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Facilitating Conditions for Engineering Faculty Technology Adoption

Michelle Jarvie-Eggart

Michelle Jarvie-Eggart, PhD, PE, ENV SP, is an Assistant Professor of Engineering Fundamentals at Michigan Technological University. Dr. Jarvie-Eggart's research interests include technology adoption of engineering faculty and students, especially the adoption of programming languages, as well as online teaching.

Alfred Lawrence Owusu-Ansah

Shari Stockero

Shari L. Stockero is a Professor of Mathematics Education at Michigan Technological University.

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Abstract
This paper summarizes the preliminary results of an NSF project funded through the Directorate for Engineering, Engineering Education and Centers. One of the main project goals is developing an understanding of the factors that support or inhibit engineering faculty technology acceptance.

As essential gatekeepers in the process of the formation of engineers, engineering faculty determine which technologies engineering students learn and adopt during their engineering studies. Faculty members' ability to adopt new and relevant engineering technologies directly affects the relevance of engineering graduates' technical skills. Additionally, by adopting and teaching new and relevant technologies, engineering faculty model life-long technology adoption to their students. Technology acceptance has been widely studied and modeled by information systems researchers. The most widely used model in educational settings is the Technology Acceptance Model (TAM) [1] and its revision, the TAM2 [2].These models are general, however, and not specific to engineering faculty. There is thus a need for qualitative research to determine facilitating conditions to support engineering faculty's technology acceptance.

This qualitative study involved interviewing engineering faculty at a Midwestern US University. Transcripts were coded leveraging analytic induction methods [3, 4]. This paper and the associated poster will discuss the facilitating conditions for engineering faculty members' adoption of new technologies that have been identified within the study. Factors that are emerging from the data include peers, mentors, and students; digital learning resources; time; non-digital learning resources; and formal training.

Background
As described in our previous work [5], in the original Technology Acceptance Model (TAM) the intention to use (or adopt) a technology is related to two primary constructs: **Perceived Usefulness**, defined as the "degree to which a person believes using a particular system would enhance his or her job performance" [1] (p. 320); and **Perceived Ease of Use**, defined as the "degree to which using a particular system would be free of effort" [1] (p.320). The TAM's revision, the TAM2, added seven additional constructs that affect Perceived Usefulness [2]. The TAM is well-known for its ease of application and is thus the model most frequently used in studies to predict teachers' use of instructional technologies [6], despite the fact that it does not account for all variability within intention to use [7-11].

In 2000, constructs from the TAM2 were combined with constructs from the Theory of Reasoned Action [12] and the Theory of Planned Behavior [13] to create the Unified Theory of Acceptance and Use of Technology (UTAUT) [14], which was later revised to the UTAUT2 [15]. Among the additional constructs included in the UTAUT2 were **price value** (what is gained from adopting a technology versus its cost), **habit,** and **facilitating conditions** (perceptions of the resources and supports available to adopt a technology). This last construct is particularly important to the work discussed here.

As most of the research on technology adoption has focused on applying adoption models, not on developing a qualitative understanding of the constructs on which they are based, there is need for additional work exploring the factors affecting technology adoption [16]. The fundamental intent of this research was to meet this need in the context of understanding the factors affecting the technology adoption by engineering faculty.

Framework

The TAM2 and UTAUT2 were used as a framework for analyzing the results of the qualitative interviews with engineering faculty. However, they were not developed for educational purposes, and do not capture all variability within intention to use. Thus, the literature was further explored for constructs which may be missing from the TAM2 and UTAUT2. Additional constructs, including **time** [17-18], were identified. The constructs within the TAM2 were combined with constructs from the UTAUT2, as well as these additional constructs that emerged from literature as suspected to influence technology adoption, to provide a framework for viewing and understanding the qualitative interview data.

Methods

This qualitative study involved interviewing 21 engineering faculty from across the College of Engineering at a Midwestern university in the USA. Interviews were conducted during the 2020/21 academic year. Due to COVID-19, all interviews were conducted via Zoom, recorded, and transcribed for analysis. Coding methods were based on analytic induction as it allows for codes to be informed by prior research, as well as for new codes to emerge from the data, through a combination of deductive and inductive coding [3, 4]. Initial codes were based upon the TAM2 [2] and the revised version of the UTAUT2 [15]. Codes for additional possible factors were drawn from the literature, as well as past work with focus groups on the researchers' campus. The analysis process included multi-pass convergent coding of each interview. A codebook was maintained and updated with each coding cycle. Two researchers independently coded each interview, and then met to compare coding and resolve any differences. Codes were applied to blocks of texts composed of single or multiple sentences that articulated a single idea related to technology adoption. As text passages sometimes reflected the concepts represented within more than one code, the simultaneous coding technique was utilized, in which two or more codes may be applied to the same text passages [19].

