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# Student Research as a Means to Closing the Gap Between Theory and Practice in Education

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## Abstract

Educational institutions face challenges of bridging gaps between teaching, research, and practice to ensure that students' knowledge and competencies are current and relevant to practitioner communities. Research apprenticeship is a student research model that supports students in becoming knowledgeable and competent members of the IS research community of practice. In this paper, I present the model and a survey among IS graduates to evaluate their learning outcomes based on the Researcher Development Framework. Responses are analyzed based on the concepts of "legitimate peripheral participation" and "community of practice." Results show that the model supports students in becoming legitimate members of the IS research community of practice and acquiring domain knowledge and competencies that IS practitioners value. The model thereby helps to reduce the practice-research gap. I discuss the implications and provide suggestions for both educators and practitioners.

**Keywords:** Student Research, Situated Learning, Legitimate Peripheral Participation, Community of Practice.

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# Student Research as a Means to Closing the Gap Between Theory and Practice in Education

*Sune Dueholm Müller*

## 1. INTRODUCTION

Information Systems (IS) is an applied science field (Orlikowski & Barley, 2001) that strives for practical relevance (Topi et al., 2017). It has, for example, been described as “a profession-based discipline that constantly seeks new ways to bridge the practice-research gap” (Mathiassen & Sandberg, 2013, p. 475). However, our current understanding of how to bridge the research-practice gap, especially regarding the role of “boundary spanners,” is lacking (Abraham et al., 2021). However, extant research shows that the gap between teaching, research, and practice can be bridged by, among other things, involving students in projects across the institutional boundaries that separate academic research and industrial practice (Mathiassen & Sandberg, 2013). This involvement increases the likelihood of graduates having the knowledge and competencies practitioner communities demand. Motivated by an interest in better understanding how to involve students in research, facilitate their role as boundary spanners, and thereby bridge the gap, I have developed the research apprenticeship model (Müller, 2022) and evaluate it from the point of view of former students who are now practitioners and are hence capable of commenting on the model’s effectiveness in reducing this gap. My research shows that allowing students to participate in research and the sociocultural practices of the community helps them eventually become knowledgeable and competent community members and makes them more skilled practitioners.

This paper is a student-centered evaluation of the research apprenticeship model introduced by Müller (2022). The purpose is to expand on that work from a student perspective. Both papers present the so-called research apprenticeship model as a framework for integrating student research into existing study programs and teaching practices. Where the Müller (2022) paper discusses the benefits of the model through personal reflections, this paper evaluates it through a graduate survey of former students’ self-reported learning outcomes. The papers share a substantial amount of content and ideas. Both papers focus on student research to bridge the gap between research and practice in the IS

field, discuss the concept and role of “legitimate peripheral participation” in student learning, and describe the research apprenticeship model. This overlap ensures that both are self-contained and independent papers. Despite this overlap in content, they address different aspects of student research within IS and present distinct evaluations.

The learning benefits of student research have been of scholarly interest for years (Obwegeser & Papadopoulos, 2016). Different means of involving students have been suggested, emphasizing integrating research activities into existing course structures (Tams, 2014). According to the AIS Global IS Education Report, some universities integrate student research into their educational offerings (vom Brocke et al., 2020), for example, through the Research Experiences for Undergraduates (REU) program (Granger et al., 2006), which supports undergraduate students’ active participation in the areas of research funded by the National Science Foundation. However, knowledge of how to involve students in practice-relevant research and, in turn, strengthen their competencies toward becoming knowledgeable and competent practitioners is lacking. Whereas extant literature focuses on incorporating research activities into existing courses (Holland & Garfield, 2012; Mustafa, 2004; Obwegeser & Papadopoulos, 2016), this paper contributes to state-of-the-art knowledge of student research (Symonds & Cater-Steel, 2009; van Toorn et al., 2011).

Recently, educational institutions are moving from a teacher-centered educational paradigm to a learner-centered paradigm (Saulnier et al., 2008). The learner-centered paradigm is particularly important in IS education because it allows for the flexible integration of new knowledge into teaching practices (Landry et al., 2019) to bridge the gap between academic research and real-world practice. Student research allows for this integration (Saulnier et al., 2008) and encourages “faculty to participate in a community of practice centered on learner-centered, outcomes-based approaches for IS” (Landry et al., 2019, p. 178).

In (Müller, 2022), I address the need for knowledge of how to involve students in practice-relevant research by discussing my experiences with the research apprenticeship model. This model entails participation in real-world projects and master-apprentice collaboration through which students learn the ropes of research and acquire practice-relevant knowledge and competencies. In this paper, I evaluate the model from a student, i.e., a learner-centered, perspective through a survey, guided by the following research question: To what extent does research apprenticeship support the acquisition of IS practice-relevant knowledge and competencies? I present and discuss the survey results and their implications and provide suggestions for educators and practitioners. As a result, the paper has two main contributions: (1) it showcases the features of the research apprenticeship model that bridge practice and research, and (2) it expounds on the learning process, which is described as legitimate peripheral participation, which fosters knowledge and competencies relevant to both research and practice.

## 2. BACKGROUND

In the following, I describe (1) the practice-research gap faced by the IS research and practitioner communities, (2) "legitimate peripheral participation" as the key to becoming a member of these communities, and (3) student research as a form of legitimate peripheral participation that bridges the practice-research gap.

### The Practice-Research Gap

Even though the IS discipline strives to bridge the practice-research gap (Mathiassen & Sandberg, 2013), the gap is still widely acknowledged (Farhoomand, 1987; Grover & Sabherwal, 1989; Szajna, 1994). This gap manifests itself in the lack of practical relevance of IS research (Benbasat & Zmud, 1999; Westfall, 1999), misalignment between industry competency requirements and educational content (Beckman et al., 1997; Lippert & Anandarajan, 2004), divergent interests between researchers and practitioners (Gosain et al., 1997), and lack of communication and collaboration between the two groups (Desouza et al., 2006; Glass, 2001; Moody, 2000). Differences in terminology between the groups and "different incentive systems lead to different interests and hence to a 'pragmatic knowledge boundary' between IS researchers and IS practitioners" (Abraham et al., 2021, p. 365). Boundary spanners like student researchers are needed to overcome this

pragmatic knowledge boundary.

Other mechanisms to bridge the gap include publications, education, and conferences (Nevill & Wood-Harper, 2001). Whereas publications and conferences are vehicles for disseminating research-based knowledge (Gosain et al., 1997; Nevill & Wood-Harper, 2001; Szajna, 1994) and for discussing its implications, education provides students with the knowledge and competencies to be bridge-builders between research and practice (Nevill & Wood-Harper, 2001; Pearson et al., 2005).

Diverging interests between researchers and practitioners (Lippert & Anandarajan, 2004) and the turnaround time of journals (Lyytinen, 1999; Moody, 2000) challenge the effectiveness of these mechanisms. Among the suggested solutions are accelerated publication processes (Benbasat & Zmud, 1999; Chen & Hirschheim, 2004), hands-on experience in the classroom (E. Watson & Schneider, 1999), and innovative partnerships between practitioners and researchers (H. Watson & Huber, 2000). Such partnerships may involve students participating in projects that seek to bridge real-world practice and academic research (Mathiassen & Sandberg, 2013).

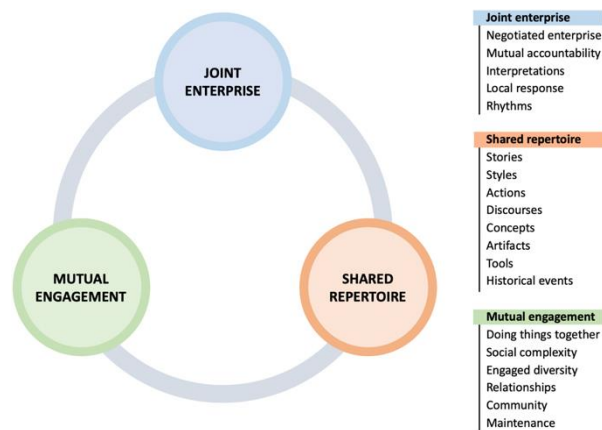
"Boundary encounters" between researchers and practitioners are important for knowledge exchange and learning (Wenger, 1998). "Boundary encounters" fall into three categories: one-to-one, immersion, and delegation. Whereas one-to-one encounters are meetings between two members of different communities, immersion means site visits that involve greater exposure to a community, and delegation is purposeful and agreed-upon knowledge exchange. An example of a boundary encounter is a student engaging in design science research to bridge the gap between theoretical and practical knowledge (Venter et al. 2015) and to participate in the IS researcher and practitioner communities of practice.

### Legitimate Peripheral Participation

According to Lave and Wenger (1991), "a community of practice is a set of relations among persons, activity, and world, over time and in relation with other tangential and overlapping communities of practice. A community of practice is an intrinsic condition for the existence of knowledge, not least because it provides the interpretive support necessary for making sense of its heritage" (Lave & Wenger, 1991, p. 98). Figure 1 (high-resolution version in Appendix A) illustrates the concept of community of practice

and its three constituent dimensions (adapted from (Wenger, 1998, p. 73)).

Mutual engagement, joint enterprise, and shared repertoire constitute three dimensions of practice and sources of community coherence, hence the wording “community of practice.” Participation and learning along these three dimensions are needed to become peripheral and eventually fully-fledged community members. A community of practice thus “acts as a locally negotiated regime of competence. Within such a regime, knowing is no longer undefined. It can be defined as what would be recognized as competent participation in the practice” (Wenger, 1998, p. 137).



**Figure 1: Communities of practice**

Legitimate peripheral participation is a situated learning activity in which newcomers learn from veteran members by participating in the sociocultural practices of the community (Lave & Wenger, 1991). Consequently, legitimate peripheral participation describes learning by doing, i.e., that knowledge and competencies are acquired by a prospective community member (“apprentice” henceforth) by engaging in practice under the supervision of a domain expert (referred to as “master” in the following) who belongs to the community of practice. The quality of both learning and teaching (by the apprentice and master, respectively) depends on effectively managing “participation that provides for growth on the part of the student” (Lave & Wenger, 1991, p. 21). Through this participation, an apprentice becomes immersed in, learns, and adapts to the “culture of practice” associated with the community of practice.

### Student Research as Legitimate Peripheral Participation

One way of bridging the practice-research gap is to involve students in projects across the boundaries that separate academic research from industrial practice (Mathiassen & Sandberg, 2013). This involvement may entail students engaging in research as legitimate peripheral participants and eventually becoming both knowledgeable and competent community members. Experiential learning projects help reduce the gap between academics and practitioners (Wu & Sankar, 2013), and “students are better prepared for the work-life as problem solvers, since they are familiar with a process for systematically solving problems” (Olsson et al., 2003, pp. 82–83) if they engage in research. Similarly, Bernat et al. (2000) argue that student research enables them to “develop domain expertise, gain an understanding and appreciation of the research process and its practice, and acquire team, communication, problem-solving, and higher-level thinking skills. Students with this experience are better equipped to make informed judgments about technical matters and to communicate and work in teams to solve complex problems” (Bernat et al., 2000, p. 17).

Research and teaching are mutually reinforcing learning processes (Obwegeser et al., 2016), and “students gain learning benefits when they are taught by active researchers and are engaged directly in research activities” (Obwegeser & Papadopoulos, 2016, p. 250). Integrating research components into IS curricula “can play an important role in improving student learning and refining student skills” (Moussawi & Vatanasakdakul, 2021, p. 9). Student research promotes cognitive and intellectual growth if students are intrinsically motivated (Parikh, 2002) and guided by an experienced researcher (Tams, 2014). By incorporating research into teaching, students take on an active role in their own learning, gaining opportunities to acquire domain knowledge and develop research skills (Natsis et al., 2018).

Despite its potential, extant IS literature on student research is limited. Exceptions include (1) the development of a conceptual research-to-practice framework to study the transfer of knowledge from research to practice (van Toorn et al., 2011) and (2) studies of various attempts at incorporating research elements into existing courses (Holland & Garfield, 2012; Mustafa, 2004; Obwegeser & Papadopoulos, 2016). Guidance is needed, e.g., in the form of “supportive elements added to a program to help

students develop a higher level of understanding” (Holland & Garfield, 2012). More real-world examples and measures of the benefits of research-teaching integration are needed to bridge the practice-research gap (Obwegeser & Papadopoulos, 2016). This paper responds to these calls for research.

### 3. METHODOLOGY

The research apprenticeship model has been evaluated from the perspective of graduates through an online survey. I decided on a survey because (1) I wanted to include all 16 former apprentices I supervised over a 9-year period, many of whom are in different parts of the world. An online survey allows for easy and flexible data collection, increasing the likelihood of respondents agreeing to participate if they can complete a questionnaire at their convenience. (2) I also wanted to be able to continue data collection in the future to continually evaluate and improve the model. The purpose is not to derive statistically significant and generalizable results. The number of students engaging in research collaboration with faculty members yearly constitutes a small percentage of the entire student population. It is therefore not possible to generalize to the entire student population, but it is arguably possible to say something meaningful about those students who are actively doing research since all of them are included in the survey.

#### The Research Apprenticeship Model

The model targets ambitious IS students (apprentices henceforth) who want to contribute to science, undertake a research project, and write an academic paper during their final study year. Instead of writing a “normal” thesis (i.e., a monograph), I offer them a research apprenticeship during which they write a conference or journal paper. Research apprenticeship is offered to everybody but presented as very demanding, although highly educational, which ensures self-selection among prospective apprentices. It is demanding because of the imperative of knowledge creation associated with research. Meanwhile, the learning outcomes are high due to sparring and collaboration with research partners, including practitioners and myself as supervisor.

Apprentices either develop their own research ideas or join existing projects in which I am involved. They are invited to all project meetings with my research partners if they decide on the latter. The partners and I assist the students in defining their contribution to the overall project

and gaining access to the selected unit of analysis (e.g., a hospital ward) and people (e.g., healthcare professionals) being investigated.

The apprentices carry out their investigation under my guidance. This investigation addresses real-world problems and often involves empirical studies and collaboration with practitioners. I advise and show them how I address similar challenges in my research practice. I am therefore involved in all phases and aspects of their project, from designing to carrying out studies. This hands-on approach involves, among other things, showing them how to conduct a literature review and collect and analyze data. In addition to individual supervision, the students participate in seminars that focus on (1) what research is and requires (in terms of, e.g., literature review and research design), (2) how to leverage the help of colleagues to advance one’s research (through peer review), and (3) how to communicate the relevance and rigor of one’s research (pitching results and contributions of studies).

I review draft versions of their papers 2-3 times before submission. I comment on the gradually maturing drafts at a detailed level and approach it as a normal paper review. In addition to high-level comments on the structure and content, I also provide in-depth comments at the sentence level. This communicates the requirements of a publishable paper and helps the apprentices improve the quality of their work. A pre-project agreement is made to publish the results of our collaboration in a publication with all contributing partners as co-authors. I do not edit or write on the paper before graduation to minimize conflicts of interest.

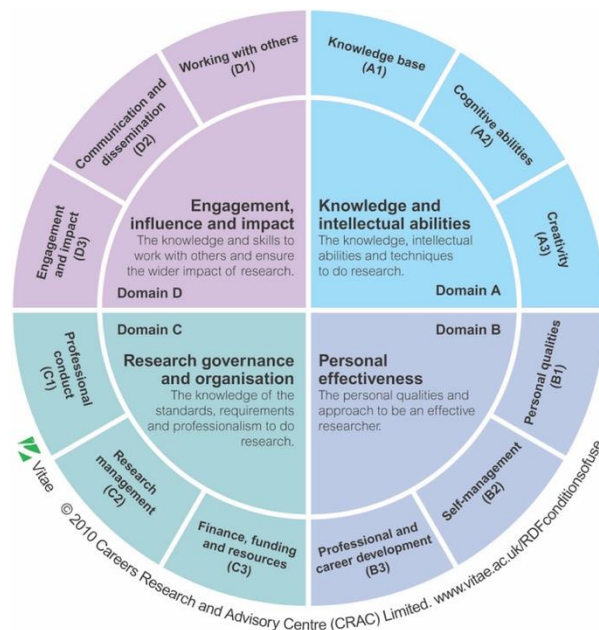
As part of their thesis, the apprentices submit a learning report reflecting on the research process, learning outcomes, and the implications of the investigations for practitioners and their future careers. The research apprenticeship model is described in detail in (Müller, 2022).

#### Survey

The survey (see Appendix D) is adapted from (Christensen & Tegtmejer, 2015) and consists of two parts: Motivation and competencies. The competency part is based on the Researcher Development Framework (RDF) (Vitae, 2011), which describes the competencies that researchers need. Other IS-specific frameworks include MSIS, a competency model for IS educational programs at the master’s level (Topi et al., 2017). I decided, however, to rely on the RDF due to its particular focus on research-based



competencies, to evaluate their relevance to practitioner communities (cf. the practice-research gap). The RDF is characterized as a professional development framework that “articulates the knowledge, behaviours and attributes of successful researchers” (Vitae, 2011, p. 1). The RDF is structured around four domains: (A) “Knowledge and intellectual abilities,” (B) “Personal effectiveness,” (C) “Research governance and organization,” and (D) “Engagement, influence, and impact.” The four domains are divided into 12 sub-domains and 63 descriptors that capture researcher competencies, including “the knowledge, intellectual abilities, techniques and professional standards to do research, as well as the personal qualities, knowledge and skills to work with others and ensure the wider impact of research” (Vitae, 2011, p. 2). Each descriptor is found at three to five stages of maturity, representing different levels of performance or development. Figure 2 (see Appendix A for a more detailed version) illustrates the RDF (adapted from (Evalueringcenteret, 1996)).



**Figure 2: Researcher Development Framework**

Each descriptor has been translated into one or more questions in the survey. First, each competency at stages 1-2 was summarized as one or more statements. Competencies at stages 3-5 were excluded as these are developed later in a research career. In total, 126 questions were reviewed by researchers from Aarhus University’s Centre for Teaching and Learning (I developed

the research apprenticeship model when I was employed there). 76 questions were selected, and a pilot test was performed on five student researchers (not part of this study). The test helped strengthen the internal validity and ensure that the questions were relevant, unequivocal, and comprehensible. The wording was carefully considered to reduce ambiguity (Olsen, 2001). Besides the test, it is worth mentioning that the motivation part of the survey has been validated previously (Herrmann et al., 2013).

For each question, respondents were asked to give two responses, one related to competency development during their apprenticeship and one related to competency use in their post-graduation employment. A Likert scale was used, but respondents could also provide qualitative comments. The motivation part of the survey includes questions regarding the background and incentive to do an apprenticeship, expectations, career plans, the research environment, and the quality and extent of supervision. The questions about expectations and motivation are inspired by (Evalueringcenteret, 1996), whereas the questions regarding the research environment and supervision are based on (Herrmann et al., 2013).

**Data Collection and Analysis**

The survey was distributed online. All 16 former research apprentices were contacted and asked to participate. All of them accepted and completed the survey. They were informed about the survey’s purpose and length (30-45 minutes). Feedback from them indicates that they spent significantly more time because many of them provided in-depth elaborations. The survey was sent out in August 2020 and completed by October 2020. Reminders helped ensure a 100% response rate. There is a risk my close relationship with the former students may have influenced their responses. This risk has been mitigated by encouraging constructive criticism to help improve the research apprenticeship model.

To render respondents’ answers measurable and comparable, each category of answers was assigned a value. For example, “to a slight degree / not at all” was assigned a value of (1), “to a lesser degree” (2), “to some degree” (3), and “to a large degree” (4). “Do not know” was coded as missing and was therefore not assigned a value. The average score of the 16 answers was then calculated for each statement with average scores potentially ranging from 1 to 4. Answers that indicate disagreement with the statement (values of 1-2) have a lower score, while answers that indicate agreement with the statement

(values of 3-4) have a higher score. Regarding the competencies part of the survey, averages above three indicate respondents having acquired the competencies in question (according to their self-assessment). In addition to quantifying survey responses and calculating average scores, respondents' elaborations and explanations of their answers to the questions were analyzed. Their comments supported interpretations of survey responses and explanations of response patterns.

#### 4. RESULTS

Below, the results are presented according to (1) motivation and (2) competencies (see Appendices B and C for details). The percentages in Table 1 and the text indicate the proportion of respondents who answered "agree" or "partially agree" to a question.

##### Motivation

The analysis reveals that the research apprentices are primarily motivated by the intellectual challenge associated with an apprenticeship (62.50%), the prospect of contributing new research-based knowledge (56.25%), and the possibility of doing research under the guidance of a faculty member (31.25%). They expected to publish a scientific paper (3.88), immerse themselves in a topic (3.81), acquire knowledge of research methods (3.56), gain research experience (3.44), and learn to work independently (3.13).

There is agreement among the apprentices that they feel respected as colleagues (92%), that senior researchers show an interest in their research (85%), that it is recognized as important (85%), and that there is a welcoming attitude toward questions from apprentices (73%). These numbers (Table 1; high-resolution version in Appendix A) indicate that they feel part of the IS research community.

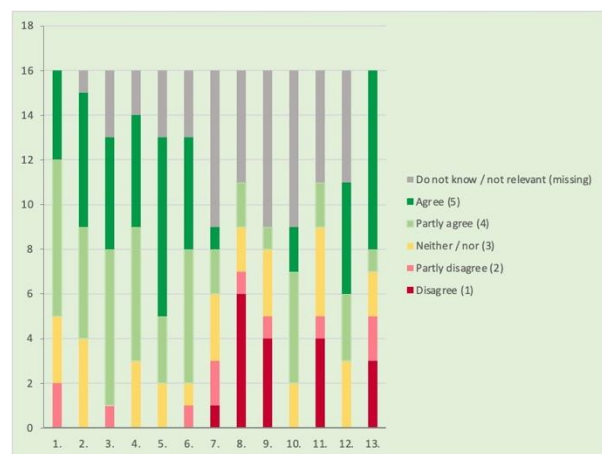
Although all respondents receive supervision as needed on all aspects of their project, they are also encouraged to work independently (100%) and assume project management responsibility (94%). The relationship between master and apprentice is one of mutual respect (100%) and discussing challenges openly (100%). The apprentices feel acknowledged (100%) and that they are being listened to (94%).

