an instrument to usefully understand their students. To this end, faculty sensemaking occurred alongside the researchers. It was useful to faculty to have an avenue in which they could discuss what the survey meant, how they interpreted it, and how they projected their students would interpret it. When prompted with questions targeted at understanding their sensemaking, faculty exhibited freedom in making suggestions to increase the usefulness of the survey to them. In this way, the sensemaking framework used in this study was useful not only for understanding data collected, but creating space for faculty members as co-developers.

4.3 Future Work

The work of this thesis was centered around the measurement of student engagement through the use of the CSCE surveys. Since engagement is a foundational principle RBISs, these tools work as indicators of the successes and failings of RBIS usage. This study did not focus on the introduction of new teaching practices or remediation of current ones. A study seeking to understand the ways in which faculty make use of new teaching practices could employ similar techniques, with interviews centered around

sensemaking generating space for collaborative reflection of the changing environment. Further work is needed in the area of understanding faculty change in response to teaching practices.

Though in-class engagement was of highest interest to faculty throughout this study, they also expressed interested in engagement outside the classroom. This is particularly relevant in flipped classrooms, where much of the content learning occurs outside of the classroom. A challenge is posed when defining "in" the classroom in such instances, suggest further work with holistic student engagement. Additionally, when discussion in-class engagement, faculty would often intermix thoughts on students' engagement outside the classroom. This lack of clear distinction between in and out of class engagement suggests future work on the ability of both faculty and students to distinguish the site of their engagement with a particular course. The newest version of the CSCE surveys has a survey to measure in and out of class engagement in a single instrument, with the intent of allowing comparative engagement between in and out of class contexts.

BIBLIOGRAPHY

[1] L. D. Fink, S. Ambrose, and D. Wheeler, "Becoming a Professional Engineering Educator: A New Role for a New Era," *J. Eng. Educ.*, vol. 94, no. 1, pp. 185–194, 2005.

[2] J. L. Melsa, "Transforming Engineering Education Through Educational Scholarship," *J. Eng. Educ.*, vol. 96, no. 3, pp. 171–172, 2007.

[3] J. L. Melsa *et al.*, *Creating a Culture for Scholarly and Systematic Innovation in Engineering Education*, vol. 98, no. 3. 2009.

[4] G. A. Gabriele, "Advancing Engineering Education in a Flattened World: EBSCOhost," *J. Eng. Educ.*, vol. 94, no. 3, pp. 285–286, 2005.

[5] K. A. Smith, A. Linse, J. Turns, and C. Atman, "Engineering Change Center for the Advancement of Engineering Education," 2004.

[6] M. H. Dancy and C. Henderson, "Barriers and Promises in STEM Reform," *Natl. Acad. Sci. Promis. Pract. Work.*, 2008.

[7] K. A. Smith, S. D. Sheppard, D. W. Johnson, and R. T. Johnson, "Pedagogies of engagement: Classroom based practices," *J. Eng. Educ.*, no. January, pp. 87–101, 2005.

[8] S. Freeman *et al.*, "Active learning increases student performance in science, engineering, and mathematics," *Proc. Natl. Acad. Sci.*, vol. 111, no. 23, pp. 8410–8415, 2014.

[9] J. A. Fredricks, P. C. Blumenfeld, and A. H. Paris, "School Engagement: Potential of the Concept, State of the Evidence," *Rev. Educ. Res.*, vol. 74, no. 1, pp. 59–109, Jan. 2004.

[10] M. T. H. Chi and R. Wylie, "The ICAP Framework: Linking Cognitive Engagement to Active Learning Outcomes," *Educ. Psychol.*, vol. 49, no. 4, pp.

219–243, 2014.

[11] K. E. Weick, *Sensemaking In Organizations*. Sage Publications, Inc.Johnson Graduate School of Management, Cornell University, 1995.

[12] A. J. Ironside *et al.*, "Incorporating Faculty Sense Making in the Implementation and Modification of an Instrument to Measure Social and Cognitive Engagement." 24-Jun-2017.

[13] R. Anderson, R. Anderson, K. M. Davis, N. Linnell, C. Prince, and V. Razmov, "Supporting active learning and example based instruction with classroom technology," *ACM SIGCSE Bull.*, vol. 39, no. 1, p. 69, 2007.

[14] M. Prince, "Does active learning work? A review of the research," *J. Eng. Educ.*, vol. 93, no. 3, pp. 223–232, 2004.

[15] K. A. Smith, S. D. Sheppard, D. W. Johnson, and R. T. Johnson, "Pedagogies of Engagement: Classroom-Based Practices," *J. Eng. Educ.*, vol. 94, no. 1, pp. 87–101, Jan. 2005.

[16] R. Khatri, C. Henderson, R. Cole, J. E. Froyd, D. Friedrichsen, and C. Stanford, "Designing for sustained adoption: A model of developing educational innovations for successful propagation," *Phys. Rev. Phys. Educ. Res.*, vol. 12, no. 1, p. 10112, 2016.

[17] K. E. Weick, K. M. Sutcliffe, and D. Obstfeld, "Organizing and the Process of Sensemaking," *Organ. Sci.*, vol. 16, no. 4, pp. 409–421, 2005.

[18] D. F. Radcliffe, "Shaping the Discipline of Engineering Education," *J. Eng. Educ.*, vol. 95, no. 4, p. 263, 2006.

[19] K. Haghighi, K. A. Smith, B. M. Olds, N. Fortenberry, and S. Bond, "The time is now: Are we ready for our role," *IEEE Engineering Management Review*, vol. 36, no. 4. p. 92, 2008.