Positionality

All researchers work at the study site. The lead author is a professional engineer, with a decade of industry experience. Their engineering education research, time within industry, and shift to academia may influence their analysis perception of the results. The second author is a Humanities PhD candidate researching 21st century literacy demands of engineering students and faculty. The third author is a professor of Cognitive and Learning Sciences.

Results

This poster session will focus on a portion of the results from the qualitative analysis of the interview data - those pertaining to facilitating conditions for engineering faculty technology adoption, with special attention to one code, that of Peers, Mentors, and Students. Facilitating conditions, a construct from the UTAUT2, pertains to perceptions of resources and supports available for technology adoption [15]. Facilitating conditions for engineering faculty members' adoption of new technologies that were identified within this study included Peers, Mentors, and Students; Digital Resources; Time; Non-Digital Resources; and Formal Training. A summary of the occurrences of these codes, as well as a description of each code, is shown in Table 1.

Table 1. Frequency of Codes within Facilitating Conditions Theme			
Code	**Code Description**	**Number of Occurrences**	**Number (%) of interviewees**
Peers, Mentors, and Students	Peers, Mentors, and Students are the people that faculty members go to for help learning technologies, including other faculty, colleagues in industry, and technology support personnel. They can also involve hierarchy-disrupting relationships where faculty members learn technologies from their students.	167	21 (100%)
Digital Resources	Digital Resources are technological resources such as YouTube, stack exchange, built in software help, and tutorials that help one learn a new technology.	136	21 (100%)
Time	Time includes class time to incorporate the technology, faculty time restrictions, and time involved in learning a technology.	128	20 (95%)
Non-Digital Resources	Non-Digital Resources are texts, manuals, and books.	63	20 (95%)
Formal Training	Formal Training pertains to classes, seminars, and workshops faculty participate in to learn or improve their use of a technology.	95	19 (90%)

Among the facilitating conditions, the most frequently identified construct was Peers, Mentors, and Students (see Table 1). The Peers, Mentors, and Students construct emerged in the interview data when faculty were discussing the people they seek out for help learning technologies (including tech support). Within the data, faculty respondents often discussed leveraging others who know a technology better than they do to give them an introduction to a technology, or to help them when they get stuck. For example, this faculty member explains going to other faculty for help when stuck working in a simulation software:

> *"And then there's also a couple of faculty in the department that have taken Amesim training classes, kind of on their own time… I would get stuck, but send it to them. And they'd say, "Oh, do this", you know, because they've used it so extensively that it would*

be an easy solution. Or if they'd say, "Well, I don't know". Then they have contacts at Amesim themselves that they would pass it along, right. Get some more insight into it that way."

Faculty also mentioned bringing people into a research or teaching team who knew a technology to leverage their expertise, including both students and other employees. Some time-pressed faculty directed students or staff to learn a technology so they could, in turn, teach the faculty only the parts of the technology they needed to use. For instance, when responding to a question about when they learned a certain simulation software, one faculty member said:

"We learned that, probably about, 10 plus years ago at least. Honestly, we learned it from some of our students. I mean, I'm not really a gamer. I have never been a gamer. I haven't played computer games ... we've always used some undergraduate and graduate students as current employees of the program. So we bring them in often into any kind of aspect, whether it's related [to] classes or building the program ...we started talking about how could we visualize better some of these principles that we are doing. And I do recall the students who said, 'You know there's some of these simulators' So we sent some of these students to go and get the simulator [telling them], 'Why don't you learn a little bit and tell us how it works?'"

Additionally, some faculty just depended on student teaching assistants to know a technology well, relieving the faculty members of the obligation to learn the technology in-depth. The poster session will provide additional details and examples from faculty to further illuminate the Peers, Mentors, and Students construct.

Digital Resources were also mentioned as a facilitating condition by all of the interviewees. Faculty discussed finding digital resources and combing through them for relevant information; many acknowledging how much easier it was to find learning resources in the digital age. Future papers will expand on faculty use of digital resources, their need for time to adopt technologies, their use of non-digital resources, and formal training.

Conclusion

A better understanding of the facilitating conditions for engineering faculty technology adoption will aid in the design of institutional supports and policies to promote technology adoption among engineering faculty. Peers, Mentors, and Students emerged as the most commonly mentioned facilitating conditions for engineering faculty adopting new engineering technologies, followed by Digital Resources, Time, Non-Digital Resources, and Formal Training. Understanding the ways in which faculty rely on other people when adopting new engineering technologies is essential to designing institutional level interventions that bridge faculty-learners with their most essential learning resource: other people.

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