	Disagree (1)	Partly disagree (2)	Neither / nor (3)	Partly agree (4)	Agree (5)	Do not know / not relevant (missing)	In sum	In sum minus missing	Partly agree + agree, %
1. In this place, I meet other research apprentices that I can verbally spar with.	0	2	3	7	4	0	16	16	69%
2. If one has a professional problem, one always feels welcome to ask one of the other researchers.	0	0	4	5	6	1	16	15	73%
3. I feel respected as a co-researcher in this place.	0	1	0	7	5	3	16	13	92%
4. There is a feeling of excitement around cooperating on research tasks.	0	0	3	6	5	2	16	14	79%
5. The permanent research staff is generally interested in hearing about my project.	0	0	2	3	8	3	16	13	85%
6. In this research environment, the research apprentices' research work is acknowledged even though it may not be pioneering.	0	1	1	6	5	3	16	13	85%
7. In this place, we regularly present and discuss each other's research.	1	2	3	2	1	7	16	9	33%
8. I experience that the researchers are tough and negative rather than constructive in their feedback on each other's work.	6	1	2	2	0	5	16	11	18%
9. People seem to be very competitive towards each other.	4	1	3	1	0	7	16	9	11%
10. One can speak openly about successes as well as failures with one's colleagues.	0	0	2	5	2	7	16	9	78%
11. I feel that I am part of a research community in this place.	4	1	4	2	0	5	16	11	18%
12. In this place, good arguments are welcomed no matter whether they are from an apprentice, PhD student or professor.	0	0	3	3	5	5	16	11	73%
13. Physically, I spend most of my research time outside the research environment (e.g., at home or with a company).	3	2	2	1	8	0	16	16	56%

**Table 1: The research environment**

The research apprentices feel ownership (94%) of their project and find it very interesting (100%). Although some of them are unsure if they are sufficiently competent (38%) and worry about whether their work is good enough (50%), they are very satisfied with the learning outcomes (100%), the product quality of their work (100%), and their supervision (94%).

Figure 3 (high-resolution version in Appendix A) provides a visual overview of the results. It shows that the research community is characterized by mutual respect, a welcoming attitude, open dialogue, cooperation among apprentices and senior researchers, and genuine interest in and acknowledgment of apprentices' work.



**Figure 3: The research environment**

Appendix B contains supplementary figures and tables related to the motivational aspects of research apprenticeships.

### Competencies

Table 2 (high-resolution version in Appendix A) provides an overview of the apprentices' self-assessment of their learning outcome for each domain and sub-domain of the RDF.

Domain/sub-domain	Number of responses		Average
	Valid	Missing	
DOM A1: Knowledge base	95	1	3.56
DOM A2: Cognitive abilities	94	2	3.55
DOM A3: Creativity	57	7	3.25
DOM B1: Personal qualities	92	4	3.54
DOM B2: Self-management	87	9	3.20
DOM B3: Professional and career development	146	14	2.74
DOM C1: Professional conduct	139	21	3.40
DOM C2: Research management	41	7	2.27
DOM C3: Finance, funding and resources	13	3	2.08
DOM D1: Working with others	157	35	2.72
DOM D2: Communication and dissemination	59	5	3.10
DOM D3: Engagement and impact	88	24	2.11
DOM A: Knowledge and intellectual abilities	246	10	3.48
DOM B: Personal effectiveness	325	27	3.09
DOM C: Research governance and organisation	193	31	3.07
DOM D: Engagement, influence and impact	304	64	2.62

**Table 2: Apprenticeship learning outcome**

The table indicates that the apprentices have acquired the competencies of successful researchers as described by the RDF (Vitae, 2011). The average scores of 3 and above for three out of four domains and seven out of 12 sub-domains are a testament to high learning outcomes. Consequently, the apprentices have acquired (1) the knowledge, intellectual abilities, and techniques to do research; (2) the personal qualities and approach to be an effective researcher; and (3) the knowledge of the standards, requirements, and professionalism to do research. These competencies are associated with domains A, B, and C of the RDF (Figure 2). Subdomains A1, A2, and B1 are particularly noteworthy, with average scores above 3.5. These scores related to "Knowledge base" (3.56), "Cognitive abilities" (3.55), and "Personal qualities" (3.54) indicate the acquisition of particularly strong competencies in information management, critical thinking, and self-reflection. In Appendix C, Tables C-1, C-2, C-3, and C-4 reveal that sub-domain averages are being pulled down by non-relevant descriptors related to funding applications and teaching activities in which apprentices are not involved. This explains why the D domain score is below 3.

Table 3 (high-resolution version in Appendix A) shows respondents' evaluation of competencies used in their post-graduation employment (see

Tables C-5, C-6, C-7, and C-8 in Appendix C for details).

Domain/sub-domain	Number of responses		Average
	Valid	Missing	
DOM A1: Knowledge base	73	23	3.10
DOM A2: Cognitive abilities	71	25	3.21
DOM A3: Creativity	42	22	3.48
DOM B1: Personal qualities	80	16	3.56
DOM B2: Self-management	76	20	3.12
DOM B3: Professional and career development	125	35	3.11
DOM C1: Professional conduct	102	58	2.74
DOM C2: Research management	33	15	2.67
DOM C3: Finance, funding and resources	13	3	2.23
DOM D1: Working with others	127	65	2.56
DOM D2: Communication and dissemination	47	17	2.40
DOM D3: Engagement and impact	84	28	2.37
DOM A: Knowledge and intellectual abilities	186	70	3.23
DOM B: Personal effectiveness	281	71	3.24
DOM C: Research governance and organisation	148	76	2.68
DOM D: Engagement, influence and impact	258	110	2.47

**Table 3: Learning outcome used in practice**

"Creativity" (sub-domain A3) is among the three highest-scoring sub-domains, which makes innovation a key competency. Also, "Professional and career development" (sub-domain B3) scores high, suggesting that career management and professional development competencies are seen as more relevant in the former apprentices' current employment. Finally, Table 3 reveals "missing" responses across domains and sub-domains (30 and 34% for domains C and D). The free-text elaborations indicate that not all questions are equally relevant in relation to their current employment (see Appendix C). Nevertheless, the competencies related to domains A and B ("Knowledge and intellectual abilities" and "Personal effectiveness") of the RDF are still seen as highly relevant.

## 5. DISCUSSION

This study confirms the learning benefits of student research and shows that the research apprenticeship model supports legitimate peripheral participation in the IS research community of practice. They acquire domain knowledge and competencies that are also needed as IS practitioners. The level of agreement between competencies learned through research apprenticeship and competencies used in the graduates' current employment shows the apprenticeship model to be a means of bridging the practice-research gap (Mathiassen & Sandberg, 2013). The contribution of the paper is twofold: (1) demonstrating the features of the model that help bridge the practice-researcher gap, and (2) explaining the learning process, i.e., legitimate peripheral

participation, that results in both research and practice-relevant knowledge and competencies.

Regarding the first contribution, this paper shows student research, specifically the student apprenticeship model, as a means of closing the practice-research gap. The survey responses point to the model characteristics that are particularly instrumental in closing the gap. First, student apprenticeship is a form of immersion "boundary encounter" (Wenger, 1998). Survey responses reveal that the possibility of immersion in a topic of their own choice is a key motivation behind students' decision to do an apprenticeship. Second, the apprenticeship model increases the relevance of IS research collaborations with the industry (Benbasat & Zmud, 1999; Westfall, 1999). The survey results show that students are also motivated by the potential for conducting research with real-world impact and relevance together with industry partners. Third, as documented in Table 3, the model enables students to acquire some of the competencies needed after graduation, thereby reducing the misalignment between industry requirements and educational content (Beckman et al., 1997; Lippert & Anandarajan, 2004). Fourth, the survey responses also show that students experience commitment from industry partners because of the model's emphasis on engaged research that involves both researchers and practitioners, which helps ensure alignment of interests (Gosain et al., 1997). Most of the students report having access to their research partners whenever needed. Fifth, the model also fosters communication and collaboration between the students as researchers and their industry partners (Desouza et al., 2006; Glass, 2001; Moody, 2000). The students see industry partners as co-supervisors who provide input and feedback on their projects. They all have regular, scheduled meetings (monthly, weekly, or even daily) with these co-supervisors. Finally, the survey reveals the value of hands-on learning experiences (E. Watson & Schneider, 1999). The responses show that the apprenticeship raises awareness among students of how to develop and apply their competencies in academic and non-academic areas. In summary, the paper contributes to state-of-the-art knowledge of bridging the practice-research gap. The research apprenticeship bridges this gap in the form of a tailorable model that provides access to the IS research and practitioner communities of practice. Through legitimate peripheral participation, students become members of the IS research community of practice and learn *how to learn* about real-world practice and what

members of the IS practitioner community care about.

Regarding the second contribution, this paper demonstrates how the research apprenticeship model as a form of legitimate peripheral participation enables apprentices to acquire knowledge and competencies needed by both researcher and practitioner communities of practice. Revisiting the three dimensions of communities of practice (Figure 1), this study shows that research apprenticeship facilitates the required learning to become a community member (Wenger, 1998). Regarding "mutuality of engagement," survey responses point to the value of a research environment that supports student projects, which suggests an "ability to engage with other members and respond in kind to their actions, and thus the ability to establish relationships in which this mutuality is the basis for an identity of participation" (Wenger, 1998, p. 137). In terms of "accountability to the enterprise," the sparring and close working relationships provide apprentices with an entry point that helps them "understand the enterprise of a community of practice deeply enough to take some responsibility for it and contribute to its pursuit and its ongoing negotiation by the community" (Wenger, 1998, p. 137). Finally, in relation to "negotiability of the repertoire," research apprenticeship is a means of learning the language of IS practice. Apprentices' research commitment and their engagement with the history of IS practice (manifested in the literature and the people they work with) provide them with "the ability to make use of the repertoire of the practice to engage in it" (Wenger, 1998, p. 137).

From the perspective of situated learning, the apprenticeship model allows for legitimate peripheral participation. The model is consistent with the movements from a teacher-centered to a learner-centered educational paradigm (Saulnier et al., 2008). The model succeeds in including apprentices in the IS researcher community of practice in the sense that they feel accepted as part of that community, they learn the language and methods of the trade, and they acquire domain knowledge and competencies that are also valued by IS practitioners. Students can be motivated to engage in research by the promise of learning and the prospect of publishing an article that contributes to state-of-the-art knowledge. In addition, the possibility of defining their own research projects and the apprentices' feeling of ownership motivate their engagement and foster learning (Parikh, 2002). Thus, the study confirms that research and teaching reinforce learning (Obwegeser et al., 2016), and

student research in the form of research apprenticeship catalyzes students' cognitive and intellectual growth (Tams, 2014). Survey responses indicate that, e.g., research guidance, project ownership, and continuous sparring stimulate learning and growth. Moreover, not only does the study confirm that students acquire team, communication, intellectual, and problem-solving skills (Bernat et al., 2000; Olsson et al., 2003), but it also breaks them down into very specific competencies, cf. domains, sub-domains, and descriptors (Figure 3, Tables 3-4, and Appendix C).

In terms of practical implications, I suggest that IS faculty members wanting to adopt the model (1) articulate high expectations and underscore the demanding though rewarding nature of research apprenticeship to promote self-selection among students. This helps ensure that only ambitious, hardworking, and able-minded students opt in. (2) Dictate and steer the process but allow for flexibility and foster ownership on the part of students by having them draft and commit to project plans. The model needs to be tailored to each student and project while maintaining the need for project oversight and management by the supervisor. (3) Be generous with your time. The model blurs the boundary between teaching and research, but learning to become a community member takes time and supervision.

Despite its strengths, questions about the research apprenticeship model remain unanswered. This study evaluates the model by focusing on input (motivation) and output (competencies) rather than the learning process itself. Consequently, a study that follows apprentices from start to finish to evaluate the individual activities associated with the apprenticeship model is suggested. To supplement the survey reported here, such a study may draw on qualitative methods and data sources like interviews and documents to investigate the process and the associated learning benefits and obstacles. A study employing qualitative interpretive methods or grounded theory could potentially provide a significant theoretical contribution, particularly when exploring a small sample of students that limits the potential for statistical generalization. Other studies should look at student research to build broader IS competencies, for example, in the context of course-based undergraduate research (Dolan & Weaver, 2021). Among the unanswered questions are: To what extent can student research promote the competencies "that enable graduates to contribute to the positive

transformation of various goal-oriented human activities through digitalization" (Topi et al., 2017, p. MSIS-1)? The MSIS competency model for IS educational programs may be used as a point of departure (Topi et al., 2017). Another related research topic is student research as a means of learning about practice. Whereas the apprenticeship model aims at teaching students about research with the added benefit of acquiring knowledge and competencies that are valued by IS practitioners, there is a need for students to learn about real-world practice, because most graduates are employed in the industry rather than academia.

## 6. CONCLUSION

In this paper, I present and evaluate "research apprenticeship," a student research model that supports so-called legitimate peripheral participation and students becoming knowledgeable and fully-fledged members of a community of practice. The model's learning outcomes are evaluated through a survey based on the Researcher Development Framework (Vitae, 2011), which draws heavily on learning theory to focus on competencies and motivation. The results show that it supports students in acquiring the domain knowledge and competencies valued by IS practitioners. Survey responses are analyzed and discussed based on concepts of legitimate peripheral participation and community of practice, and the paper contributes to state-of-the-art knowledge by providing a model that bridges the practice-research gap (Mathiassen & Sandberg, 2013). The model supports legitimate peripheral participation in the IS research community of practice and helps them become knowledgeable and competent members and IS practitioners.

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**APPENDICES A - D**

Appendices A through D are available by contacting the author or online at <https://u.pcloud.link/publink/show?code=XZyEOz0ZkNxaj67O6pVYAzXRJyOzdXusDOMX>

# Teaching the Metaverse: Applying TPACK to a Multidisciplinary First Year Seminar Course Design

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## Abstract

This paper explores the course design and implementation of a first-year discovery seminar on “Living in the Metaverse” offered at a business university. Integrated with standardized college-readiness topics, the course combines hands-on activities with collaborative assignments and class discussions to present a multidisciplinary exploration of the metaverse from business, technology, and societal perspectives. The authors describe how they utilized the TPACK (Technology, Pedagogy and Content Knowledge) model in designing the course, and how this model can be applied when considering how to incorporate new technologies into courses. To assess the effectiveness of this approach, the authors surveyed students in three sections of the course taught during two consecutive semesters to determine their attitude toward relevant technologies and the course topics. We found that hands-on activities with virtual reality headsets helped make metaverse concepts easier to grasp, while students still had concerns about widespread use of the metaverse, including privacy and security.

**Keywords:** metaverse, virtual reality, TPACK model, first-year seminar, experiential learning.

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# Teaching the Metaverse: Applying TPACK to a Multidisciplinary First Year Seminar Course Design

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## 1. INTRODUCTION

This paper describes the design of a first-year discovery seminar (FDS) course at a business university where the instructors chose as its theme, "Living in the Metaverse." The FDS course at many universities provides an extended orientation for incoming students to adapt to their new college surroundings, meet their peers, and learn about research by exploring complex problems from a multidisciplinary perspective (Reid et al., 2014; Rust & Korstange, 2018). This combination of academic-skill building (critical thinking, information literacy, working across differences, problem solving, learning how to learn, intellectual curiosity, and academic integrity) within the context of a larger open-ended question provides a compelling model for exploration and learning and can have a positive impact on student success.

Each incoming student enrolls in an FDS course during the fall semester (the exception being transfer students and those who need to repeat the course.) The university offers more than 50 sections of FDS each fall, collectively, these are taught by more than 40 different instructors. One-third of the FDS course content is standard material, common across all sections: campus resources, time management, academic expectations, information literacy, unconscious bias, doing research, writing a research paper. The other two-thirds of the course content can be any "wicked problem" or open-ended issue that each instructor selects for their section. The authors chose to explore the metaverse as the open-ended "challenge" in their sections, and designed the course to be *about the metaverse*, presenting an overview of the topic from a multidisciplinary perspective, focusing on its connections to business, society, and technological development.

At its most basic level, a metaverse is a three-dimensional space in which users interact using virtual reality and with other users represented as avatars. Many metaverses exist: decentralized virtual spaces, or worlds, such as Meta Horizon Worlds, Roblox, Decentraland, and the Sandbox, where people gather synchronously online to conduct business meetings, play video games, attend social events, purchase real estate, and

visit destinations they may not be able to get to in real life. Many metaverses have their own digital economies. Avatars or digital twins form a person's online identity in and across metaverses (Kshetri, 2022). As metaverse technologies evolve, a goal is to link individuals' avatars and digital assets so that users can operate consistently across multiple metaverses. Some consider the metaverse as the next iteration or future of the internet (Ramesh et al., 2022), a Web3 application that brings value to the user generated content that characterizes Web 2.0 (Suderman, 2022).

The following questions guided this study:

- When designing a multidisciplinary course intended to introduce a new technology, what pedagogical approaches and technology tools can instructors utilize to make course concepts relevant and accessible to students?
- How can student attitudes and concerns be measured to ascertain their learning and engagement with the topic?

This paper is organized as follows: the next section describes the goals of the course from a multidisciplinary perspective. The subsequent sections analyze the course design using the TPACK (Technology, Pedagogy, and Content Knowledge) framework (Niess, 2011), mapping learning goals and assignments to its various components. The final sections of this paper present the authors' methodology to develop a survey instrument and share findings related to the student experience during the course. The paper ends with a discussion of lessons learned and other considerations while designing and teaching the course.

## 2. THE METAVERSE FROM A MULTIDISCIPLINARY PERSPECTIVE

Because the metaverse has connections to business, society, and technology development, the instructors chose to teach "Living in the Metaverse" from a multidisciplinary perspective. To that end, the instructors posed more complicated questions to motivate in-class discussion. For example:

- What new benefits does the metaverse offer for engaging in business and social interactions, and what is required to do so? What risks might come with these benefits?
- How does the metaverse allow us to blend physical and digital experiences? How do we represent ourselves and interact with others similarly or differently in physical and virtual worlds?
- How has the development of mobile devices, wearable computing, augmented and virtual reality, wireless internet, digital currencies, and advanced communication networks converged to create a new frontier where interacting in activities of daily life, from learning to business to social, are possible?

To choose supporting material, instructional content, and teaching methods, we were guided by learning objectives specific to the metaverse. Furthermore, by stating what we wanted the students to accomplish, we were better able to understand whether students had gained the appropriate knowledge and skills by the end of the course. The learning objectives we used appear in Appendix A.

To support these learning objectives, the course included several hands-on opportunities to explore metaverses both in a browser and wearing VR (Virtual Reality) headsets. Students attended events in online virtual communities, created avatars, designed their own virtual worlds and interactive games, and investigated features of established metaverse spaces. This approach included connecting student experiences to theory. This connection was especially of interest to FDS program administrators who wanted students to appreciate both principles and practices within the scope of the course. The expansive nature of the learning objectives encouraged students to select a diverse array of topics within the realm of the metaverse for their research papers, including fast fashion, technology addiction, community governance, decentralization of authority, and the impact of the metaverse in developing countries.

The cadence of the course content included a somewhat gentle beginning and end. Most of the learning resources during the first three weeks were introductory in nature and appeared in the popular press and online video sites, e.g. (CNET, 2022; Hill, 2022). Such resources illustrated the relevance of the metaverse and were written (and produced) in a way that is accessible to first-year students. During the last two weeks, the students learned about personal identity and avatars

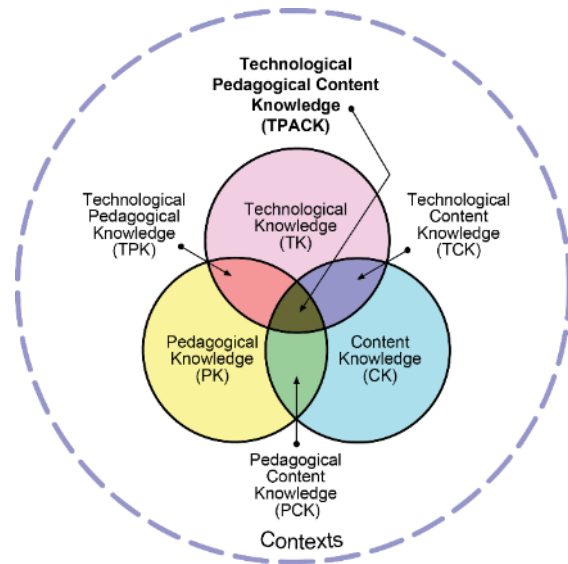
(Szita, 2022; Trinity College, 2022) and how meetings are hosted in the metaverse (Chodor, 2022). Appendix A presents the structure and sequencing of the Spring 2023 course. Appendix D shares selected readings from the course that represent course topics including business, cultural, social, and technological perspectives on the metaverse.

The perspective of the private sector was well articulated by metaverse reports from Forrester (Truog et al., 2022), Gartner (Furlonger et al., 2022), Ernst & Young (Morini Bianzino, 2022), McKinsey & Company (2022), and others. These business-focused resources were balanced by reports focused on education (Korinek, 2023) and benefits and risks to society (J. Anderson & Rainie, 2022). Taken together, these resources provided examples of in-depth analysis of the subject matter and helped catalyze deliberative discourse among the students and exposed them to multiple perspectives from which they could draw upon when considering topics for their research papers.

Section 3 discusses the pedagogical model behind our multidisciplinary course design. Section 4 proceeds to describe the course assignments that support the learning objectives described in Appendix A.

### **3. AN ANALYSIS OF THE METAVERSE COURSE DESIGN USING THE TPACK FRAMEWORK**

Technological Pedagogical and Content Knowledge (TPACK) is a conceptual framework to describe the knowledge base for the effective integration of technology in teaching (Mishra & Koehler, 2006). This model extends the work of Gudmundsdottir and Shulman (1987) by introducing the use of technology to enhance and support student learning. As an educational framework for course design, TPACK describes the knowledge that teachers need to successfully integrate Technology (T), Pedagogy (P), and Content (C) knowledge about a topic in the classroom. The TPACK framework requires instructors to make pedagogical decisions as to the best ways to introduce digital technologies in their courses to teach content knowledge. Figure 1 shows the interplay and relationships between these elements. The region at the intersection of technology, pedagogy, and content represents a full understanding for teaching with technology. TPACK provides a framework for using technology to teach concepts to enhance the learning experience. (Mishra & Koehler, 2006; Niess, 2011; *TPACK.ORG*, 2018).