[20] K. A. Smith, A. Linse, J. Turns, and C. Atman, “Engineering change,” *Am. Soc. Eng. Educ. Annu. Conf. Expo.*, no. 1997, pp. 1–18, 2004.

[21] E. Seymour, “Tracking the processes of change in US undergraduate education in science, mathematics, engineering, and technology,” *Sci. Educ.*, vol. 86, no. 1, pp. 79–105, Jan. 2002.

[22] L. R. Lattuca, “Influences on engineering faculty members’ decisions about educational innovations: A systems view of curricular and instructional change,” in *Nat. Acad. Sci.*, 2001.

[23] M. Borrego, J. E. Froyd, and T. S. Hall, “Diffusion of Engineering Education Innovations: A Survey of Awareness and Adoption Rates in U.S. Engineering Departments,” *J. Eng. Educ.*, vol. 99, no. 3, pp. 185–207, 2010.

[24] A. McKenna and B. Yalvac, “The role of collaborative reflection on shaping engineering faculty teaching approaches,” *J. Eng. Educ.*, vol. 98, no. 1, pp. 17–26, 2009.

[25] E. M. Walter, C. R. Henderson, A. L. Beach, and C. T. Williams, “Introducing the postsecondary instructional practices survey (PIPS): A concise, interdisciplinary, and easy-to-score survey,” *CBE Life Sci. Educ.*, vol. 15, no. 4, 2016.

[26] M. T. H. Chi, “Active-Constructive-Interactive: A Conceptual Framework for Differentiating Learning Activities,” *Top. Cogn. Sci.*, vol. 1, no. 1, pp. 73–105, 2009.

[27] N. Lin, R. S. Burt, and K. S. Cook, *Social Capital: Theory and Research*. New York: Aldine de Gruyter, 2001.

[28] C. Henderson and M. H. Dancy, “Increasing the Impact and Diffusion of STEM Education Innovations,” *Charact. Impact Diffus. Eng. Educ. Innov. Forum*, 2011.

[29] C. Henderson and M. H. Dancy, “Increasing the impact and diffusion of STEM education innovations,” *Increasing Impact Diffus. STEM Educ. Innov.*, 2011.

[30] C. Henderson and M. H. Dancy, “Barriers to the use of research-based instructional strategies: The influence of both individual and situational characteristics,” *Phys. Rev. Spec. Top. - Phys. Educ. Res.*, vol. 3, no. 2, p. 20102, Sep. 2007.

[31] C. Henderson and M. H. Dancy, “Physics faculty and educational researchers: Divergent expectations as barriers to the diffusion of innovations,” *Am. J. Phys.*, vol. 76, no. 1, pp. 79–91, Jan. 2008.

[32] J. R. Hutchinson and M. Huberman, “Knowledge and Dissemination and Use in Science and Mathematics Education: A Literature Review,” *J. Sci. Educ. Technol.*, vol. 3, no. 1, 1994.

[33] M. BORREGO, J. E. FROYD, and T. S. HALL, “Diffusion of Engineering Education Innovations: A Survey of Awareness and A...: EBSCOhost,” *J. Eng. Educ.*, vol. 99, no. 3, pp. 185–207, 2010.

[34] P. Spooren, B. Brockx, and D. Mortelmans, “On the Validity of Student Evaluation of Teaching: The State of the Art,” *Rev. Educ. Res.*, vol. 20, no. 10, pp. 1–45, 2013.

[35] R. Johnson, “The Authority of the Student Evaluation Questionnaire,” *Teach. High. Educ.*, vol. 5, no. 4, pp. 419–434, Oct. 2000.

[36] C. Knapper, “Broadening Our Approach to Teaching Evaluation,” *New Dir. Teach. Learn.*, vol. 2001, no. 88, pp. 3–9, 2001.

[37] P. M. Simpson and J. a. Siguaw, “Student Evaluations of Teaching: An Exploratory Study of the Faculty Response,” *J. Mark. Educ.*, vol. 22, no. 3, pp. 199–213, 2000.

[38] J. (POD N. Franklin, “Interpreting the Numbers: Using a Narrative to Help

Others Read Student Evaluations of Your Teaching Accurately," *New Dir. Teach. Learn.*, vol. 87, no. Fall 2001, pp. 85–100, 2001.

[39] H. Tsoukas and R. Chia, "On Organizational Becoming: Rethinking Organizational Change," *Organ. Sci.*, vol. 13, no. 5, pp. 567–582, 2002.

[40] L. D. Gonzales, "Faculty Sensemaking and Mission Creep: Interrogating Institutionalized Ways of Knowing and Doing Legitimacy," *Rev. High. Educ.*, vol. 36, no. 2, pp. 179–209, 2013.

[41] B. L. Berg and H. Lune, *Qualitative research methods for the social sciences*, vol. 8th. 2014.

[42] Qualtrics, "Qualtrics." Provo, Utah, 2005.

[43] Dedoose, "Dedoose." Web Applicaiton for Managing Analysing and Presenting Qualitative and Mixed-Methods Reserach Data, 2017.

[44] J. W. Creswell, *Research Design: Qualitative, Quantitative and Mixed Approaches (3rd Edition)*. 2009.

[45] R. Whittemore, S. K. Chase, and C. L. Mandle, "Validity in Qualitative Research," *Qual. Health Res.*, vol. 11, no. 4, pp. 522–537, 2001.

[46] Y. S. Lincoln and E. G. Guba, *Naturalistic Inquiry*. 1985.