**Figure 1: TPACK model; image courtesy of (TPACK.ORG, 2018).**

Underlying truly meaningful and deeply skilled teaching with technology, TPACK is different from knowledge of all three concepts individually. Instead, TPACK is the basis of effective teaching with technology, requiring an understanding of the representation of concepts using technologies; pedagogical techniques that use technologies in constructive ways to teach content; knowledge of what makes concepts difficult or easy to learn and how technology can help redress some of the problems that students face; knowledge of students' prior knowledge and theories of epistemology; and knowledge of how technologies can be used to build on existing knowledge to develop new epistemologies or strengthen old ones" (Koehler & Mishra, 2009).

The authors considered this model as part of the course design for their FDS seminar on living in the metaverse. The instructors considered

various pedagogies, processes, and practices necessary to make this content relevant to student learners. One technique used frequently was to create an online slide deck using Office 365 to which students could work in groups to add content.

By doing so, different groups could explore more deeply distinct parts of a complex article or reading, and develop their understanding with each other, and then share it with the class (Al-Samarraie & Saeed, 2018). When evaluating technology tools for the course, the instructors considered a suite of collaboration tools to incorporate. The instructors also explored scenarios for incorporating virtual reality headsets, applications, and toolkits for students to experience and create their own immersive virtual spaces.

#### 4. COURSE ASSIGNMENTS

In addition to several extended orientation and study skills assignments often found in first-year seminar courses and common to all FDS sections at the university, approximately two-thirds of coursework was based on the section's wicked problem, living in the metaverse.

Appendix B describes the various metaverse-related assignments. The hands-on assignments progressed in difficulty from visiting existing metaverses (i.e., Decentraland) using a browser, to visiting a metaverse using VR headsets for an immersive experience, to creating one's own original interactive metaverse experience. Headsets were available for use in the technology learning lab (the CIS Sandbox) at Bentley University (Frydenberg, 2013). Each of these assignments required students to apply their technology knowledge and their content knowledge of the metaverse to complete.

TPACK Component	Description	Pedagogy to Meet Learning Objectives
CK	Knowledge about subject matter to be learned or taught	Provide background and materials for students to understand metaverse subject areas and topics
PK	Methods, processes, and practices of teaching, including learning and assessment	Create open ended assignments for students that foster curiosity and discovery
TK	Technology knowledge needed to use hardware/software	Design activities for students to effectively use VR equipment and metaverse software applications for experiential learning
PCK	Representing content and adopting pedagogical strategies to make topics more understandable to learners	Read and discuss in-depth articles with partners, think/pair/share, etc.
TCK	Using technology to represent/research and create content in different ways without consideration of pedagogy	Gather external readings from Forrester, Gartner, Forbes, popular blogs and websites, and videos from YouTube to support classroom learning
TPK	Using technologies to enable teaching approaches without consideration of subject matter	Assign students to develop collaborative slide presentations to divide and conquer complex journal articles; assign students in-class topic presentations
TPACK	Using technologies to teach and encourage knowledge creation of specific subject content	Enable students to become co-creators of immersive experiences using Roblox (fall) and Frame VR (spring), and meet in those spaces with VR headsets or via a browser

**Table 1: TPACK components in the metaverse course design.**

As shown in Table 1, assignments combined content knowledge (CK), technology knowledge (TK), and employed pedagogical methods for structured or experiential learning (TPACK) to give students opportunities to interact with the metaverse in various ways.

Table 2 maps several course elements to their corresponding TPACK components. The variety of assignments and activities were intended to engage and motivate students to analyze the metaverse from a variety of perspectives.

### Content Assignments

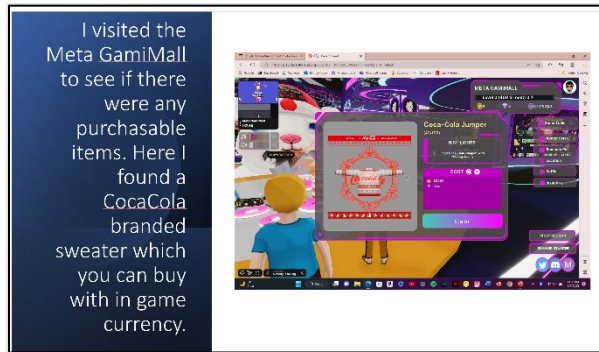
Students also presented a topic in class using a Pecha Kucha/Ignite style lightning talk format (Courtney Klentzin et al., 2010). Frequently during class, students worked in small groups to study different parts of a longer article and add a few slides summarizing their key takeaways. This pedagogical approach made longer or more complex articles more manageable for students and allowed the entire class to learn from and share with each other.

TPACK Component	Assignments and Activities
CK	Research Paper, Key Takeaways from Readings
PK	Reflections on Experiential Learning Activities
TK	AltspaceVR/Meta Horizon Worlds
PCK	Ignite Presentation, The Great Debate
TCK	Decentraland, In-Class Collaboration & PowerPoint Presentations
TPK	Creating Avatars
TPACK	Roblox/Frame VR

**Table 2: Mapping TPACK components to course assignments and activities.**

The Decentraland assignment, given in both semesters, was an effective way for students to apply their content knowledge as they applied what they learned from the readings to what they saw/experienced in Decentraland. See Figure 2

for a sample slide/explanation from a student's assignment.



**Figure 2: Exploring Decentraland.**

During both semesters, students were assigned weekly assigned readings for which they prepared summaries or responses to discussion questions.

During the spring semester, the second time that the course was offered to one section, the instructor replaced short presentations of student research papers during the final exam period with a debate on the topic "Metaverse: Hope or Nope"? Students were preassigned roles in one of two "rounds" of the debate. Each round lasted 30 minutes, and consisted of a team "in favor", a team "against", and questioners. Students submitted prior to the start of the debate, a document containing at most two pages showing how they prepared for their role in the debate, with arguments and talking points for questions they anticipated. Using classroom debate as a pedagogical tool has a long tradition in the humanities (Musselman, 2004) and social sciences (Abernathy & Forestal, 2021) but has also been adopted in business courses (Rao, 2010).

The debate format got students engaged and involved in lively discussions with each other. Rather than giving an essay final exam based on the readings, having the students submit their arguments and talking points ahead of time required them to make up the questions and forced them to synthesize what they thought were the most salient points and take-aways from the course. Students naturally called out their peers whose positions were not argued as well as they could have been.

### **Experiential Assignments – Exploring Online Virtual Communities with VR**

Students used VR headsets to explore online virtual communities. In Fall 2022 they explored the AltspaceVR metaverse, and in Spring 2023, the Meta Horizon Worlds metaverse. (AltspaceVR

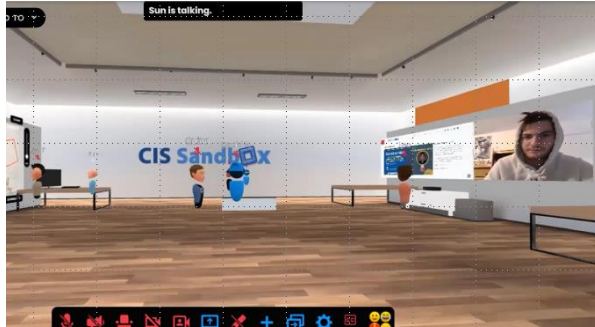
was discontinued in early 2023, necessitating the switch to a different online virtual community.) For many students this was their first experience with a VR headset, and they needed some guidance from lab tutors on how to use the hand controllers to navigate and explore their virtual spaces. In the fall, this assignment was given later in the semester; in the spring, it was earlier, so that students could better appreciate readings about immersive technologies and spaces having experienced them themselves. (See Figure 3.)



**Figure 3: Students explore virtual words wearing VR headsets.**

During the final two-hour class session of the fall semester, and during a snow-day in the spring semester, students met in a virtual learning space, designed as a digital twin of the university's technology learning center, as shown in Figure 4. The goal was to explore the feasibility of meeting in immersive learning environments. Before the class, students added slides to a common PowerPoint Online slide deck. The instructor showed the slide deck on one of the floor-to-ceiling displays, as students maneuvered their avatars around the virtual space to see it. They joined their classmates in this virtual environment to present their work in real time. Students then reflected on their experiences learning in this type of space. "By combining virtual reality learning with physical learning, an educational social space can be constructed where students are able to interact and socialize with peers while learning" (Cui et al., 2023).





**Figure 4: Students as avatars meet in a virtual environment.**

### **Content Creation Assignments: Building a Metaverse**

Students in the Fall sections completed tutorials using Roblox Studio, a development environment to create three-dimensional models and worlds that integrate with the Roblox metaverse. "Roblox is the world's largest multiplayer game community in which players can create a sandbox game online, and its platform includes virtual worlds, leisure communities, and self-built content" (Han et al., 2023). The platform contains virtual worlds and games built by its users, and the instructors originally felt that since many students were familiar with Roblox as a game playing platform, being able to create their own games would be an empowering experience.

The tutorials provided instructions to create VR games or other simple immersive experiences, as shown in Figure 5. While no original coding was involved except for possibly copying a line or two of code provided into a specified screen as shown in the instructions, and most elements of the scene or game were controlled by setting properties, the instructors found that many students had difficulty following these steps or making simple enhancements to add a billboard or sign with their name on it. Roblox Studio may be a better fit for students studying computer science as it introduces computer programming concepts (Hoffman et al., 2022; Malva et al., 2020).

Given the difficulty that many students had with following the instructions in the Roblox tutorials in the fall, during the spring semester, the instructor replaced that assignment with a new exercise to create an immersive scene using the Frame VR platform. Frame VR is a tool for creating immersive spaces where users can gather in real time for meetings, collaboration, and other events (Hwang et al., 2023).



**Figure 5: Virtual world created in Roblox Studio, personalized with a student's name on the road sign.**

Frame VR turned out to be a useful tool for business students to use because of its simple drag and drop interface and extensive templates and asset libraries. No coding is involved; Frame VR integrates with avatars created using the popular ReadyPlayer.Me platform, allowing students to take their digital identities with them; they can explore their worlds easily in a browser on laptops or mobile devices or visit them wearing VR headsets. As such it is becoming popular in many educational settings (Lee & Hwang, 2022; Wallace, 2022).

Students worked in groups of three to design a scene representing an element of popular culture. Figure 6 shows one group's scene from Seattle Grace Memorial Hospital, the setting of the popular Grey's Anatomy series. Users can explore the scene by visiting it in a browser and navigating with the keyboard, or in VR using a headset.

Students found this assignment allowed them to be more creative. After watching a few tutorials online and with no set instructions to follow, they were able to design immersive scenes and place themselves (as avatars) within those scenes to explore with their team members. Scenes ranged from popular movies and TV shows to museum-like exhibits showcasing favorite musical performers. As an alternative to demonstrating their understanding by writing a paper about metaverse features and benefits, students created their own immersive spaces, and in an accompanying video tour, discuss how they applied the metaverse design principles studied in class (Truog et al., 2022) to their work.





**Figure 6: A Frame VR metaverse depicts a scene from Grey’s Anatomy, with an avatar of Dr. Grey.**

## 5. METHODOLOGY

This study, conducted with surveys and student interviews administered at the end of the Fall 2022 and during Spring 2023 semesters, involved students enrolled in three sections of FDS. (See Appendix C.) These sections were taught by two different instructors who followed the same schedule, assignments, topics, and readings during the fall semester. The instructor teaching the course in the spring for a second time adapted the course based on lessons learned from the fall student experience. Students enrolled during the fall semester were all incoming college students and, in the spring, most were transfer students. Most had not chosen a major, and all were acclimating to their new university. The university assigned students randomly to their FDS sections, with no opportunity for them to select (or avoid) a section based on its topic. Students learned that they would be studying aspects of the metaverse during the first class session.

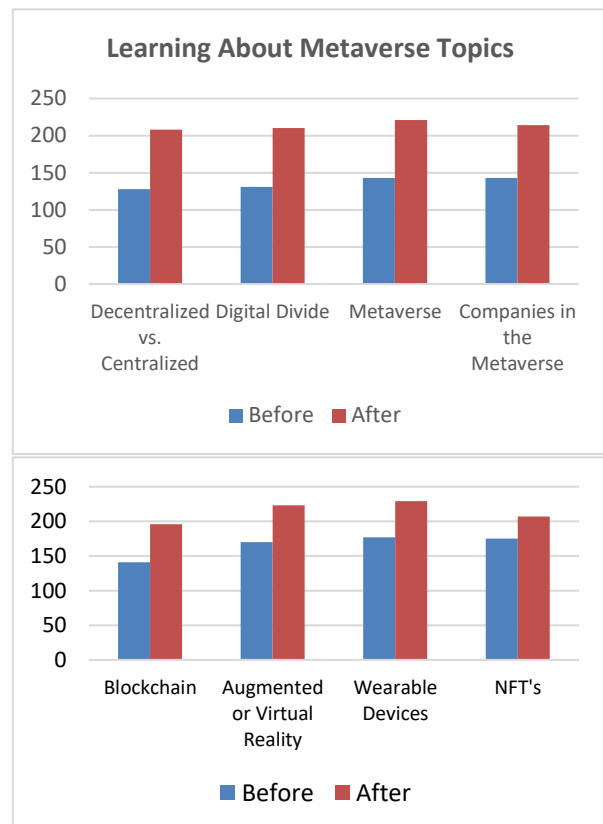
The authors first set out to learn what student perceptions were toward the metaverse and the multidisciplinary approach to the course in which they learned about it. To gather data around these issues, the authors conducted online surveys using Qualtrics (see Appendix C) at the start and end of each semester, reviewed student work, and conducted interviews with some students in each class. The survey was identical in both semesters, and therefore the results were combined.

The authors administered pre- and post-course surveys to 78 students in three synchronized

sections of FDS, taught by two different instructors during two semesters. Of these, 53 students provided valid survey responses. Two were under 18 years of age, so their responses were not included. The remaining students from each section were between 18 and 21 years old.

## 6. RESULTS

Figure 7 compares students’ pre- and post-course learning about specific topics set out in the course learning objectives. Each “before” value comes from the pre-course survey, and each “after” value comes from the corresponding question in the post-course survey. By assigning numeric values 1 through 5 to each of the values on a 5-point Likert scale (no nothing about, heard of, have some understanding, have good understanding, have excellent understanding), multiplying the number of responses for each scale item by its corresponding numeric value and adding the results, we obtain a numeric value representing the overall understanding level for each topic across all sections.



**Figure 7: Pre- and post-course familiarity with important concepts.**

In each case, as expected, students had greater familiarity with several course topics at the end of the course when compared to their knowledge

about these topics coming in. Students were most familiar with augmented and virtual reality, headsets, and NFTs (non-fungible tokens) prior to the start of the course, so those items saw the smallest increase in student learning. Less familiar topics, such as decentralization and the digital divide, saw the greatest increase in student learning.

### Favorite Metaverse Topics

To ascertain students' perceptions toward learning about the metaverse, the survey posed an open-ended question, "What was your favorite aspect of the course?". A simple word cloud analysis, where more frequently appearing words in their responses appear in a larger font than those which were less frequently cited, is shown in Figure 8, to get a general sense of their preferred topics and activities. Common stop-words were removed, and similar words (crypto and cryptocurrency, for example, were combined, for the sake of clarity.



Figure 8: Favorite metaverse topics.

Crypto, business, real estate, and NFTs were the most frequently cited favorite topics in the course. The course covered aspects of the digital economy's significance within the metaverse, and the role of cryptocurrencies in transactions, virtual commerce, and digital assets. Business-related responses suggested student interest in exploring entrepreneurial opportunities and innovative businesses within the metaverse.

### Favorite Course Activities

Figure 9 shows the most popular words that emerged when students considered their favorite activities in the course.



Figure 9: Favorite course activities.

The most popular activity among the students was using VR headsets to experience immersive environments. Specifically, they mentioned Roblox and Frame and "building" as most popular, demonstrating their interest in becoming co-creators of original metaverse environments. Also of note is that assignments on meeting in VR worlds and communities had strikingly different popularities. The number of students who mentioned AltspaceVR as a favorite activity in the fall far exceeded the number who mentioned the Meta Horizon Worlds activity in the spring, despite the hype associated with Facebook's immersive environment at the time this was assigned. (While the assignments were similar, visiting virtual communities in Meta Horizon Worlds replaced visiting AltspaceVR virtual communities after that platform was discontinued in early 2023.)

Students found building their own virtual worlds and meeting in them to be exciting, although they also found completing Roblox tutorials to be incredibly challenging. In response, the instructor replaced Roblox the following semester with a new assignment using Frame VR.

### Metaverse Attitudes and Concerns

Tables 3 and 4 show student concerns and attitudes toward the metaverse, based on data from the post-course survey. The survey posed questions about specific course topics and their concerns or attitudes toward them. Each item received 53 responses. Results are presented in reverse sorted order by mean score, to highlight the items of greatest concern or relevance to students.

Concern	Mean	Std Dev	Variance
Privacy	3.98	0.84	0.70
Security	3.89	0.92	0.86
Being hacked	3.79	0.90	0.81
Lack of regulation	3.74	0.95	0.91
Lack of norms	3.48	0.97	0.94
Cost of technology to participate	3.43	1.06	1.11
Why anyone would participate in the first place	2.92	1.00	0.99

**Table 3: Concerns about the metaverse.**

As shown in Table 3, students were most concerned about privacy, security, and being hacked. These findings, especially those related to concerns about privacy and security of online information, are consistent with Gen Z attitudes assessed by the Pew Research Center (M. Anderson et al., 2022).

Based on survey responses, students recognized the opportunities for new metaverse technologies to grow and develop over time as well as a desire to continue using them to explore new realms. Students were also optimistic about opportunities for businesses to break ground and innovate in

virtual markets.

The data in Table 4 suggest that that students mostly agree regarding the potential impact and opportunities associated with the metaverse. However, there is some variation in opinions, particularly regarding the long-term sustainability and widespread adoption of the metaverse.

## 7. DISCUSSION

### Lessons Learned

While many students showed interest in learning about the metaverse, many had a challenging time identifying with it as a tangible experience because they had not used VR headsets previously, or because their only prior experience with VR was in a gaming context and hence, they could not identify with its business and social applications. During the fall semester, the first assignment to use VR headsets began during week six, which was far too late. During the spring semester, the first VR headset assignment was given during week two. Conducting the first VR headset activity earlier in the semester enabled more students to have a common experience around the technology whose applications to the metaverse they were beginning to study and made these concepts more concrete.

Attitude or Perception	Mean	Std Dev	Variance
I worry about the societal impacts of the metaverse	3.87	0.85	0.72
The metaverse will accelerate the use of digital assets	3.85	0.60	0.35
The metaverse is exciting and offers the opportunity to be creative in a virtual world	3.79	0.84	0.71
The metaverse will revolutionize businesses creating a "creator economy"	3.72	0.86	0.73
Accessing the metaverse is easy	3.62	0.99	0.99
The metaverse will be the next social platform for businesses	3.57	0.81	0.66
The metaverse is a place aimed at younger people	3.57	0.84	0.70
A true metaverse won't be achieved within the next ten years	3.51	0.92	0.85
The metaverse is the next incarnation of the internet	3.49	0.94	0.89
Virtual environments can offer a sense of place and connection to physical environments	3.42	0.96	0.92
The metaverse is inclusive to all	3.21	1.00	0.99
The metaverse is a fad whose popularity will diminish within the next five to ten years	2.98	0.86	0.74
The metaverse will not materialize or catch on	2.85	0.96	0.92

**Table 4: Attitudes toward the metaverse.**

The TPACK model worked well, even for a course with content that is changing and evolving. TPACK aligns the content that is taught with techniques and technologies that can be used to support or enhance student learning.

The most helpful information from our post-course survey (see Appendix C) gave us feedback on favorite topics, favorite readings, and advice for instructors that teach this course in the future. Although some of these findings are summarized in figures 8 and 9, we present a more detailed analysis here.

Most of the favorite topics in the course integrated learning a technology and applying it in the metaverse. From a TCK perspective, students were most interested in marketing, advertising, fashion, digital retail, and digital real estate. The most popular technology elements of the course (TK) were blockchain, NFTs, and cryptocurrency. The favorite aspects of the course that integrated metaverse content, technology, and pedagogy (TPACK) were understanding digital asset markets (Zainab et al., 2022), leveraging Web 3 technologies (Bobier et al., 2022), learning the platforms themselves (e.g., AltspaceVR, Roblox, and Decentraland), and building digital experiences using these platforms (see Section 4).

Students provided a variety of feedback when asked about their favorite reading. The clear favorite was chapters selected from *Snow Crash* (Stephenson, 2003). Outside of these chapters (CK), readings that integrated two or more disciplines (CPK and TPACK) were most popular. Examples include the concerns and risks of unconscious bias and lack of diversity, equity, and inclusion in the metaverse (Morini Bianzino, 2022; Zallio & Clarkson, 2022). Some of the foundational readings (TCK and TPACK) were also popular with some students, most notably those that presented design principles (Chaturvedi et al., 2011; Truog et al., 2022) and discussed privacy, security, and ethics (Hackl, 2020; Pooyandeh et al., 2022; Wang et al., 2022). Other favorite areas of interest included metaverse economics (Du et al., 2023; Korinek, 2023; McKinsey & Company, 2022), workplace culture (Purdy, 2022), and commerce in the metaverse (Bratu & Sabău, 2022; Shen et al., 2021).

Because of the timeliness of this topic when it was initially offered (three months before the launch of ChatGPT), administrators saw this course an engaging way to introduce a current technology trend with wide business and societal implications

to students. The course design balanced theoretical content, reflective teaching methods, and VR experiential learning, and was therefore well-received.

Two dominant themes emerged when we asked students to suggest ways to improve the course. A considerable number of students thought more hands-on activities would improve the course. Many students also felt disoriented by the mix of material focused on extended orientation and academic skills (both common across all sections of FDS), and the metaverse topic of the sections in which they were enrolled.

### **Limitations and Future Work**

Because applications, use cases, and technology development surrounding the metaverse continue to evolve, this course needs to evolve with these trends to remain relevant. Metaverse platforms come and go, as we have witnessed, and some are easier to use than others. While the premise of assignments might stay the same in future iterations of the course, their implementation would need to be re-examined to incorporate currently available technologies and environments.

The authors would also identify readings selected specifically to explore some of the student concerns as articulated in Table 3 in the context of existing course topics (security, privacy, and safety, the digital divide, societal impact of the metaverse). Increased discussion of these topics could inform the attitudes of future students toward the metaverse, as presented in Table 4.

## **8. CONCLUSION**

This paper described the use of the TPACK framework (Mishra & Koehler, 2006; Niess, 2011) to integrate technology, pedagogy, and conceptual knowledge into a first-year discovery seminar course on "Living in the Metaverse." The instructors incorporated several pedagogical approaches, including collaborative work, discussions, and hands-on activities with VR headsets, designed to enrich student learning about the metaverse in a classroom environment that promoted inquiry, thoughtful conversations, experiential learning, and deliberative discourse. Surveys on student attitudes toward the metaverse showed both interest in its promise and concerns about its consequences.

Applying the TPACK framework, identifying multidisciplinary perspectives, and considering various attitudes to the topic allowed students to develop a greater understanding of the

metaverse and its applications to areas of their own interest. This approach to course design can serve as a model for instructors designing future courses which include learning about and experimenting with new technologies.

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## APPENDIX A Learning Objectives and Course Schedule for Spring 2023

### Learning Objectives for “Living in the Metaverse”

- Identify key companies and innovators whose work is shaping the metaverse.
- Describe the technologies needed for the continued development of the metaverse.
- Create digital artefacts (avatars, virtual spaces) to be used when exploring an immersive environment.
- Implications for Business, Individuals, and Society.
- Define characteristics of the metaverse, and their applications and implications for social and business interactions.
- Explain how companies in various industries might do business in the metaverse, and what that looks like in a virtual world.
- Evaluate the future of the metaverse from a socio-economic perspective, including risks.
- Compare the metaverse of today and tomorrow with its origins in popular culture.
- Reflect on being a consumer or a citizen in an immersive, virtual experience and compare that with a similar in-person experience.

### High-level Structure and Sequencing of the Spring 2023 First-Year Discovery (FDS) Seminar

Advanced topics were introduced after the first three weeks of the course following the structure of a survey course (Crews et al., 2015). Instruction on technology topics often included demonstrations and hands-on activities during class time to prepare students to complete their assignments. For example, students explored design principles, practices, and ethics during week four (Truog et al., 2022). Ethics was a recurring theme in the course, especially as it relates to privacy and psychological safety (Ayub, Yazdani & Kanwal, 2022; Hackl, 2020). Students explored different business opportunities in the metaverse, e.g., value creation (McKinsey & Company, 2022), customer engagement (Furlonger et al., 2022), and the future of work (Purdy, 2022).

### Detailed Structure and Sequencing of the FDS Seminar

#### BENTLEY UNIVERSITY FIRST-YEAR DISCOVERY SEMINAR SPRING 2023 SCHEDULE






























### FDS 100 SECTION 2 | Tuesday/Thursday | 3:30 - 4:50 PM | Class Location

Ⓜ = FDS Module    📄 = [Research Paper](#)    ✍ = Reflection (common to all sections of FDS)  
🥽 = [Metaverse](#) (our section's topic)

This schedule is tentative. Any changes to themes or assignments will be updated here. Watch for Ⓜ Module assignment due dates on Blackboard.



Week	Dates	Theme	Assignment
1	Jan 24, 26	Introductions (M) 1 Campus Resources VR 1: What is the Metaverse?	VR 1 – Decentraland Assigned Jan 26
2	Jan 31, Feb 2	(M) 2 Time Management VR 2: Definitions VR 3: Technology Foundations	All About Me Worksheet Due
3	Feb 7, 9	(M) 3 Academic Expectations Presentation Skills VR 4: Virtual Communities and the Future of Work	VR 1 – Decentraland Due Feb 7 Reflection #1 Due Feb 9 VR 2 – Horizon Worlds Assigned Feb 9
4	Feb 14, 16	(M) 4 Information Literacy, Critical Thinking, Library Search 1 Select a Research Paper Topic VR 4: Virtual Communities and the Future of Work, continued VR 5: Design Principles, Privacy, and Ethics	
5	Feb 21, 23	(M) 5 Unconscious Bias (Tue) (M) Unconscious Bias Slides Group Work (Thu) VR 6: Frame VR Introduction 2 Get Started with Research Zotero, Annotated Bibliography	Research Paper Topic Proposal Due VR 2 – Horizon Worlds Due Feb 21 (M) 5 Unconscious Bias Group Conversation
6	Feb 28, Mar 2	(M) 6 Academic Integrity (M) 7 Diversity, Equity & Inclusion (DEI) VR 7: DEI in the Metaverse 3 Form a Thesis Statement 4 Create an Outline	VR 3 – Frame VR Assigned Feb 28
7	Mar 7, 9	(M) 5 Unconscious Bias Debrief VR 8: Frame VR Workshop (Tue) 5 Research Paper workshop	(M) 5 Unconscious Bias Reflection Due FRIDAY Mar 10
	Mar 14,16	Spring Break	
8	Mar 21, 23	(M) 8 Academic Advising I VR 3/21 Guest Speaker: VR in Health Care	(M) Academic Advising Reflection #2 Due Mar 23

Week	Dates	Theme	Assignment
		 9: Privacy, Security, and Ethics	 Annotated Bibliography for Research Paper Due
9	Mar 28, 30	 9 Peer Collaboration & Academic Advising II  6 Editing your Research Paper workshop	 <b>3 – Frame VR Project Due Tue Mar 28</b>  Research Paper Thesis and Outline Due -- TUESDAY Mar 28 for review; THURSDAY to submit
10	Apr 4, 6	 7 Peer Review 1  10: Snow Crash & Predicting the Future  Visit to VR Research Lab	 Readings from VR Lab  Peer Review 1 Comments Due
11	Apr 11, 13	 11: Social Concerns, including Tech Addiction  8 Peer Review 2  9 Write your Research Paper abstract  12: Business Applications	 VR Lab Visit Report Due  Peer Review 2 Comments Due
12	Apr 18, 20	 10 Quiet time to Read/Write – Plan to finish Research Paper  13: Metaverse and Personal Identity, Avatars	 How to Make an Avatar  Final Research Paper Due Thu Apr 20
13	Apr 25, 27	 14: Meetings in the Metaverse  Make your RPM avatar and visit a virtual world with your avatar	 Final Reflection (#3) Due Thu Apr 27  Completed Avatar Due
FINAL	Wed May 3, Final Exam Block (11:30 AM)	 The Great Debate, Metaverse: Hope or Nope?	 Research Paper in Four Slides Due before Final Exam Block

## **APPENDIX B**

### **Metaverse/VR Assignment Summaries**

#### **Weekly Readings**

Students submitted three bullet point “takeaways” or wrote short reactions on a discussion board to demonstrate that they read at least some of the assigned weekly readings.

#### **In Class Presentation (Individual, Fall 2022 and Spring 2023)**

An Ignite-style presentation uses a PowerPoint deck with 20 slides, each of which advances automatically after 15 seconds. That gives you five minutes to present a topic by telling a story about it. Don't put too many words on your slides since you won't be able to read them so quickly. Instead, use automatically playing videos and images to be the backdrop of your story. Practice so that your presentation is smooth!

You will sign up to give an Ignite presentation one week during the semester in which you present an article of your choice related to the readings for a given week. You may perform additional research to find related material to add to your presentation. Two or three students will give presentations during most weeks of the semester. Your classmates will evaluate your presentation based on content, delivery, and appearance of the slides, and their evaluations will contribute to your grade on this assignment. You will also receive feedback from your classmates (shared anonymously) about your presentation.

#### **Explore Decentraland (Fall 2022 and Spring 2023)**

Read the articles and watch the videos from weeks 1 and 2 that talk about features and characteristics of the metaverse. Decentraland (<https://decentraland.org/>) is an evolving metaverse created by members of the community, that you can explore in a web-browser. It was opened to the public in February 2020 and is overseen by the nonprofit Decentraland Foundation.

Visit <https://decentraland.org> and click Open in Browser. Click on play as guest. Create your avatar. Dismiss the message about the graphics card if it appears.

Complete the “tour” / tutorial so you learn how to navigate the metaverse with keyboard commands (W/A/S/D to move around and using the mouse to look around or set your view.)

Explore the Decentraland metaverse. Open a PowerPoint presentation. Take five screenshots, showing elements of the metaverse that you encountered. Place each screenshot on its own slide. Write a caption of at least two sentences about each screenshot and describe how it is an example of an idea or concept that you learned about in the readings or videos for weeks 1 and 2. (In PowerPoint, use Insert -> Screenshot to take a screenshot and insert it on a slide.)

Create a title slide containing your name as a new slide in your presentation. Submit your presentation.

#### **Explore AltspaceVR (Fall 2022)** **Explore Meta Horizon Worlds (Spring 2023)**

After completing the assigned readings about virtual communities visit the lab to explore Altspace/Meta Horizon Worlds using Oculus 2 VR headsets. Then write a short report about your experience; be sure to respond to each of the questions below.

Create an avatar. Screenshot your avatar. Write a paragraph about how you designed the avatar, and what it says about you.

Select a metaverse event or activity to visit with your partners.

- What did you do? Who else was there? Describe your experience.
- How “real” or immersive is it? What do you see?

- How could you interact with the environment?
- How can you interact with other people/avatars in the environment?
- What other elements (audio, video, images) were available?
- How do you navigate around? Where can you go?
- What can you do in this virtual world that you can't do in the physical world?
- Do you feel present in this space? Or isolated? Or something else?

Include a photo of yourself wearing the headset with the event behind you on the big screen.

### **Roblox Metaverse (Group Assignment, Fall 2022)**

Working with a partner of your choice, design a VR Scene or game using Roblox Studio. You will follow a tutorial and add a feature of your choice as you design, build, evaluate, test, and share your virtual world.

Follow these steps to build your game:

- Select one of the Build it Play it Tutorials from Roblox Studio and follow the instructions to complete it. See <https://create.roblox.com/docs/education/landing-pages/build-it-play-it> .
- Add a block or a sign to your game that contains your first name somewhere in the scene.
- Based on your own discovery after playing with Roblox, or after searching online for ideas, make a change to your game design so that the game has a different appearance, storyline, background, or other features.

Follow these steps to play your game:

- Play your game and test it. Make sure it works! Create a screen recording of no more than 30 seconds as you play your game, and upload it to the Flip website.
- Share your game to Roblox, get a link, and post the link on the class discussion board.

Write a discussion post in which you and your partner answer these questions together:

- What features did you add to the game? ii. Which element(s) from the Designing the Metaverse article that we read in class last week does your project incorporate?
- Write an individual discussion post in which you answer these questions (separate from your partner, each of you should respond individually).
- What was most enjoyable and most challenging as you completed this project?
- What did you learn about the process of designing a virtual world by completing this project?

### **Frame VR Assignment (Group Assignment, Spring 2023)**

In this assignment you will work with your assigned partners to design a 3D interactive metaverse using Frame VR (<https://framevr.io>) by recreating a scene from your favorite book/movie/TV show or a favorite place you like to visit (restaurant, famous building, etc.) in virtual reality, Create an account on Frame VR for your team.

Your virtual world should include:

- 5-10 Digital Assets either imported either from Frame VR's asset library or from your computer.
- At least three photos or images
- At least one text file or document,
- At least one video clip
- At least one collaboration tool (white board, screen sharing, basketball, etc.)

Create your own avatar in ReadyPlayer.me that you can use in Frame VR when you visit it with your team. Visit your World with your partners in a browser and with the VR headsets.

Team Submission: Create a screen recording (from visiting in a browser) of approximately 5 minutes where you and your partners explore your world, talk about the contributions that each of you made to

it, and show some of its features. What metaverse design principles based on the readings did you implement? Walk around and see how it feels to be closer or further from others. Post your video to Flip.

Individual Submission: Write a short report (one page) describing the scene you are trying to recreate, your contributions to the Frame VR metaverse (and the design principles, based on the readings, for which your contribution is an example). Include a screenshot of your avatar created in ReadyPlayer.Me, when exploring your metaverse.

### **Research Paper (Individual Assignment, Fall 2022 and Spring 2023)**

Write a research paper (8 to 10 pages) exploring a topic related to our class “wicked problem” (Living in the Metaverse). Your paper will be due in stages, and will consist of these deliverables:

- Select a topic. Review with a partner to determine that the scope is not too broad or too narrow.
- Create an annotated bibliography of at least ten sources, from at least two scholarly, two trade, and two popular media publications.
- Create a thesis statement that you wish to explore.
- Create an outline of your paper.
- Complete a peer review with a partner of your thesis statement and outline.
- Create a first draft and a peer review with a partner. Complete the peer review form.
- Complete a second draft and peer review if time permits. Comment on improvement since first draft in the peer review form.
- Submit your paper.

### **The Great Debate (Spring Semester during Final Exam Period)**

We will hold a debate during final exam period, The topic: Metaverse: Hope or Nope? You will be assigned to one of two groups, each of which will debate for 30 minutes during the final exam period. Within each group, you will be assigned one of three roles: a team arguing in favor of the future potential of the metaverse (“hope”), a team against it (“nope”), and questioners. You will submit prior to the start of the debate, a Word document containing at most two pages of your preparation for the debate. If you are a questioner, don't just ask a question such as “How can people engage in the metaverse if headsets are uncomfortable?”, but instead, provide a story around each question. For example,

Studies have shown that technology addiction is a growing concern, with the average person spending more than 5 hours per day using mobile devices. This can lead to various negative effects such as anxiety, depression, and poor sleep quality. Given the potential negative impact of technology addiction on individuals, what are the long-term implications for the viability of the metaverse as a technology platform? How else might people engage in the metaverse to ensure its long-term success?

If you are a respondent, create four detailed talking points that you can use to take a stand and respond to issues you think may come up when arguing for or against the future potential of the metaverse. This will help you to argue your assigned position.

You might read different articles from earlier in the semester, or review articles from your research paper. You will be graded on your participation, the quality of the questions and responses you give, and your written preparation, which must be submitted before the start of class.

**APPENDIX C**  
**Pre- and Post-Course Student Survey Questions**

**Pre-Course Survey for First-Year Discovery (FDS) Seminar, Living in the Metaverse**

[introduction, consent, age, and gender not shown]

	Not at all	Slightly	Moderately	Very	Extremely
Would you describe yourself as entrepreneurial?					
Are you an early adopter of technology?					
Are you technology savvy?					
Are you socially well connected in your (offline) life?					
Are you socially well connected online?					

In this course we will explore metaverses through the lens of business opportunities, social concerns, and technological innovations. List two business opportunities that are possible in the metaverse.

In this course we will explore metaverses through the lens of business opportunities, social concerns, and technological innovations. List two social concerns that arise because of the impact of the metaverse.

In this course we will explore metaverses through the lens of business opportunities, social concerns, and technological innovations. List two technological innovations that enable interaction in the metaverse.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I follow news about the metaverse / metaverses out of curiosity.					
I can go to places using a metaverse that I can't go in real life.					
I can't wait to try a metaverse.					
I think that metaverse experiences are (or will be) exciting for me.					
I want to try a metaverse because it is an interesting technology trend.					
I think that using the metaverse / metaverses is a good idea for society.					
I believe that using the metaverse / metaverses will be helpful to me.					

Select all the statements below that you believe are True or Mostly True

- In ten years, people will live and co-exist mainly in the metaverse.
- The metaverse will become a part of our everyday life in the next ten years.
- The metaverse can cause harm to society.
- I am concerned about privacy in the metaverse.
- Some activities in the metaverse should be age-restricted.
- Some activities in the metaverse should be censored or disallowed.
- Extended use of the metaverse can cause health problems.

Select all reasons below that express why you would likely join a metaverse.

- Work possibilities
- Art and live entertainment
- Money and investing
- Education

- Socializing and online dating
- Gaming
- Adult entertainment

How would you rate your current understanding of the following topics?

	Not familiar with	Heard of it	Have some understanding	Good understanding	Excellent understanding
Avatars					
Multi-player games					
3-D Worlds					
Augmented reality					
Virtual reality					
Wearable devices					
Internet of Things					
Blockchains					
Cryptocurrencies					
Non-fungible tokens (NFTs)					
The Metaverse / metaverses					
The digital divide					
Internet addiction					

For each response that is not "I never heard of it," display the corresponding question:

- Briefly describe, define, or give an example of an avatar.
- Briefly describe, define, or give an example of a multiplayer game.
- Briefly describe, define, or give an example of a 3-D world.
- Briefly describe, define, or give an example of augmented reality.
- Briefly describe, define, or give an example of virtual reality.
- Briefly describe, define, or give an example of a metaverse.
- Briefly describe, define, or give an example of the digital divide.
- Briefly describe, define, or give an example of internet addiction.

What would you most like to learn about the metaverse this semester?  
 Do you have any additional comments, questions, or concerns?

**Post-Course Survey for FDS, Living in the Metaverse**

[introduction, consent, age, and gender not shown]

	Not at all	Slightly	Moderately	Very	Extremely
Are you an early adopter of technology?					
Are you technology savvy?					

In this course we explored metaverses through the lens of business opportunities, social concerns, and technological innovations. List two important business opportunities that are (or will be) enabled by the metaverse.

In this course we explored metaverses through the lens of business opportunities, social concerns, and technological innovations. List two social concerns that are (or will) arise because of the metaverse.

In this course we explored metaverses through the lens of business opportunities, social concerns, and technological innovations. List two technological innovations that are (or will) enable interaction in the metaverse.

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I believe that the metaverse is an interesting technology trend.					
I think that using the metaverse /metaverses is a good idea for society.					
I believe that using the metaverse / metaverses will be helpful to me.					

What was your favorite topic during the course?

What was your favorite reading during the course?

What was your favorite hands-on activity in class, in the technology lab, or out of class?

What was your least favorite topic during the course?

What was your least favorite reading during the course?

What was your least favorite hands-on activity in class, in the technology lab, or out of class?

AFTER this course ...

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
I would like to explore virtual reality more with headsets					
I could see myself purchasing NFTs					
I could see myself attending a concert, sporting event, or other event in the metaverse					
I could see myself involved in a virtual community					
I could see myself doing business with companies in the metaverse					
I feel prepared to follow topics about the metaverse that are in the news					

AFTER this course, when I consider participating in the metaverse, I am concerned about ...

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Privacy					
Security					
Being hacked					
Lack of norms					
Lack of regulation					
Cost of technology to participate					
Why would anyone participate in the metaverse in the first place?					

AFTER learning about the metaverse in this course, I believe that ...

	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree
Accessing the metaverse is easy					
Virtual environments can offer a sense of place and connection to physical environments					
The metaverse will revolutionize businesses creating a 'creator economy'					
The metaverse will be the next social platform for businesses					



The metaverse is the next incarnation of the internet					
The metaverse will not materialize or catch on					
I worry about the societal impacts of the metaverse					
The metaverse is a place aimed at younger people					
The metaverse will accelerate the use of digital assets					
The metaverse is exciting and offers the opportunity to be creative in a virtual world					
The metaverse is inclusive to all					
The metaverse is a fad whose popularity will diminish within the next five to ten years					
A true metaverse won't be achieved within the next ten years					

BEFORE this course, how would you describe your knowledge of ...

	Never heard of it	Heard of it	Have some understanding	Good understanding	Excellent understanding
The metaverse					
Companies in the metaverse					
Decentralized vs. centralized					
Digital divide					
Augmented or virtual reality					
Wearable devices					
NFTs					
Blockchain					

AFTER this course, how would you describe your knowledge of ...

	Never heard of it	Heard of it	Have some understanding	Good understanding	Excellent understanding
The metaverse					
Companies in the metaverse					
Decentralized vs. centralized					
Digital divide					
Augmented or virtual reality					
Wearable devices					
NFTs					
Blockchain					

AFTER this course, how would you describe your knowledge of each of the learning objectives ...

	Never heard of it	Heard of it	Have some understanding	Good understanding	Excellent understanding
Companies and innovators whose work is shaping the metaverse					
Technologies needed for the continued development of the metaverse					
How to create avatars and virtual spaces to be used when exploring the metaverse					
Implications of the metaverse for businesses					

Implications of the metaverse for individuals					
Implications of the metaverse for society					
Origins of the metaverse in popular culture					
Characteristics of the metaverse					
How companies in various industries do business in the metaverse					

What would you suggest that your instructors do differently to improve the FDS “Living in the Metaverse” course when we teach it again?

Do you have any additional comments, questions, or concerns?

## APPENDIX D – SELECTED READINGS

▶ = video □ = reading

### 1. What is the Metaverse?

▶ CNET. (2022). **Explaining the Metaverse: Everything You Need to Know About Future of the Internet**, <https://www.youtube.com/watch?v=7DEVfUk2zCk>

□ Leslie, J. (2022). **The Roblox Metaverse: What is it, and why is it so Popular Amongst Gen Z?**. Fanbytes blog, <https://fanbytes.co.uk/the-roblox-metaverse> .

□ Ravenscraft, E. (2022). **What Is the Metaverse, Exactly?** Wired, <https://www.wired.com/story/what-is-the-metaverse> .

### 2 – Definitions

▶ Jung, B. (2022). TEDx, [How the Metaverse Will Change the World | Brian Jung | TEDxRockville](https://www.tedxrockville.com/events/how-the-metaverse-will-change-the-world)

□ Resnick, M. et al. (2022). **Building a Digital Future: The Metaverse**. Gartner, <https://www.gartner.com/document/4015962> . Log in to the library website or access the PDF [here](#).

□ Lovich, D. (2022). **What Is the Metaverse and Why Should You Care?** Forbes, <https://www.forbes.com/sites/deborahlovich/2022/05/11/what-is-the-metaverse-and-why-should-you-care/> .

### 3 - Technology Foundations

□ ▶ Marr, B. (2022) **The Important Difference Between Web3 And The Metaverse** <https://www.forbes.com/sites/bernardmarr/2022/02/22/the-important-difference-between-web3-and-the-metaverse>

### 4 – Virtual Communities and the Future of Work

□ Purdy, M. (2022). **How the Metaverse Could Change Work**. Harvard Business Review, <https://hbr.org/2022/04/how-the-metaverse-could-change-work>.

□ [Meta Pursues Teen Users as Horizon Metaverse App Struggles to Grow](https://libguides.bentley.edu/news/wsj) (Wall Street Journal). You will need to create a free account to read this. Get your FREE subscription here: <https://libguides.bentley.edu/news/wsj>

□ [This is Life in the Metaverse](#) (New York Times)

### 5 – Design Principles

□ Truog, D. et al. (2022). **Designing The Metaverse**. Forrester, <https://www.forrester.com/report/designing-the-metaverse/RES177430>.

### 6 – Roblox / FrameVR Introduction

(No recommended readings)

### 7 – Diversity, Equity, and Inclusion

☐ Williams, M. (2022, February). **Building the Metaverse with Diversity and Inclusion from the Start.** <https://about.fb.com/news/2022/02/building-the-metaverse-with-diversity-and-inclusion-from-the-start>.

☐ Lu, J. (2022, June). **Metaverse platforms face diversity, equity and inclusion challenges. Here's how to address them.** World Economic Forum blog, <https://www.weforum.org/agenda/2022/06/metaverse-platforms-face-diversity-equity-and-inclusion-challenges-heres-how-to-address-them/>.

### 🎧 8 – Frame VR Workshop

(No recommended readings – hands-on session)

### 🎧 9 – Privacy, Security, and Ethics

☐ PwC (2022). **Metaverse security: Emerging scams and phishing risks** <https://www.pwc.com/us/en/tech-effect/cybersecurity/emerging-scams-and-phishing-risks-in-the-metaverse.html>

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# Examining Factors Predicting Programming Self-Efficacy for Computer Information Systems Students

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## Abstract

Programming is a major subject in various Information Systems (IS) programs, with students often finding it a challenging skill to acquire. While there is extensive literature on factors helping students learn to program, most of which focuses on non-IS students. Due to the increasing demand for professionals with programming skills, there is a pressing need for further research on factors that could enhance learning programming skills at the higher education level. One promising approach to address this issue involves examining students' internal characteristics, their programming self-efficacy, and its connection to instructional methods that can enhance it. This study adopted a quantitative research design to evaluate students' programming self-efficacy. A survey was conducted to measure students' beliefs in their programming competence and engagement in various instructional activities, including the value they attributed to learning programming, the time spent practicing, and the frequency they sought guidance from teaching assistants (TA). Through a hierarchical multiple regression analysis, this work investigated how these mentioned variables could predict student-programming self-efficacy. The results indicated that the value students placed on learning programming emerged as the most significant predictor for programming self-efficacy. On the other hand, there was no substantial evidence that the practice time or consulting TA predict programming self-efficacy and the practice time or consulting TA. These findings suggest that educators and instructional designers need to emphasize the practicality and importance of learning how to program to enhance students' perceived value.

**Keywords:** Information Systems, Predicting Programming Self-Efficacy, Pedagogy, Fragmented Learning, Mobile Learning.

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# Examining Factors Predicting Programming Self-Efficacy for Computer Information Systems Students

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## 1. INTRODUCTION

Information Systems (IS) students envision themselves as programmers in the future, and they believe programming is a significant and valuable skill they need to acquire (Abdunabi, Hbaci, & Ku, 2019). Additionally, many of the IS-related jobs, such as business analyst, data analyst, data mining, project manager, and others, require programming skills. As technology advances and companies and government agencies seek efficiency and cost savings, demand for information system specialists should continue to grow at a projected rate of 23% from 2021 to 2031, which would be higher than the projected growth for all other occupations (U.S. Bureau of Labor Statistics, 2023).

Although programming is a required outcome of IS graduates and core competency for employment in many IT industries (Bashir & Hoque, 2016), difficulty with computer programming has been shown to contribute to well-documented dropout rates in introductory programming courses in the United States (Kori, Pedaste, Leijen, & Tõnisson, 2016; Zhang, Zhang, Stafford, & Zhang, 2014). Programming has been considered a difficult task because it involves skills that go well beyond how to write error-free programs (Loksa, Jernigan, Oleson, Mendez, & Burnett, 2016; Forte, & Guzdial, 2005).

Learning to program requires effective instruction on syntax, data structures, and abstraction but additionally requires investigation and evaluation of physiological traits of the individuals, such as self-efficacy (Bandura, 1977; Gupta and Bostrom, 2019; Metcalfe, & Shimamura, 1994). Self-efficacy is an individual's judgment of their capabilities to organize and execute courses of action required to attain designated types of performance (Metcalfe, & Shimamura, 1994). Further, it has been observed by Schunk & Pajares (2005) that how people behave can often be better predicted by the beliefs they hold about their capabilities than by what they are capable of accomplishing, for these self-efficacy perceptions help determine what individuals do with their knowledge and skills. Based on Bandura's (1977) theory, individuals who have a strong sense of

self-efficacy in a specific situation would devote their attention and effort to the demands of this situation and, when faced with difficulties, these individuals would try harder and persist longer than individuals who have had low perceived self-efficacy. Programming self-efficacy is defined as individuals' evaluation of their ability to solve computational problems by employing their programming skills and experiences (Kong, 2017; Marakas et al., 2022). Students with high computer programming self-efficacy tend to utilize their skills to solve computational problems and persist in solving challenging ones (Latifah & Nugraha, 2023).

Since the nineties of the last century, researchers have started to examine the possible instructional factors within educational contexts affecting students' self-efficacy within the higher educational level (Van Dinther, Dochy, & Segers, 2011). Based on the literature reviewed (Sheokand, 2022; Gumelar et al., 2022; Van Dinther, Dochy & Segers, 2011) concluded that it is possible to influence student self-efficacy by instructional factors, but these factors are more effective if they are based on social learning theory by Bandura (1977). While widespread research has been conducted to investigate factors that are related to students' programming self-efficacy and how it is influenced by various pedagogies and demographic variables (Askar & Davenport, 2009; Bashir & Hoque, 2016; Cigdem & Yildirim, 2014; Konecki, 2014; Korkmaz & Altun, 2014; Nurhikmah et al., 2021; Özmen & Altun, 2014; Rogerson & Scott, 2010; Tsai, 2019; Tsai, Wang, & Hsu, 2019; Wiggins, Grafsgaard, Boyer, Weigold & Weigold, 2021; Wiebe, & Lester, 2017), most of these studies are focused on the population of computer science and engineering students (non-IS students), and their varying outcomes make it difficult to draw any conclusions regarding reliable predictors for students' programming self-efficacy, particularly among IS students.

An instructor of two introductory programming classes at the CIS department, College of Business, Colorado State University, has explored various instructional approaches in teaching programming. This research elected three instructional approaches based on Bandura's

(1977) theory, as Van Dinther et al. (2011) recommended. This study aimed to explore how three instructional approaches—(a) perceived value of programming, (b) weekly time spent on programming practice, and (c) frequency of TA consultations—contributed to the programming self-efficacy scores of IS students in two introductory programming courses. The research question related to the body of this study is defined as follows: *Do undergraduate IS students' perceived value of learning programming, the number of hours they spend per week practicing weekly assigned programs, and the number of times they consult TA predict their levels of programming self-efficacy?* The findings should help educators and instructional designers to develop, update, or improve instructional approaches for their classes that, in turn, facilitate high levels of programming self-efficacy among students.

## 2. RELATED WORK

The key point of computing self-efficacy attributed to individuals with high self-efficacy would competently write programs and utilize different software systems. Nevertheless, those with low computer self-efficacy would perceive their capabilities as limited to software or computer systems (Gupta & Bostrom, 2019; Malaquias et al., 2021). The principle of self-efficacy is further emphasized by Zimmerman (2000) that self-efficacious students participate more readily, work harder, persist longer, and have fewer adverse emotional reactions when they encounter difficulties than do those who so doubt their capabilities.

Although Bandura's theory has been widely used in the literature and has demonstrated validity, there was a growing recognition that additional explanatory variables that rely on this theory were needed (Gupta & Bostrom 2019; Metcalfe, & Shimamura, 1994), particularly for a unique population like IS students. This work combined the variables: value of learning programming (students' perceptions of the interest, usefulness, and importance of a task), practice programming, and consulting TAs, and investigate how these three key variables could predict student perceptions of programming self-efficacy.

### Value of Learning Programming

It has been argued by Simpkins, Davis-Kean, and Eccles (2006) that individuals' values of learning a particular aspect influence educational and career choices and course success in many fields. Beyer (2014) also found that if students believed that careers in computer science (CS), for

example, did not reflect their interpersonal values, they did not desire to pursue a CS major, even if it could lead to lucrative careers. In a review research of 64 articles highlighting the potential utility of self-efficacy to maximize student learning outcomes, Bartimote-Aufflick, Bridgeman, Walker, Sharma, and Smith (2016) found that self-efficacy is repeatedly highly correlated with the value of learning programming. Further, Wigfield et al. (2000) explain that individuals' expectancies for success and achievement values predict their overall achievement outcomes, including their performance, persistence, and choices of activities. In this regard, students who recognize the significance of technology and coding in computer-based products, which are now more accessible in society than ever before, typically possess strong programming self-efficacy. Powell et al. (2015) conducted two studies to explore the impact of screencast creation and group participation on student learning outcomes in programming. The findings suggest that both screencast creation and group participation have a positive influence on learning success in programming. However, both studies show a limited effect of Self-Efficacy development while creating screencasts and group participation.

### Programming Practice Time

In addition to the importance of the variable value for learning to program, it was necessary to practice how to code on a regular basis to acquire, improve, or even maintain it. The amount of practice required would depend on the nature of the activity and on each individual. For example, a key determinant of success for novice programmers would be the extent to which they practiced writing code (Denny, Cukierman, & Bhaskar, 2015). Practically, the time spent practicing programming during the semester was found to be a significant predictor of students' academic performance, with students who spent more time coding having better performance (Niiitsoo, Paales, Pedaste, Siiman, & Tõnisson, 2014). Referring to the conducted literature review, research effort regarding how programming self-efficacy is related to the amount of time practicing programming out of the class time is limited, specifically, for IS majors.

### Teaching Assistant

Graduate student TAs have played a vital role in undergraduate teaching in higher education through their work as graders, tutorial leaders (tutoring), and lab demonstrators. The teaching abilities and preparedness of TAs could directly influence undergraduate instruction in different fields. For instance, in numerous fields,



undergraduates reported greater gains in content knowledge when TAs were perceived as supportive of their learning (Wheeler, Maeng, Chiu, & Bell, 2017). Regarding the relation between tutoring and programming self-efficacy, Wiggins, Grafsgaard, Boyer, Wiebe, and Lester (2017) found that tutoring tends to be associated with student programming self-efficacy among CS students. Students who acknowledged the tutor's feedback and had dialogs with tutors were found as highly self-efficacious students. Students who engaged in fewer interactions with tutors, compared to those with high programming self-efficacy, exhibited lower levels of programming self-efficacy (Wiggins, Grafsgaard, Boyer, Wiebe, & Lester, 2017). To the best of our knowledge, the research conducted regarding the role of TAs and its relation to programming self-efficacy, specifically in IS schools, is still limited; hence, this study shed light on the question of "Do TAs Matter?" by exploring if students' communications with TAs could predict their programming self-efficacy.

### 3. CONCEPTUAL FRAMEWORK

This study was based on Bandura's self-efficacy theory (1977). Concerning the factors that build, assess, and interpret individuals' self-efficacy, Bandura (1977) highlighted that users' value of learning a skill (such as a coding skill) was a critical factor and it formed an individual skill self-efficacy. Therefore, when considering the importance of learning programming, it is essential to focus on enhancing users' programming self-efficacy. Moreover, Gist and Mitchell (1992) presented processes that assess self-efficacy such as the analysis of task requirements (an individual's determination of what it takes to perform a task) and attributional analysis of experience (an individual's judgment about why a performance level occurred). Practically, applying Gist and Mitchell (1992) processes in an educational setting demonstrated that the analysis of task requirements included

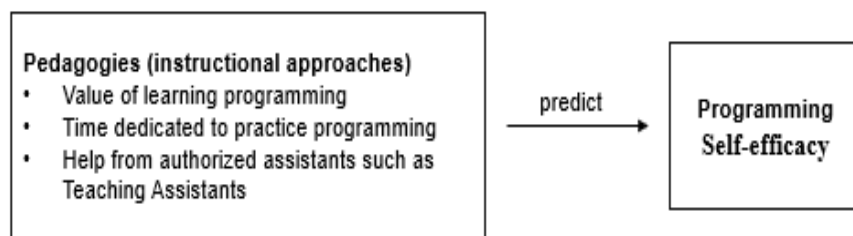
the time dedicated to the course work, which indicated that the time a student spent learning programming skills could be considered one of the factors related to a student's programming self-efficacy. Additionally, Bandura's Social Cognitive Theory (1986) emphasizes that effective communication channels are critical for successful learning outcomes. Based on this theory, individuals who engage in effective communication and receive understanding, and feedback are more likely to develop higher levels of self-efficacy. When teachers/TAs engage in open and supportive communication with students, students receive better support, guidance, and personalized attention. Hence, students' communication for guidance and support from their TAs could contribute to their programming self-efficacy. Figure 1 summarizes the conceptual framework that addresses the research questions.

### 4. METHODOLOGY

This section describes the research methods, reliability, measurements, and results that were conducted and obtained. This study used a reliable measurement of programming self-efficacy for students where individuals operationally have been asked whether they could perform specific levels of programming tasks through the degree of that endorsement (such as from total uncertainty to total certainty).

#### Participants

The research was conducted at a large state university in the United States after obtaining the approval of the Institutional Review Board. A nonprobability convenience sampling method allowed data collection within time and place restrictions. A total of 140 students completed the survey and the norms for participants' selection were: the target population was undergraduate CIS students, the accessible population was undergraduate students from the Colorado State University, College of Business, Computer



**Figure 1: Instructional approaches to predict programming self-efficacy.**

Information Systems. Participants were 18 years or older, and each participant was taking either a junior-level programming course (CIS240) or a senior-level programming course (CIS340). Table 1 contains the participants' demographics.

Participant and Class Info	N (%)
Gender	
Male	99 (70.7%)
Female	41 (29.3%)
Class	
Application Design and Development course	74 (52.9%)
Advanced Application Design and Development course	66 (47.1%)

Note. Ages ranged from 19 to 61 years old. N=140.

**Table 1: Participants' Characteristics**

The two-course activities included in-class exercises where the TAs helped students, viewed interviews with influential people in the sector of programming, lectures by guest speakers who discussed their programming experience, and advised students on how to find appropriate jobs. There was one TA for each class, and these were master's students in Computer Information Systems. Each one had at least two (2) years of programming experience with Java. Their work experience as TAs ranged from 2 to 4 semesters. Their responsibilities included working on multi-step programming problems during in-class exercises, tutoring students during lab hours, responding to students' questions via emails, and grading that included descriptive feedback. The assignments are due every two weeks, and the first week is designated for finishing practice examples related to the covered topic. These practice examples are not graded, but students are advised to practice them before completing the assignments.

**Research Process and Measurements**

This study used a survey research design. Data was collected during two spring semesters in two consecutive academic calendar years. The survey link was created with Qualtrics and distributed to the students of the two programming classes at the end of the Spring semesters. Participants completed a set of questions in three sections: student programming self-efficacy, the perceived value of learning programming, and demographic characteristics.

To measure students' programming self-efficacy, this work used 32 items from Askar and

Davenport's (2009) Java Programming Self-Efficacy scale, where students rated their perceived self-efficacy in doing various programming-related tasks on a Likert-type scale. Askar and Davenport's (2009) administered the instrument with a sample from the similar target population as the current study consisting of English speakers who are undergraduate non-CS students using Java programming language. Their scale for Java Programming consisted of 32 items (as one construct), and the reliability of the scores from their sample was 0.99. In the current study, all 32 items in their original format were utilized. However, modifications were made because of the limited number of students who attended both classes. Hence, the scale from a 7-point Likert-type was reduced to scale to a 5-point Likert-type scale, ranging from 1 (not confident at all) to 5 (confident). A five-point scale rather than a seven-point scale was chosen based on the literature suggestion that five-point scale increases response rate and response quality along with reducing respondents' frustration level (Babakus & Mangold, 1992).

The questions created for the scale measuring the perceived value of learning programming were largely based on Baser's attitude survey (2013). This scale indicated to what degree students agreed with statements related to their perceived value of program learning. This scale consisted of five items on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The last section of the survey contained questions about the age and gender of the participants as well as the name of the course they were taking. In addition, this section included two additional questions: (a) How many hours do you spend practicing the weekly assigned programs by the instructor? and (b) How many times this semester did you consult the TA for help in your assignments?

**Validity and Reliability**

The construct validity of the computer programming self-efficacy scale was examined via Exploratory Factor Analysis. The scale's allocation to the factors was specified through principal component analysis with oblique rotation (Promax). After an iterative process to examine scree plots and the eigenvalue, the scree plot clearly showed inflexions that would justify retaining two to three factors to extract. For meaningful interpretation, two factors were extracted out of 32 items, 20 items with load values over 0.3 were retained and included in the analysis, and 12 items with loads separated into two factors were excluded. The Kaiser-Meyer-

Olkin (KMO) measure verified the sampling adequacy for the analysis,  $KMO = 0.90$ , and all KMO values for individual items were greater than 0.79, which was above the acceptable limit of 0.5 [20]. Bartlett's test of Sphericity,  $\chi^2 (190) = 1620.100$ ,  $p < 0.001$ , showed that there were patterned relationships between the items so that the factor analysis could be used (Field, 2009). The two factors explained a cumulative variance of 53.07% and were labeled as (a) independence and persistence in programming tasks and (b) ambition for programming. Table A in Appendix A presents the 20 retained items with their factor loadings and eigenvalues. Cronbach's alpha for the 20 retained programming self-efficacy items was 0.93. Individually, the reliability of independence and persistence scores were similarly high ( $\alpha = 0.93$ , 16 items), and the reliability for ambition scores was slightly lower ( $\alpha = 0.79$ , 4 items) but was still an acceptable value (Field, 2009).

In addition, convergent validity and discriminant validity were run to establish the construct validity for the five items measuring perceived value of learning. The output showed that two items needed to be dropped. These two items had Pearson correlation ( $r$ )  $< 0.30$  with related variables, and Pearson correlation ( $r$ )  $> 0.20$  with unrelated variables (Robinson, 2018). For the remaining three items that measure the perceived value of learning programming, Cronbach's alpha was high ( $\alpha = .81$ ), and the corrected item-total correlation was all above 0.30, which was encouraging (Field, 2009).

## Results

This work employed IBM SPSS Statistics 21 to administer the survey and complete the data analyses. The data revealed that the self-efficacy perceptions levels of CIS students ranged from 37 to 99, with an overall mean of 3.55 ( $SD = 0.63$ ). In terms of percentage distribution, 22.2% of students had a high level of self-efficacy perceptions ( $M > 4.00$ ), 76.4% had a medium level of self-efficacy perceptions ( $M > 2.00$  but  $< 4.00$ ), and 1.4% of students had a low level of self-efficacy perceptions ( $M < 2.00$ ). Relatively, students' perceived value of learning to program ranged from 7 to 15, with an over-all mean of 4.45 ( $SD = 0.63$ ) and fell into medium and high level. In regard to percentage distribution, 72.1% of students perceived high value of programming, while 27.9% of students perceived medium value of programming.

Results from a G\*Power analysis (a statistical tool used to estimate needed sample sizes based on the selected statistical test) indicated the sample size required to answer this study's research question (with medium effect size = 0.15,  $\alpha$  err prob = 0.05, power ( $1 - \beta$  err prob) = 0.90) was 108. The actual sample size used for the regression analysis was very suitable ( $N = 121$ ).

Prior to conducting a hierarchical multiple regression, the relevant assumptions of this statistical analysis were tested. Firstly, a sample size of 121 out of 140 was deemed adequate, given four independent variables (course, value, practice time, and consulting TA) to be included in the analysis. The assumption of collinearity was

Variable	$\beta$	T	Sig.	R	R <sup>2</sup>	$\Delta R^2$
Step1				.04	.002	.002
Course	.04	.43	.665			
Step 2				.20	.043	.042
Course	.018	.202	.840			
Consult TA	-.206	-2.227*	.025			
Step 3				.21	.046	.003
Course	.024	.262	.794			
Consult TA	-2.26	-2.330*	.022			
Practice Time	.058	.594	.554			
Step 4				.36	.133	.087
Course	.039	.448	.655			
Consult TA	-.176	-1.877	.063			
Practice Time	.028	.300	.765			
Value	.299	3.416**	.001			

Note:  $N = 121$ , \* $p < .05$ , \*\* $p < .01$

**Table 2: Summary of hierarchical multiple regression Analysis for Variables Predicting Independence and Persistence of Programming Self-Efficacy.**

also met as VIF scores were well below 10, and tolerance scores above 0.2. There were no influential cases biasing the model as the values of Cook's Distance were all under 1. Residual and scatter plots indicated the assumptions of normality, linearity, and homoscedasticity were all satisfied.

Two hierarchical multiple regression with four stages were conducted with Independence and Persistence and ambition (overall self-efficacy) as the dependent variables. Course was entered at stage one of the regressions as an extraneous variable to control for the variable course (control the difference between the two course levels). The Attachment variable consulting TA was entered at stage two; practice time was entered at stage three; and value was entered at stage four.

The first hierarchical multiple regression was ran with Independence and Persistence of Programming Self-Efficacy. Regression statistics are presented in Table 2. The analysis revealed that, at stage one, Course did not contribute significantly to the regression model,  $F(1, 119) = 0.188, p > 0.05$ , and accounted for 0.2 % (0.002) of the variation in Independence and Persistence of Programming Self-Efficacy ( $R^2$  change = 0.2%). Introducing the attachment variable Consulting TA increased the value to 0.04, which meant Consulting TA accounted of 4.3% of the variation in Independence and Persistence of Programming Self-Efficacy, and this change in  $R^2$  was not significant,  $F(2, 118) = 2.68, p > 0.05$ , ( $R^2$  change = 4.2%).

Adding Practice Time variable to the regression model explained 4.6% (0.046) of the variation in Independence and Persistence of Programming Self-Efficacy, and this change in  $R^2$  was not significant,  $F(3, 117) = 1.89, p > 0.05$ , ( $R^2$  change = 0.3%). Finally, the addition of the variable Value explained 13.3% (0.13) of the variation in Independence and Persistence of Programming Self-Efficacy, and this change in  $R^2$  was statistically significant,  $F(4, 116) = 4.47, p < 0.01$ , ( $R^2$  change = 8.7%). When the four independent variables were included in stage four of the regression model, they explained 13.4% of the variance in Independence and Persistence of Programming Self-Efficacy, and the most important predictor in Independence and Persistence of Programming Self-Efficacy was the variable Value. The prediction power of the variable Value was moderate (.299) suggesting that approximately 29.9% of the variation in the variable Independence and Persistence of Programming Self-Efficacy (Dependent variable) can be explained by the variable Value (Independent variable).

The second hierarchical multiple regression was run with Ambition of Programming self-efficacy. Regression statistics are presented in Table 3. The analysis revealed that, at stage one, Course did not contribute significantly to the regression model,  $F(1, 119) = 2.90, p > 0.05$ , and accounted for 2.4 % (0.024) of the variation in Ambition of Programming Self-Efficacy ( $R^2$  change = 2.4%). Introducing the attachment variable consulting TA increased slightly the value to 0.025, which meant consulting TA accounted

Variable	$\beta$	T	Sig.	R	$R^2$	$\Delta R^2$
Step1				.15	.024	.024
Course	-.154	-1.704	.091			
Step 2				.15	.025	.001
Course	-.158	-1.713	.086			
Consult TA	-.037	-.407	.085			
Step 3				.16	.028	.002
Course	-.153	-1.661	.099			
Consult TA	-.056	-5.567	.572			
Practice Time	.053	.535	.594			
Step 4				.36	.130	.130
Course	-.136	-1.557	.122			
Consult TA	-.002	-.018	.985			
Practice Time	.020	.217	.829			
Value	.325	3.698*	.000			

Note: N=121, \* $p < .001$

**Table 3: Summary of hierarchical multiple regression Analysis for Variables Predicting ambition of Programming Self-Efficacy.**

for 2.5% of the variation in Ambition of Programming Self-Efficacy, and this change in  $R^2$  was not significant,  $F(2, 118) = 1.53, p > 0.05$ , ( $R^2$  change = 0.0.1%). Adding Practice Time variable to the regression model explained 2.8% (0.028) of the variation in Ambition of Programming Self-Efficacy, and this change in  $R^2$  was not significant,  $F(3, 117) = 1.11, p > 0.05$ , ( $R^2$  change = 0.2%). Finally, the addition of the variable Value explained 13% (0.13) of the variation in Ambition of Programming Self-Efficacy, and this change in  $R^2$  was statistically significant,  $F(4, 116) = 4.33, p < 0.01$ , ( $R^2$  change = 10.3%). When the four independent variables were included in stage four of the regression model, they explained 13% of the variance in Ambition of Programming Self-Efficacy, and the most important predictor in Ambition of Programming Self-Efficacy was the variable Value. The prediction power of the variable Value was moderate (.325) suggesting that approximately 32.5% of the variation in the Ambition of Programming Self-Efficacy (Dependent variable) can be explained by the variable Value (Independent variable).

In summary, the variable "Value" emerged as the most important predictor, suggesting that approximately 29.9% of the variance in Independence and Persistence of Programming Self-Efficacy can be explained by this variable alone, and approximately 32.5% of the variance in Ambition of Programming Self-Efficacy can be explained by this variable alone. This indicates that the perceived value attached to programming likely plays a significant role in individuals' self-efficacy in this domain.

## 5. DISCUSSION AND CONCLUSIONS

The findings in this study confirmed that the value of learning programming was the most predictable value among the three examined variables for both independence and persistence, and ambition for programming self-efficacy. This indicated that the more students valued learning programming, the more they became independent and persisted in solving challenging programming problems. Relatively, the more student valued programming, the more ambition they have to escalate their programming skills. Therefore, the value of learning programming was an important factor that should be a part of educational interventions that seek enhancing IS students programming self-efficacy.

IS educators and instructional designers could clarify the utility of programming skills through various instructional methods. First, not only

through explicit verbalization of course goals and usefulness but also through less direct means (Neuville, Frenay, & Bourgeois, 2007). For instance, educators could utilize professionals' stories of successful people in programming from around the world and meeting with guest speakers with IS degrees. Since one of the class activities provided to the participants in our study was utilizing this method and most of these students perceived high value of programming, this method could be supported.

Second, educators would need to stress how learning programming would be a "relevant and authentic" skill that has meaning in their career. Third, educators would activate students' personal interest through opportunities for choice and control over some academic activities. For example, they could constrain the general framework of an oral or written exercise (e.g., to have recourse to the theories developed in the course), while giving students the freedom to choose their own specific subject (Neuville, Frenay, & Bourgeois, 2007). This technique demonstrated its effectiveness when Denny, Cukierman, and Bhaskar (2015) in their experiment allowed students ( $n > 180$ ) in an introductory programming course to invent numerous programming exercises. This technique helped students not only to be more exposed to real world problems but also develop confidence and skills which, in turn, assisted them to practically developing and assessing their own value of learning programming.

The lack of any significant predictive relationship between programming self-efficacy of IS students, practice time, and TAs consultations from this study was unexpected. This finding contradicted Özmen and Altun (2014), who concluded that more practice time led to high programming self-efficacy among non-CS students. Moreover, the findings of this study conflicted with Wiggins, Grafsgaard, Boyer, Wiebe, and Lester's (2017), who concluded that tutoring tend to be associated with increased programming self-efficacy among CS students. These results did not lead us to ignore the influence of these variables on programming self-efficacy. Instead, it led us to think deeper and provide some interpretations that might justify our findings and improve our future research.

In this work, due to a lack of literature that presents the number of hours should students practice programming and consulting TAs, it was difficult to draw a conclusion or measure in the survey questions. Thus, this was an unavoidable step and it was considered subjective to students;

it could be regarded as a limitation of this research.

As a result, there is one possible interpretation for finding a lack of any significant predictive relationship between programming self-efficacy of IS students, practice time, and TAs consultations. The subjective survey question format might have made the students unable to estimate the realistic number of hours practicing programming and consulting the TAs. It was hard for students to think and remember the number of practice hours while taking the survey. For example, they needed to estimate how much time it took them to download the practice examples from the course shell, think and manipulate the code, and then run them to solve problems. It was also realizable that it was difficult for students to provide realistic number of hours in case they think the practice examples are a waste of time since they are optional, not graded, not tracked, and solve a problem that is similar to the assignment; hence, they preferred to skip the practice examples and work immediately on the assignments instead. Furthermore, students might have thought that their need to contact the TA depended on the topic difficulty level; hence, estimating the consultation number of hours was not easy.

Since this study was exploratory among the population of IS students, more data is also needed to analyze in greater depth to increase our understanding of the relations between programming self-efficacy with both programming practice times and the number of consulting hours with TAs. For instance, students practice time should be tracked using one of the online labs such as Pearson MyLab where educators can monitor and track the amount of time students spend. Future studies should also ask students from the beginning of the semester to record the number of hours spent consulting TAs and the reasons for consulting them. Students must be asked to turn in all this information for each assignment. Also, future data should provide more evidence regarding whether the students find consulting the TAs helpful and conducting an in-depth qualitative approach which gives access to richer, contextualized, and holistic descriptions.

This study led us to further validate a tool created to measure programming self-efficacy for our sample population of IS students. This allowed us to utilize the instrument to its full potential for this study and present evidence for future use in the IS population. Educators can use this instrument to identify their student's programming self-

efficacy level and for more in-depth future studies looking at other factors that might enhance it. These research findings could contribute to the body of the literature, which, in turn, could promote accomplishing longitudinal evidence to prove or demonstrate the nature of the relationships between programming self-efficacy and factors that might be necessary to enhance it, specifically for IS students.

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**APPENDIX A**

	Independence and persistence in Programming Tasks	Ambition for Programming
26. I could come up with a suitable strategy for a given programming project in a short time.	.78	
3. I could write logically correct blocks of code using Java.	.77	
17. I could debug (correct all the errors) a long and complex program that I had written and make it work.	.76	
18. I could comprehend a long, complex multi-file program.	.74	
6. I could write a Java program that computes the average of any given number of numbers.	.74	
28. I could mentally trace through the execution of a long, complex multi-file program given to me.	.73	
8. I could build my own Java swing GUIs.	.72	
13. I could understand the object-oriented paradigm.	.71	
5. I could write a Java program that computes the average of three numbers.	.71	
11. I could write a long and complex Java program to solve any given problem as long as the specifications are clearly defined.	.70	
29. I could rewrite lengthy and confusing portions of code to be more readable and clear.	.65	
12. I could organize and design my program in a modular manner.	.63	
10. I could write a reasonably sized Java program that can solve a problem this is only vaguely familiar to me.	.62	
14. I could identify the objects in the problem domain and could declare, define, and use them.	.62	
27. I could manage my time efficiently if I had a pressing deadline on a programming project	.58	
9. I could write a small Java program given a small problem that is familiar to me	.51	
21. I could complete a programming project if I could call someone for help if I got stuck.		.91
22. I could complete a programming project once someone else helped me get started.		.90
19. I could complete a programming project if someone showed me how to solve the problem first.		.74
24. I could complete a programming project if I had just the built-in help facility for assistance.		.61
Eigen value	8.75	1.86
% of variance	43.77	9.30
$\alpha$	.93	.79

Note: N=140

**Table A: Items Loadings for the Two Factors of Self-efficacy**

## Teaching Case

# The Southwest Airlines Winter Meltdown Case studies on risk, technical debt, operations, passengers, regulators, revenue, and brand

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### Abstract

The winter storm of late 2022 caused difficulties for many US-based airlines, but none more so than Southwest Airlines. Like other airlines, Southwest canceled flights in the early stages of the storm. Their attempted recoveries failed due to procedural and technology issues. The airline was unable to cope with the magnitude of canceled flights, aircraft and crews in the wrong places, disrupted passenger plans, and luggage separated from its owners. Over the next several days, Southwest canceled tens of thousands of flights, called in thousands of additional staff to support manual operations, and flew a reduced schedule for a time before returning to normal operations. The case provides numerous scenarios for you to analyze and research, to strengthen your understanding of the underlying concepts.

**Keywords:** Teaching Case, Supply Chain, Airline Industry, Risk Management, Scalability, Technical Debt.

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# The Southwest Airlines Winter Meltdown.

## Case studies on risk, technical debt, operations, passengers, regulators, revenue, and brand

*Paul D. Witman, Jim Prior, Tracy Nickl and Scott Mackelprang*

### 1. OPENING STORY

You planned a holiday trip to visit your family months in advance. You arranged to take some additional days off from work. Earlier this morning, with trepidation, you dropped off Clyde at a local kennel. Just now, while standing in line waiting for TSA security screening, you learn that your flight has been canceled.

The bad news ripples through the long line of expectant flyers, who moaning and groaning, jump on their phones, looking for travel alternatives and calling relatives. You do the same. But you quickly realize that this flight cancellation is one of many, and your trip has probably ended before it ever started.

A brutal winter storm that swept across Central and Eastern U.S. in late December 2022 led to the cancellation of more than 12,000 domestic airline flights the week before Christmas (Josephs, 2023). No airline was spared – ice knows no brand allegiance. And while many carriers were able to quickly recover - United Airlines had to cancel approximately 36% of their flights, but they got 90% of their passengers to their destinations within four hours of schedule – the story at Southwest Airlines was far different (Miguens, 2023).

Days after major carriers were back to mostly business as usual, Southwest continued to cancel flights. From December 24th to the 31st, the major carriers canceled 19,421 flights; Southwest accounted for 72% of those cancellations - 14,042 (US Department of Transportation, 2023).

There were many impacts and, likewise, many causes:

- Close to 3 million holiday travelers had flight segments cancelled (Arnold, 2023). Their attempts to reschedule were hampered by overwhelmed phone systems and a reduction in customer service agents, as many stayed away from work to avoid irate passengers.
- With planes available, pilots and flight attendants sat idle due to multiple

challenges with crew scheduling software.

- The financial toll on Southwest - more than \$1.1 billion in lost revenue (Arnold & Skores, 2023).

We hope that this real-world case will help students understand and analyze situations from several fundamental perspectives. These include technical debt, scalability, risk management, and supply chain management. Note that all references to people by first name only are real people unless stated otherwise.

### 2. TECHNICAL BACKGROUND

There are a number of technical concepts that apply to various aspects of this case, and we identify and describe them briefly here.

#### Technical Debt

In technical circles, the phenomenon of deferred maintenance is called "technical debt." When citizens find that deep potholes in the road are destroying their cars, they realize that their tax dollars were not focused enough on road maintenance, and perhaps were spent on less-important things. Technical debt within computer systems, on the other hand, is not nearly so easy to discern. Quite often, unless a person is directly involved in the creation, care, and feeding of a computer-based service, it can be difficult or impossible to know the impact of technical debt.

Technical debt can result from various causes and appear in various forms (Besker et al., 2018; Kruchten et al., 2019):

- System Capacity limitations: Workloads can outgrow a system's design capacity.
- System Integration limitations: Very often, individual systems must cooperate to make an overall system function end to end - crews, planes, catering, de-icing, passengers, baggage - all must be coordinated.
- Security limitations: Frequently, investment is required to protect systems with no improvement in system function.
- Product Lifespan limitations: Computers don't last forever, but sometimes

companies keep using them well beyond their "end of formal support" date.

- Vendor Maintenance limitations: Support for third party computer hardware or software costs money and effort and may have diminishing value as systems age.
- Process mismatch: Changing business operations requires changes to systems, and sometimes businesses skimp on that - "there's nothing so permanent as a temporary solution" (a quote from one of this case study's authors, from industry observations in banking).
- Failing to integrate technology acquired through acquisition of other airlines.
- Business investment in customer-visible software features which promise new revenue versus investments in back-office core processing can lead to systems which lack capacity to meet customer demand.

Southwest made a point of saying, in their action plan, that the airline would spend over \$1B on "technology projects" in 2023 (Southwest Airlines, 2023). However, as in prior years, they don't specify whether or how much of those projects are customer-facing, versus how much is focused on improving the stability and performance of the "back end" operational systems required to get planes in the air and back to the ground safely.

### Scalability

Scalability is a "desirable attribute of a network, system, or process ..., to process growing volumes of work gracefully, and/or to be susceptible to enlargement" (Bondi, 2000). In the case of Southwest's systems, a central question of this case will be, were they scalable to handle the load of the large volumes of activity that ensued when flights were canceled? Southwest had issues with crew and flight scheduling systems (the systems that tracked crew location, rest status, and contractual obligations), as well as with crew reporting and authorization systems. Pilots and cabin crew members were required to dial a voice phone number to report their status and location. Due to staffing constraints, that number sometimes forced crew members to wait up to 9 hours before they could begin to get scheduled.

Similarly, passengers who tried to reschedule their flights had to wait on hold for hours as the Southwest customer service lines were jammed. Those wait times were due both to the shortage of trained customer service staff, as well as to the

lack of reliable information about how to schedule those passengers on new flights. While customers did have the option of conducting those activities online (which the crew did not), most unhappy customers want to talk with a real person to ensure against further surprises.

### Root Cause Analysis

Root cause analysis refers to the process of attempting to discern the most fundamental, or root, cause of a problem or situation. It is often conducted, conceptually, by repeatedly asking "why" after identifying a partial cause for a problem. The goal of root cause analysis is to focus on solving the fundamental cause, and to avoid solving what amounts to a symptom, rather than solving the underlying cause (Rooney & Heuvel, 2004).

As an example of this process, for this situation:

*Question:* Why did Southwest Airlines have a cascade of failures which led to a loss of service which lasted for days and cost the company between \$725 and 825 million?

*Answer:* Because unusually severe weather caused travel disruptions that overwhelmed the scheduling system's ability to manage all of the airline's scheduling and logistics needs.

*Question:* Why?

*Answer:* Because the system was not designed nor provisioned to deal with such a high level of disruption and the subsequent logistical complexity.

*Question:* Why?

...

This line of questioning has taken us nearer to the real cause of the outage: A lack of investment in mission critical IT resources which left the company with dangerously high technical debt. Now that the causal analysis has drilled down to a more relevant 'why' question, useful explanations for the failure can be proffered.

### Risk Management

Risk is a concept that is not unique to business or technology - it is fundamental to many aspects of everyday life. Risk refers to the probability that a certain type of event will occur. Impact, in contrast, is the magnitude of damage that might result should the event occur. Risks are usually perceived as having negative outcomes (injuries, damage, cost, and the like), though sometimes

they are positive (we most commonly focus on risk as being related to negative outcomes).

There are several fundamental approaches to managing risk (Ahmed, 2017). One can avoid the risk, transfer it to someone else, reduce it to acceptable levels or simply accept it.

- Avoidance: If a risk is determined to be too high, then you avoid the activity that creates the risk.
- Transfer: In many cases, the risk can be transferred to another party.
- Reduction: Risk reduction is a common step for processes or activities that cannot be avoided, and where the risk cannot be transferred to another party.
- Acceptance: In some cases, the best option is to accept a risk. If steps have been taken (as in the above strategies) to reduce or mitigate the risk, the remaining level of accepted risk is known as "residual risk."

Sometimes, organizations take an approach that *externalizes* some part of their risk. This means that they (deliberately or inadvertently) *transfer* some of their risk to external parties - customers, vendors, employees, etc. In Southwest's case, some have argued that Southwest's choices for technology investment effectively transfer some of the impact of these risks to various other parties. Pilots and cabin crews are left away from home and without work; customers are left stranded somewhere during their travels, sometimes without their luggage. Some of these external parties may be compensated, but often they perceive that compensation to be inadequate. The details of that transfer of risk and impact are not calculated here, but it is clear that some parties believe they did not agree to take on that risk, and were not compensated appropriately (e.g., Arnold & Walters, 2023).

### **Airline Industry Issues**

Managing an airline industry requires dealing with several specific challenges due to the nature of its operations and competitive environment. Supply chain challenges are common to all industries; airlines in particular have very large and expensive equipment (planes) that are hard to move and are highly regulated, making the airline industry somewhat uniquely challenging. Similarly, airlines sell a product (seats) that are highly time-sensitive - when the aircraft door closes, the value of an empty seat immediately goes to zero, since no revenue can be generated without a passenger in that seat (Wang et al., 2021).

Challenges include:

- Crew rest requirements - flight and cabin crew members are limited in how many hours they can work in a row, and how much rest/sleep time is required before they can fly again.
- Pilots can "declare" a fatigue issue, even if they've just finished a rest period.
- Getting all the pieces in the right place at the right time is critical (Belhadi et al., 2021; Vieira & Loures, 2016):
  - ✓ Aircraft, crew, landing rights, gate space, fuel, catering supplies, and ground crews all must be ready in time to get the plane in the air and to land and unload it at the other end.
  - ✓ Passengers must know the plane is going to fly and be ready to board. Unlike retail, where an unsold object can be sold the next day, an unsold/unoccupied seat on a plane generates no revenue.
  - ✓ The plane must be flight-ready, which means it must have been inspected and maintained by ground crews and flight crews before the flight. Some of this is expected to be handled on a daily basis, when the plane is parked overnight in its expected location.
  - ✓ Planes are not generally expected to sit idle for more than a day or two, and an idle period triggers a need to do additional maintenance and testing. In this case, some of that had to be done away from the usual locations, requiring that maintenance workers be moved to those airports (Sider, 2022b).

Southwest operates an unusual routing system, relative to its major US airline competition. Most airlines operate with a small number of hub airports, and most flights begin or end in one of the hubs - a hub and spoke approach. Southwest, in contrast, uses a point-to-point model. In this model, flights tend to go direct from one destination to another and back again, but do not routinely transit through a central hub airport. As such, getting aircraft back to a starting point for a new day of flying is much harder to do with most flights starting from smaller and less "busy" airports (Sider, 2022a).

### **Potential Impact of Social Media on Communication and Amplification**

Communication occurs quickly and in real-time in social media. The potential amplification/reach of media in general and social media

communications specifically, including posts, shares, comments, and “likes/dislikes” can be significant, multiply very quickly, and amplify things intentionally – or unintentionally. This is particularly important during a crisis and presents a modern-day challenge for firm leadership and the marketing and PR teams, as social media empowers the users and requires that firm’s focus on effectively influencing perceptions, behaviors, and knowledge. If the strategy is not well thought out and executed, it can have a significant impact on the brand – especially if the communication is not seen as authentic. Also, in the absence of information, people often make things up to fill the void, and those things tend toward the negative (Zide et al., 2014).

Impression management theory (Goffman, 2002) establishes the correlation between branding and managing others’ impressions, while signaling theory (Spence, 1973) addresses how this plays out in social media impacting employees, customers, the media, and other stakeholders. Impression management requires controlling and managing others’ impressions through the information presented. In social media, the firm is working to control its brand and social media influencers are simultaneously working to maintain and control their own brands, consequently weighing in on posts and providing their perspectives that influence perceptions (Kietzmann et al., 2011). Social media also provides the customers/passengers the ability to partake real-time in the conversations and influence the dialogue, often done in their personal social media accounts and delivered as part of the passengers’ personal brands (Van Zoonen, 2009).

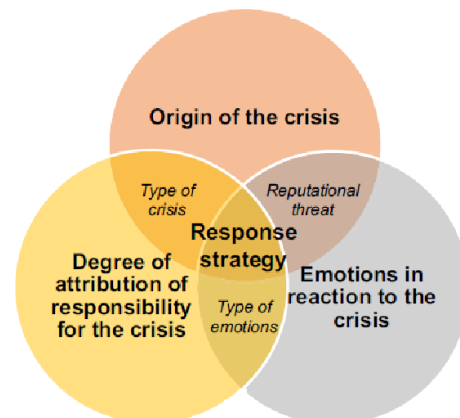
The wide variety of stakeholders with potentially competing priorities creates a complicated landscape to navigate for the firm and often requires a sophisticated multi-pronged approach. The signaling theory in social media occurs when signals are sent in social media to influence the receiver’s perceptions, behaviors, and knowledge. The receiver then determines if the signal is authentic and impactful enough to influence/change their perceptions. The multi-stakeholder participation in the conversation occurs in personal and corporate (both internal and external) networks and platforms making it difficult to influence – especially if there are not clearly defined strategies, policies, procedures, and trained effective staffing.

### **Crisis Communication Considerations and Tools**

Bukar et al (2020) conducted a systematic literature review and found that the three most popular response strategies to a crisis are: rebuilding/apology followed by denial/scapegoating and then, diminish/excuse . Southwest’s response strategy for the recent crises is primarily based on apology with some information strategy that will be further discussed in Scenario 6 below.

### **Social Media-based Crisis Communication Models**

At a strategic level, it helps to consider three models - Integrated Crisis Management (ICM), Situational Crisis Communication Theory (SCCT), and Social-Mediated Crisis Communication (SMCC) - that link stakeholder emotions and the response strategy as outlined in Figure 1.



**Figure 1 – Integrated Crisis Management Strategy (Vignal Lambret & Barki, 2018) – used with permission**

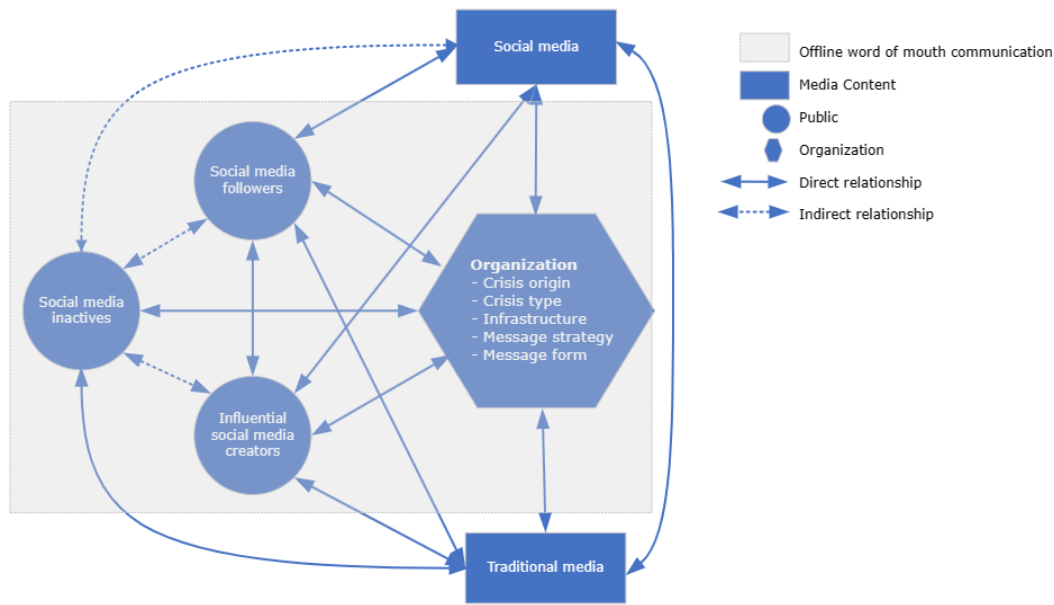
Jin & Liu's (2010) SMCC model and framework can then be applied tactically to help further assess potential gaps, issues, and opportunities in Southwest’s crisis communication strategy. See Figure 2 for an overview of that approach.

### **3. DISCUSSION SCENARIOS**

The following scenarios may be assigned by your instructor as individual or group exercises. Each is designed to be self-contained, so you could analyze any one scenario on its own, and from either a technical level or an organizational level. All individuals named in the scenarios are fictional composites, unless otherwise stated.

#### **Scenario 1 - Where’s my luggage?**

Along with the numerous pains associated with



**Figure 2 – Social-Mediated Crisis Communication Strategy (Jin & Liu, 2010)-  
used with permission**

canceled and rescheduled flights, many Southwest Airlines customers suffered an additional headache - lost luggage. They'd check their bags, wade through security, discover that their flight had been canceled; and, at some point, ask themselves... Where's my luggage?

For many passengers who were fortunate enough to book new flights and reach their intended destination, they'd arrive to discover that their luggage wasn't there. Unable to get concrete information from baggage agents, who genuinely didn't know where their bags were, many travelers would return to the airport multiple times to check for their luggage while having to purchase replacement clothing and belongings. The reversed result was all too common as well. Travelers unable to get to their destination canceled their travel plans - only to discover (via the airline, or via Apple AirTags or other trackers) that their luggage went without them to their destination, leading to additional time and cost spent retrieving their bags. These separations were frustrating and problematic, as some checked luggage included pets, car keys, Christmas presents, and critical medications (Sider, 2022b).

Across the country there was chaos in Southwest baggage claim areas as passengers searched for their luggage. Among them were a few good Samaritans, who while searching for their own luggage, took time out to text random phone numbers that they saw on luggage tags, letting their owners know where their bags were.

Southwest Airlines has for years carried the most luggage of any U.S. carrier, in part because they allow every passenger up to two bags for free. They have a good record evidenced by a low frequency of mishandled bags, lower than competitors in general. However, Southwest does not offer baggage tracking capabilities that are common to many other airlines (Sider, 2022b).

Ultimately, many thousands of Southwest Airlines customers went almost two weeks before they got their luggage back (Gimbel, 2023; Sider, 2022b).

#### Questions

- As an airline customer, how might you protect yourself from such an outcome?
- What information system solutions could Southwest Airlines have had in place to minimize this disruption?
- What other questions or observations can you make about this scenario as it relates to risk management, technical debt, information, and information systems?

#### Scenario 2 - Where'd my flight crew go?

The brutal winter storm triggered a cascading set of challenges. Thousands of Southwest Airlines customers were affected, as were flight crews, increasing the overall impact and delaying recovery of normal operations.

As the storm continued, ground crews were required to work overtime - in frigid conditions.



Some of them developed frostbite and many of them called in sick. As ground operations slowed, more flights were canceled. Cancellations in Denver, for instance, led to cancellations in Dallas, Chicago, etc. as planes and/or their crews wouldn't arrive from Denver (Leff, 2022). Steve (a real passenger and friend of one of the authors) was passing through Denver on another airline that day, and reported seeing 2-3 thousand people in line at Southwest counters.

In normal conditions, as part of their point-to-point model, it is very common for Southwest flight crews to start their day in one city and finish their day in another city after numerous flights. With this once-in-a-lifetime storm, the many cancellations caused planes, pilots, and flight attendants to not be where they needed to be, adding to challenges for the next day's flights.

Once many Southwest pilots and flight attendants were out of position, Southwest's outdated crew scheduling system failed to keep up with the work of rescheduling, notifying, and relocating them. In a message to the company, Southwest Chief Operating Officer Andrew Watterson said, "we had aircraft that were available, but the process of matching up those crew members with the aircraft could not be handled by our technology." He added that the process had to be handled manually, which was "extraordinarily difficult" (Sangal et al., 2022).

One possible contributor to these failures might be found in Southwest's investment strategy. Recent capital expenditures, which includes technology projects, have been \$1 billion in 2019, \$515 million in 2020 and \$505 million in 2021. Similarly, the number of employees in their business group which includes technology workers dropped 27% from 2018 to 2021, while overall full-time employee count dropped just 6% over the same time period (Arnold & Walters, 2023).

#### Questions

- How could Southwest Airlines communication systems be improved to more easily allow flight crew personnel to update their location and availability when phone systems are overwhelmed?
- Compare and contrast Southwest Airlines' "point-to-point" scheduling methodology to their competitors' "hub and spoke" approach, including pros and cons of each.
- What other questions or observations can you make about this scenario as it relates to risk management, technical debt,

information, and information systems?

#### **Scenario 3 - Rebecca gets delayed by a firewall, and (sort of) changes planes**

On March 30, 2023, Southwest released its "action plan" (Southwest Airlines, 2023) to address the issues that arose in December 2022, hoping to put its operational challenges behind it. But just a few weeks later, on Tuesday, April 18, a firewall failed in a Southwest data center, which grounded all Southwest flights. On that same Tuesday, Rebecca (a real person and friend of one of the authors) was on her way from New Orleans to Dallas, and on to California for a brief visit with old friends. Her flight, and hundreds of others, were delayed for an hour due to the failure of "a vendor-supplied" component. The component failure blocked access to "operational data," preventing flights from boarding or departing. The winter breakdown, along with the April 18 failure, has been blamed by many on "technical debt." In the April 18 case, Southwest's published analysis reported the problem was a single third-party component, specifically, a firewall (Lampert & Singh, 2023).

In Rebecca's case, even though her takeoff from New Orleans was delayed by an hour, and her layover in Dallas was reduced from two hours to 40 minutes, it turned out that the re-scheduling system worked in her favor. She wound up right back on the same plane for the trip to California, and that leg of the journey landed on time. However, while on the ground in Dallas, she had to get off the plane and then get right back on that same plane, using her second boarding pass.

#### Questions

- Given Southwest's published analysis of the April 18 issue, what is the alleged cause of the delay?
- Is the alleged cause, from the prior question, really the root cause? If not, what more fundamental causes can you identify?
- Do any elements of this explanation seem potentially misleading or unsupported?
- What other questions or observations can you make about this scenario as it relates to risk management, technical debt, information, and information systems?

#### **Scenario 4 - Flight and cabin crews ask, "Why do I have to call to reschedule? I can't just click a button?"**

Mary and Sam, Southwest flight attendants, had landed in Burbank and ended their workday as the winter storm started to have its effects. Sam realized he was not likely to be assigned a flight any time soon, so he rented a car and drove three

hours to visit friends near Los Angeles. Mary stayed at a hotel near the airport. Both would need to let Southwest know where they were at the start of their next duty period. Janice (also a fictional composite), the pilot on that Burbank flight, still had several hours left in her duty period, and stayed at the airport.

Southwest requires crew members to use a voice telephone system to deliver the data required to allow its crew scheduling team and their software, called SkySolver, to make informed scheduling decisions. SkySolver's job (working with other systems) is to get the crews, planes, and passengers aligned, assigned, and positioned for their next flight, and to let crew members know where they have been assigned (Sider, 2022a). When large numbers of crew members were reassigned, due in this case to canceled flights, the task of collecting crew data and delivering assignments was messy and ultimately not scalable without adding large numbers of additional staff in the crew scheduling call center.

There are several constraints around how Southwest, and all airlines, can schedule crews. For pilots, so-called "Part 117" rules control how much rest a crew member needs to have between assigned duty periods (which often include several flights) and between flights. Both flight attendants' and pilots' assignments are governed in part by union rules. Some of those rules may have been involved in forcing the voice-based dialog on crew scheduling (Snyder, 2023).

About those three Burbank crew members: Janice had been scheduled to fly out of Burbank, but her destination airport was closed. She tried to reach someone at Southwest to arrange to make another flight, but to no avail - she was on hold for several hours, and then her duty period expired. Sam was trying, at his friend's home, to get scheduled for the next day, but no luck. Mary returned to the airport the next day and was able to reach Southwest's crew assignment team by phone early in the day and get scheduled for a flight out of Burbank. But even that was difficult, as it took significant time to find all of the crew members and get them to Burbank, ready to fly.

Questions:

- In looking at this series of events, what seems to be the bottleneck in the system as described from the crew members' viewpoint?
- What alternative methods of data collection might be used instead?
- If you were consulting for Southwest, what fundamental changes would you

recommend they make to their crew availability and scheduling system?

- What other questions or observations can you make about this scenario as it relates to risk management, technical debt, information, and information systems?

### Scenario 5 - A Myriad of Problems

Readying an airplane for flight requires many steps by many teams. Schedulers assign a plane and flight crew. Reservation systems compile a list of expected passengers. When the designated plane lands, ground crew members guide the pilot to the terminal gate and connect the passageway to the plane. As passengers disembark, baggage handlers move luggage off the plane, while other teams clean the cabin and bring in food. And, all the while, gate agents are readying passengers for boarding.

Winter weather - particularly devastating with Winter Storm Elliott - often adds additional steps to the preparation process. Frost, snow and/or ice on any of the critical surfaces of an airplane can affect takeoff performance. Under these conditions, maintenance workers and the ground crew follow deicing/anti-icing procedures.

Then, throw into the mix Southwest's self-inflicted challenges - crew scheduling software unable to scale as needed, phone systems swamped due to insufficient staffing levels - and you get a myriad of problems:

- Southwest gate agents struggled to provide flight crews with passenger manifests, leading to delays as crew members walked through cabins checking off passengers against a paper print out.
- Although terminals were filled with passengers stuck due to delayed and canceled flights, gate agents often couldn't create tickets for them, leading to flight delays and open seats once flights finally took off.
- Seth, a Southwest pilot, landed at Orange County airport in California, an hour behind schedule. On the tarmac, he discovered that there were no open gates due to already gated flights suffering their own delays. This led to further delays.
- Veronica, another Southwest pilot, was asked to "deadhead" as a passenger to Albuquerque (so she could pilot a flight starting there), but then her flight leaving from Albuquerque was canceled. There were countless instances of flight crews deadheading, sometimes multiple times, trying to set them up for assignments

that never materialized. Trying to recover, Southwest reduced the number of planned flights, giving them time to get flight crews and planes into proper position to return to normal operations. Even this approach led to challenges. Planes can't remain parked for long, so they were put into both short- and long- term storage, which required that they rotate through their entire fleet to keep their planes from sitting idle too long. Workers had to travel in order to maintain those planes (Sider, 2022c).

#### Questions

- What changes to Southwest's systems might have made it easier to find a full flight crew in a situation like this?
- What further problems result from these challenges?
- What other questions or observations can you make about this scenario as it relates to risk management, technical debt, information, and information systems?

#### **Scenario 6 - People are saying what? Is an apology enough?**

On December 29, 2022, as reported in multiple media outlets (Muntean & Wallace, 2023), the Secretary of Transportation, Pete Buttigieg, whose office received thousands of complaints, sent a letter to Robert Jordan, the Southwest CEO and posted it on the Department of Transportation's (DOT) website (Buttigieg, 2022). The letter confirmed their phone conversation and stated four key priorities: getting passengers to their destinations, providing services for disrupted passengers, providing appropriate refunds, and reuniting passengers with their luggage.

On December 30, Robert Jordan stated, "This has been an incredible disruption, and we can't have this again" (Sider, 2022c). Southwest has repeatedly apologized in the media. On March 30, 2023, Southwest posted their "Final Summary and Action Plan" on their website outlining three key root causes: "Winter Operations" - a lack of winter infrastructure, equipment, and staffing, which impacted flight crews; "cancellation waves" that overloaded the system and forced a reversion to manual processes; and "cross-team collaboration" - communication process gaps created bottlenecks and issues. The report adds an information response strategy component and indicates significant progress has been made but it does not address the technology issues to any substantive level.

Unfortunately, Southwest has continued to have technology issues and based on social media they

are continuing with the "apology response strategy" and appear to still be lacking cross-team collaboration regarding messaging, as key components of their marketing communication and PR strategy are at odds, as outlined below.

On Tuesday morning, April 18th, José was flying from Miami to Dallas when his plane was grounded on the tarmac. The longer they sat, the more concerned he became. José pulled out his cell phone and searched Facebook to see if anything had been posted - he quickly found many posts all stating things like: "Heads Up - Southwest asked the FAA to pause all nationwide departures due to technology issues ... this is crazy as it has been less than six months since Southwest had to cancel 15,000 flights".

José found a lot of other posts with similar information. He began skimming them when a new post popped up with the following embedded in the post: "This from Southwest: As a result of the intermittent technology issues that we experienced, we should hopefully be resuming our operation as soon as possible. We apologize for any inconvenience this may cause, but we're hoping to get everyone going ASAP. STAND BY" (Nick Beres NC5, 2023). José began to read the 352 comments (many from very unhappy stranded flyers) and decided to share the post as 425 others did, to try to help any of his friends and family who might also be traveling.

José scrolled back to the top of his feed, and when it refreshed, he noticed a new post from another passenger - PAUSE CANCELED - GET READY TO SIT AND WAIT.....THERE WILL BE DELAYS! - this post already had 3,000 likes and 1,000 shares. An hour later the flight attendant announced, "The issue has been resolved, and we are getting in line to take off. Please take your seats."

José got to Dallas 3 hours late and met his son at baggage claim. As they waited for his bags, José's son showed him a post from "The Points Guy," an influencer that he follows. The post said: "UPDATE: Southwest Airlines flights resume after IT issues cause systemwide ground stop. Southwest Airlines grounded its entire operation on Tuesday morning, citing unspecified IT issues. The airline did not give a time for the fix. Here's the latest. (536 comments and 321 shares)".

On April 21, 2023, the Department of Justice's (DOJ) legal arm joined the investigation (Skores, 2023). "The investigation is focused on whether Southwest engaged in unrealistic flight scheduling which is illegal under federal law and whether Southwest provided timely refunds and

reimbursements to affected passengers as required," the spokesperson said.

#### Questions

- Given the responses of the public and stakeholders (media, passengers, influencers - "The Points Guy," DOT, DOJ, and others), how successful has Southwest been in managing perceptions about the technology and technical debt issues?
- What would you advise Southwest to consider doing immediately/in the short term based on recent activities and results?
- What advice would you give to the Southwest leadership about their brand?
- What other questions or observations can you make about this scenario as it relates to risk management, technical debt, information, and information systems?

#### 4. ADDITIONAL RESEARCH QUESTIONS

Please feel free to use these prompts as you and your instructor see fit, to conduct additional research and analysis of this painfully spectacular failure.

Social Media Engagement and Artificial Intelligence: Social media obviously provide a mechanism for significant numbers of people to publicly impact a company's brand. Responding in a timely manner to individual comments is impossible using human-powered responses. However, recent developments in generative artificial intelligence may change that dynamic. Consider the risks and tradeoffs associated with using so-called generative AI to respond to customer social media postings and share your insights.

Action Plan Review: Southwest Airlines has published their action plan (Southwest Airlines, 2023) about three months after the winter disruption settled down. Read the document (see reference list) and provide feedback per your instructor's guidance about some chosen aspect(s) of the plan. This could be an assessment of the plan's candor, an analysis of the timeline called out by the plan, comments on the relative investments in infrastructure and inward-facing technology vs. external or customer-facing technology, or others.

Outsourcing, Customizing Software, and Technical Debt: Outsourcing is the process of moving a logically consistent unit of work to another company, paying that company to do the

work for your company. Southwest used outsourcing to get access to the flight- and crew-scheduling software called SkySolver. They are reported to have acquired this technology from GE's Aviation Services unit and have heavily modified it to suit their specific needs. What are the tradeoffs and risks of buying or licensing software from someone else and then customizing it? What are the advantages and disadvantages? Why not just build one's own technology for operations like this, since that gives you much more control of how the system works?

#### 5. CONCLUSIONS

Airlines are not easy businesses to run. They are capital *and* labor intensive, they are subject to impacts from weather, politics, public health, and other unexpected issues. And they are competitive, seeking not only to provide good price and performance for customers but also an appropriate yield for every seat on the plane, and to keep planes in the air and generating revenue (Wang et al., 2021).

The Southwest Airlines 2022 Winter cancellation storm provides an opportunity to dig deeply into the need for scalability, the challenges of risk management and technical debt, and the wide variety of challenges of managing airline supply chains. In addition, it brought up the challenges of brand management amidst a crisis. We hope that this provides you with a useful and accessible tool to apply these fundamental business and technology concepts to real-world events with very real-world impacts.

As a conclusion to the case for the regulatory aspects, nearly a full year later Southwest agreed to pay a total of \$140 million, including a \$35 million fine to the US Department of Transportation. The other \$100+ million will come in the form of reimbursements to travelers delayed on Southwest in coming years (Shepardson, 2023).

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# Leveraging ChatGPT for Higher Education Course Offerings

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## Abstract

Since it was released on November 30, 2022, ChatGPT has offered numerous opportunities for higher education professors to improve their course offerings. However, not all information provided by the application is accurate. The application has been known to yield highly inaccurate information with high confidence. Yet, with that knowledge, ChatGPT can still save education practitioners hours of time and improve their courses, as well as help students with library research. By January, 2023, ChatGPT was the fastest growing consumer software application in history, with over 100 million users. Despite any misgivings, it is here to stay. This paper investigates how ChatGPT can be used help IS faculty more easily and effectively prepare and present their courses and discusses potential opportunities and threats from its use. Ways in which students may use the application for library research and feedback are also discussed. Generative AI in its current and evolving formats are proving helpful for students and faculty alike.

**Keywords:** ChatGPT, Academics, Chat Bots. Artificial Intelligence, Information Systems, Education, Information Security.

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# Leveraging ChatGPT for Higher Education Course Offerings

*Lionel Mew and William H. Money*

## 1. INTRODUCTION

This paper investigates how ChatGPT can be used to help Information Systems faculty more easily and effectively prepare and present their courses, as well as helping students with library research and obtaining feedback on their efforts. Since it was released on November 30, 2022, ChatGPT has offered numerous opportunities for professors to improve their course offerings. However, is believed to sometimes yield highly inaccurate information with high confidence. There may be biases which are difficult to determine, but which are intuitively obvious. Even with that knowledge, ChatGPT can still save professors hours of time. Although it is not perfect, it is suggested that ChatGPT can help instructors develop organized materials, and help students develop insight and improve their deliverables.

This paper provides background on ChatGPT, examines the literature on use in Academia, discusses and how it can help instructors prepare courses. It also discusses how students can ethically use generative AI to add value to their assignments.

## 2. LITERATURE REVIEW

The literature suggests that ChatGPT may offer value in all aspects of planning, organizing, providing content, assessing, and offering courses in higher education.

### ChatGPT

Ofgang (2023) found using ChatGPT to prepare for class to be easier than anticipated, although they would not personally use it due to fear of violating institutional policies, fear of plagiarism and preference for human content. The author suggested that the freeware version of ChatGPT was an easy way for educators to prepare for and create course materials. They suggest it can help to quickly generate syllabi, lesson plans, homework assignments and quizzes.

In a 2023 article, Abramson suggests that rather than ban ChatGPT in the classroom, professors use it to encourage critical thinking in liberal arts courses in a similar fashion to calculators helping students learn mathematics. Students can also

use generative AI to improve their research into specific topics as well as to give them feedback on specific assignments.

## 3. BACKGROUND

### Introduction of AI and ChatGPT

Chat Generative Pre-trained Transformer, or ChatGPT, is a model known as a chatbot. It is formed from a combination several technologies including Artificial intelligence, natural language processing, and Neural Networks (machine learning models composed of interconnected processing nodes trained by adjusting the strengths of connections between them (Bishop, 1994). ChatGPT works because it has extensive stored data and is capable of interpreting user requests and generating a suitable response as if it were human.

The application uses components that can trained or be parameterized, and data that can be collected and examined using user input scenarios (Biswas, 2023). The output data include analyses, interpretations, developed stories or generated scenarios, generation, and assessed models. Chat GPT is capable of "learning," and taking direction from prompts to improve its output (McGee, 2023).

The growth and popularity of the system is enormous. ChatGPT, the recent version GPT-3, has reached 1 million users only in 5 days. For comparison, major technology companies, Facebook, Netflix, Instagram, and Twitter could reach this number in 300, 1200, 75, and 720 days respectively (Firat, 2023).

A preview of the AI chatbot created by OpenAI created a media sensation in December 2022. It is based on GPT-3.5, the newest version from OpenAI (Roose, 2022). The most current version, GPT-4 was released on March 14, 2023. It includes an API for the product (Olson, 2023).

### What the Model Does

The model is composed of several modules that enable it to train on a set of inputs. OpenAI has developed a Generative Pre-Trained Transformer (GPT) language model that can create responses in a text form that appears to be human language (Dale, 2021). Two forms of AI are used to create 3

the outputs. Unsupervised learning is used for pretraining with unlabeled data to generate the associations in the data. Supervised (guided) AI learning is used to fine-tuning and improve the output on specific prompts or tasks (Erhan, Bengio, Courville, Manzagol, & Vincent, 2010).

#### **How components Work to Produce a Product**

ChatGPT works by attempting to understand user prompt and then produce (non-random) strings of words that it predicts (based on weights given to the parameters) will best answer the user's question. To do this, the data it was trained on is critical to the result. It human like learning allows it to GPT to learn patterns and relationships and to create what might be human-like responses (Guinness, June 2, 2023).

#### **Understanding the bias potential**

Lund (2023) states that use of the GPT data can maintain biases and stereotypes present in the data. This is logical since the generative model is trained on a data set. It will incorporate what it has encountered in its response. McGee (2023) observed (by accident) that ChatGPT tendered to generate a biased response to a request that it write Irish Limericks. The outputs from ChatGPT appeared to be positively biased for liberal politicians and negatively biased for conservative politicians. He constructed a test with a sample of 80 limericks and compared the probability of the results showing that the AI was biased to favor liberal politicians and disfavor conservatives. The generative method employed was to instruct ChatGPT to: "Write an Irish Limerick using the word X. "In each instance, X was the name of an individual that was the target of the Limerick. Was this a pattern, or a random occurrence? The sentiment would be one of three results, either positive, negative, or neutral. The Limerick generated outcomes indicated that there is "...strong probability of bias in favor of liberals and against conservatives" (McGee, 2023, pg. 2).

#### **4. HIGHER EDUCATION APPLICATION**

The literature suggests that AI chatbots such as ChatGPT may be useful for all aspects of preparing and presenting courses in higher education. Ofgang (2023) suggested several ways that educators could easily use ChatGPT for preparing their courses, including generating lesson plans, creating quizzes, developing homework assignments, and developing syllabi. Ofgang uses the ChatGPT freeware version to generate those documents, using various example courses.

#### **Syllabus Generation**

In the case of syllabus generation, Ofgang uses the example of a survey journalism course on basic news writing. To make the work of the current paper more relevant to Edsig, it was decided to use an Information Security Social Engineering example. The authors signed up for the open access version of ChatGPT, and did not practice or partake of any training. Immediately after joining the application, the chat playground was queried with the prompt, *Create a Syllabus for a 12-session social engineering course*. Within a few seconds, the following output was received:

Course Title: Introduction to Social Engineering

Instructor: \_\_\_\_\_

Course Description:

This course is an introduction to the vast and dynamic field of social engineering. In this course, students will gain an understanding of the psychological mechanisms underlying how social engineering works, and will also gain the technical skills needed to properly identify and defend against social engineering attacks. Upon completion of the course, students will have a working knowledge of social engineering techniques and be able to identify the most common vectors used in social engineering attacks.

Instructor's Contact Information:

Email: \_\_\_\_\_

Phone: \_\_\_\_\_

Course Objectives:

- Learn the fundamentals of social engineering
- Develop the ability to recognize common tactics and strategies used in social engineering attacks
- Create strategies for defense against social engineering attacks
- Develop an understanding of the psychological and technical mechanisms behind social engineering

Course Materials:

- Textbook: Social Engineering: The Art of Deception (By Christopher Hadnagy, Wiley, 2010)
- Compilation of supplemental materials and readings

Course Requirements:  
- Active participation in discussion  
- Completion of reading assignments  
- Mid-term and final examinations

Session Overview:

Session 1: Introduction  
- Introduction to Social Engineering  
- Overview  
- Social Engineering Techniques  
- Human Psychology - Overview

Session 2: Building Trust  
- Introduction to Human Psychology  
- Establishing and Maintaining Trust  
- Influence and Persuasion

Session 3: Pretexting  
- Tactics of Pretexting  
- Common Types of Pretexting  
- Social Engineering Techniques Used in Pretexting

Session 4: Phishing  
- Tactics of Phishing  
- Common Types of Phishing  
- Social Engineering Techniques Used in Phishing

Session 5: Vishing  
- Tactics of Vishing  
- Common Types of Vishing  
- Social Engineering Techniques Used in Vishing

Session 6: Midterm Exam

Session 7: Human Psychology - Advanced  
- Building Rapport  
- Understanding Cognitive Biases

Session 8: Social Engineering in the Real World  
- Practical Social Engineering Scenarios  
- Social Engineering Mitigation Strategies

Session 9: Spamming  
- Tactics of Spamming  
- Common Types of Spamming  
- Social Engineering Techniques Used in Spamming

Session 10: Defending Against Social Engineering Attacks  
- Tactics to Neutralize Social Engineering Threats  
- Principles of Defending Against Social

Engineering

Session 11: Detection Strategies  
- Common Social Engineering Detection Strategies  
- Understanding Social Engineering Vectors

Session 12: Final Exam

Grading:

Grades will be based on participation, exams, assigned readings, and class contribution. The final grade will be calculated as follows:

- Participation: 10%
- Exams: 40%
- Reading Assignments and Class Contribution: 50%

Textbook:

Social Engineering: The Art of Deception (By Christopher Hadnagy, Wiley, 2010)

Campus Resources

- Academic Resource Center
- Library
- Student Success Center
- Technology Support Center
- Writing Center

The course outline was compared to the recommended text to determine how much the content was incorporated into the social engineering course. The ChatGPT course did not simply replicate the content of the text. The course approaches the social engineering subject from a psychological perspective. It emphasized the psychological construct of trust to explain how the social engineering technique could be successfully employed, including a section for an example case (detailed in the recommended text) and addressing the processes involved in both creating social engineering attacks and defending against them.

A second comparison was made to assess if the ChatGPT course addresses the topics covered in a college-level course on social engineering. The suggested outline and content were again contrasted with Purdue University's short course on social engineering. This course is designed to provide cybersecurity professionals with opportunities to broaden their skills on an accelerated basis. This university-level course

incorporated a historical perspective (omitted for the ChatGPT course), included the psychological constraints, and again included social engineering processes and techniques.

There is no apparent plagiarism or copying of the text or this specific sample course and assigned text used for the comparison. As would be expected, "words" produced by ChatGPT appear to be strongly relevant to the prompt (social engineering course), and there are no anomalous insertion or unrelated inputs or assignments.

It was thought impressive that within a few seconds, the ChatGPT application generated a useable syllabus. Upon reflection, it was seen that the application selected a book to be used as the course text. The assumption may be that the course description, objectives and lessons would be drawn from the text, with housekeeping such as tests, grading, resources, etc. inserted based on typical syllabi, or a standardized syllabus.

It was found in later investigation, however, that the application not only listed the title of the text incorrectly, but that the sessions did not correspond to the chapters in the text. So, the question is, how was the syllabus generated? Like Google, the search algorithms used are not easily available. Despite this, the application generated in seconds, something that would likely take a professor much longer to develop. It is suggested that the generated syllabus may be used as a starting point, with verification, due diligence and modification, to yield a definitive course syllabus.

The syllabus was not used for the actual course. The syllabus used was constituted from relevant subjects contained in various texts, and updated over a number of years. However, it would have been okay to use the generated syllabus as it covered most, if not all of the objectives expected of a social engineering course.

For comparison, the syllabus actually used in the course contained the following topics:

Introduction  
Elicitation  
Pretexting  
Mind Tricks  
Persuasion & Influence  
Physical Tools  
Software Tools  
Targeting  
Information Gathering  
Scenarios  
Prevention & Mitigation

As a comparison shows, the generated topics are more specific in some areas, where the actual syllabus is more holistic in nature.

### Test/Quiz Generation

Ofgang suggests that ChatGPT may be used to quickly generate quizzes, further noting that in liberal arts courses not using a textbook, creating quizzes can be a time-consuming endeavor (2023). Once again using a journalism example, Ofgang asks ChatGPT to generate a writing exercise using the inverted pyramid. Interestingly, instead of a writing exercise, the application generates five multiple choice questions, each with four answers. It is interesting because when the application is questioned using a Social Engineering example, ChatGPT returns a series of short-answer questions. Using the query:

*Create a quiz for the following session: Session 1: Introduction*

- *Introduction to Social Engineering*
  - *Overview*
  - *Social Engineering Techniques*
  - *Human Psychology - Overview*

The application returns:

1) What is social engineering?

A) Social engineering is a type of exploitation that relies on human interactions and psychological manipulation to gain access to confidential information, assets, or sensitive data.

2) What are some of the techniques used in social engineering?

A) Common social engineering techniques include phishing attacks, impersonation attacks, and pretexting.

3) What is the role of human psychology in social engineering?

A) Human psychology plays an important role in social engineering as it is used to manipulate people into giving away confidential information or assets.

A few more attempts at quiz generation were made using trial-and-error (remember, these queries were made without training, and just minutes after signing up for the app). The revised queries were to make it 10 questions, to make the quiz multiple choice with four answers per question, and to provide correct answers in addition to the choices. The final query used is:

*Create a 10-question multiple choice quiz with correct answers for the following session:*

*Session 1: Introduction*

- *Introduction to Social Engineering*
- *Overview*
- *Social Engineering Techniques*
- *Human Psychology – Overview*

The resultant quiz returned is:

1. What is the definition of Social Engineering?
  - a. The use of physical tools to physically gain access to an organization
  - b. The process of attempting to convince people to do something, give away something, or believe something
  - c. The study of how humans interact with computers
  - d. The use of malware to invade a system

Answer: b. The process of attempting to convince people to do something, give away something, or believe something

2. What is a primary goal of social engineering?
  - a. To gain mental control of a system
  - b. To maliciously circulate false information
  - c. To gain physical access to a building or company
  - d. To gain control of system resources

Answer: c. To gain physical access to a building or company

3. What is one example of a social engineering technique?
  - a. Lifting a security badge from an employee
  - b. Creating a computer virus
  - c. Writing a program to infiltrate a system
  - d. Posing as a service technician

Answer: d. Posing as a service technician

4. What is the goal of social engineering techniques?
  - a. To gain physical access to an organization
  - b. To damage the reputation of an organization
  - c. To gain control of a computer system
  - d. To spread malicious software

Answer: a. To gain physical access to an organization

5. What is an example of human psychology that can be used to aid in social engineering?
  - a. The use of fear tactics
  - b. The use of complicated technical jargon
  - c. The use of encryption algorithms
  - d. The use of false identities

Answer: a. The use of fear tactics

6. How can human psychology be used to help prevent social engineering?
  - a. By educating people about the potential risks
  - b. By investing in advanced security systems
  - c. By implementing strict access control policies
  - d. By using encryption algorithms

Answer: a. By educating people about the potential risks

7. What is one way to detect a social engineering attack?
  - a. Monitoring employee emails
  - b. Analyzing system logs
  - c. Installing antivirus software
  - d. Limiting physical access

Answer: b. Analyzing system logs

8. What is one way to protect yourself against social engineering attacks?
  - a. Keeping confidential information secure
  - b. Limiting physical access
  - c. Using strong passwords
  - d. Installing antivirus software

Answer: c. Using strong passwords

9. What is a basic rule of social engineering?
  - a. Never accept files from strangers
  - b. Never click on suspicious links
  - c. Always trust people
  - d. Always give out personal information

Answer: b. Never click on suspicious links

10. What is an example of a physical security measure to prevent social engineering?
  - a. Installing antivirus software

- b. Using strong passwords
- c. Limiting physical access
- d. Monitoring employee emails

Answer: c. Limiting physical access

Many of these questions show up in Social Engineering test banks, and are apparently well-designed questions. The application quickly generated the questions, answers and correct answers. While the caution to use due diligence and verification remains, the application again proves to be a quick quiz generator which, with those caveats, may be a great help to professors.

With respect to traditional guidelines for developing and assessing multiple choice questions, such as using plausible distractors, avoiding clues and negatives, having only one correct answer, etc., the application does a good job of creating basic questions to good effect.

In summary, the ease with which the application generated multiple choice questions cannot be overrated. Especially with increased specificity of the question content, the application easily and quickly generated usable questions. As anyone who has developed questions for a quiz at the last minute can attest, this is not the easiest of endeavors, and the tool is helpful in this regard.

The authors have since used the application to generate questions for various subjects, courses and chapters, all with varying content. These were often used, as those with experience will understand how difficult it is to self-generate multiple choice questions. By providing the application with the specific content from which to generate the questions and answers, concerns about reliability and correctness are diminished.

### Lesson Plans

Ofgang notes that while it takes experienced educators a significant amount of time to organize and coherent lesson plans, ChatGPT can generate one in short order. Ofgang (2023) again used a Journalism example, but this work used the same Social Engineering scenario used for previous generations. The prompt is:

*Create a lesson plan for the following session:*

- Session 1: Introduction*
- Introduction to Social Engineering*
  - Overview*
  - Social Engineering Techniques*
  - Human Psychology - Overview*

The result is:

Objective: By the end of the session, students will understand the basics of social engineering, several of the most common social engineering techniques, and the psychological principles upon which social engineering relies.

Time: 60 minutes

Materials Needed:  
Whiteboard/Blackboard, Markers/Chalk, Handouts

Activity 1: Introduction (10 minutes)

- Instructor introduces the topic of social engineering and its ethical and legal framework (5 minutes)
- Instructor explains the reasons why social engineering is a problem and the types of attackers who use it (5 minutes)

Activity 2: Overview of Social Engineering Techniques (20 minutes)

- Instructor reviews common social engineering attack techniques, such as phishing, vishing, baiting, and tailgating (10 minutes)
- Instructor provides examples of each type of attack (10 minutes)

Activity 3: Human Psychology Overview (30 minutes)

- Instructor explains the psychology which drives social engineers, including how to manipulate emotions, predict behavior, gain trust, and take advantage of cognitive biases (15 minutes)
- Instructor reviews tactics used by social engineers to build relationships and earn trust (15 minutes)

Activity 4: Summary/Questions (10 minutes)

- Instructor summarizes the lesson objectives (5 minutes)
- Students ask any remaining questions (5 minutes)

These results are impressive, since given the task, the application sequentially organizes the material, with not only the material to be covered, but the time it takes to cover each area. Although the instructor must make changes to this lesson plan to achieve the specific results desired, this is a good starting point which is anticipated to save the instructor a significant amount of time. As with test generation, increased specificity yields

more specific results.

### Homework Assignments

Ofgang used the example of the inverted pyramid to ask ChatGPT to devise a short homework assignment. In this work, the same Social Engineering example previously used was used again. The query is:

*Create a homework assignment for the following session:*

*Session 1: Introduction*

*- Introduction to Social Engineering*

*- Overview*

*- Social Engineering Techniques*

*- Human Psychology - Overview*

The results are:

Homework Assignment:

1. Research the three models of social engineering (Cialdini Model, Social Engineering Triangle, and Integrated Model). Create an overview of the three models and write a brief essay comparing and contrasting them.
2. Read an article or watch a video on human psychology related to social engineering and summarize the key points.
3. Think of an example of an effective social engineering technique and explain what made it successful.
4. Prepare a short presentation for the next session summarizing the key points you have learned about social engineering and human psychology.

As in the previous examples, while the results may have to be modified, the application quickly provides a sound basis for the instructor to build on. As with previous use cases, the more specific the input, the better the output.

### Critical Thinking and Other Uses

In a 2023 article, Abramson suggests that rather than ban ChatGPT in the classroom, professors use it to encourage critical thinking, thus helping students prepare for life as they leave academia. In the same way as calculators help students learn mathematics, ChatGPT may be used to help students think critically about liberal arts assignments. One example of this is using ChatGPT to generate the first draft of an essay,

then critically reviewing and editing it as a second draft.

Others suggest it can be used for brainstorming, content creation, translating and tutoring. Liberman (2023) provides examples where ChatGPT is used for generating and analyzing text with varying tone, generative email, grading and finding resources.

Generative AI can also provide valuable feedback to students. Applications such as Claude.AI can provide detailed recommendations for improving essays and writing assignments based on various writing manuals.

### Generative AI Assignments

Specific deliverables may be assigned by instructors to help students understand and investigate how generative AI may be used to improve their work.

One such assignment has three parts. The first part is to have students read an article on a specific topic, then write a 500-word essay highlighting and expounding on the topic. The second part of the assignment involves having students use ChatGPT to generate the same 500-word assignment. In the final part of the assignment, students are asked to write 500 words comparing their essay with the same essay generated by ChatGPT. This has proven successful in encouraging students to consider whether generative AI adds value to the final product, how it can prove insightful in adding value through library research, how attribution and citation are applied, and what the advantages and limitations are of using this technology in their studies.

Another assignment adds value through improving the quality of student writing. In a freshman seminar, students are required to visit the school writing center to meet with a writing consultant before submitting each major deliverable, including a six-page literature review and a 12-page argument paper. Although it is a course requirement, many students balk at meeting with the writing consultant.

In the latest offering of the seminar, students were required to use Claude.AI to provide detailed feedback on their writing prior to meeting with the writing consultant. They were then tasked to revise their papers using the generated feedback, then meet with the writing consultant. It was found that after this assignment, students were more likely to visit the writing consultant, and those students who still did not use the

services of the writing consultant had improved papers simply through use of the AI generated feedback.

## 5. CONCLUSION

There is no question that ChatGPT adds value and saves time for faculty developing and generating courses. It can quickly generate syllabi, homework assignments, quizzes and lesson plans and much, much more. However, it has been demonstrated to display biases, and to confidently generate incorrect information. As a program, it is unable to capture insight the instructor may have through knowledge, experience, critical thinking or the integration of those processes. Like any tool, it can add value when its outputs are validated, checked, and massaged to yield savings of time and effort. It can also be used to help students deliver better assignments through assistance in library research as well as improving their written assignments. Emerging AI applications will prove useful in current and future academic efforts by students and instructors.

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*Invited Paper*

# What's in a name? Student preferences for cybersecurity-related major titles

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## Abstract

There is a significant skill gap, with millions of cybersecurity jobs still needing to be fulfilled due to a lack of a trained workforce. Various academic programs are available that teach students in different aspects of cybersecurity. This paper investigates if the title of an IT program has any impact on the desirability of a program and if this impact differs based on gender, with a focus on cybersecurity majors. Two focus groups were conducted for data collection at two different universities, and participants were asked to rank order a variety of titles for cybersecurity programs. An interpretive thematic analysis technique was used to analyze the data. Our results suggest that cybersecurity is a preferred title for both men and women. Recommendations are provided, and implications are drawn.

**Keywords:** cybersecurity, workforce, skill gap, women in cybersecurity, focus group, thematic analysis

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# What's in a name? Student preferences for cybersecurity-related major titles

Peter Draus, Sushma Mishra, Kevin Slonka and Natalya Bromall

## 1. INTRODUCTION

Cybersecurity job opportunities have grown over the last several years due to increased demand, a not-so-ready workforce, and a lack of students majoring in security-related degrees ((ISC)<sup>2</sup>, 2021). The global cybersecurity workforce needs to grow by 65% to effectively defend organizations' critical assets ((ISC)<sup>2</sup>, 2021). There is a need for more than 3.4 million security professionals worldwide, an increase of over 26% from 2021's numbers. Why do we have a shortage of skilled workforce when there are so many well-paying cybersecurity jobs available? The problem adding to the security gap remains the same: a disturbing increase in threat exposure to businesses, governments, and individuals worldwide from ever-evolving new threat vectors has fueled the growth of job opportunities in this field. The available potential workforce is not trained in cybersecurity skills to enter the job market.

Organizations are looking to academia to develop a strategy to recruit, train, and develop a pipeline of skilled cybersecurity professionals to address the significant talent gap. There are multiple cybersecurity programs at different institutions with the intent to educate young professionals in this domain. However, there needs to be more students in these programs to meet this unprecedented demand. Men and women should seek cybersecurity degrees to address the demand-supply gap in the near future. There are many reasons for the lack of interest in pursuing computer science and cybersecurity degrees. Many students need more math and science skills, making them unqualified for advanced programs in technology (Poremba, 2023). Cybersecurity requires high adaptability with this mix of technical and soft skills (Polmera, 2023). Academics need to address this unique combination of soft and technical skills. Another area that adds to this serious skill gap is a growing shortage of university professors willing and able to teach cybersecurity to students.

Women in cybersecurity have even lower representation than in other information technology fields. Microsoft's survey, conducted

in 2021, suggests that men are more likely than women (21% vs. 10%) to feel qualified to apply for a cybersecurity job. In contrast, more women than men (27% vs. 21%) believe men are seen as a better fit for technology fields (Owen, 2022). The majority of women in this survey feel that there is gender bias in the industry that results in unequal pay and support (Owbe, 2022). Overall, women think they need more preparation to deal with a technical field like cybersecurity. Women who are unaware of the nuances of the cybersecurity domain typically regard those who work in the area as "nerds" or "hackers." On the other hand, those who have more awareness have a positive perception of such workers. These are consistent with broader perceptions of the field (Hoteit, 2022). These perceptions about cybersecurity are reflected in the choice of majors by men and women of college-going age. Therefore, it is essential to understand the perceptions of college-going men and women of cybersecurity programs available in academia.

This paper aims to understand how the title of a program in the cybersecurity field influences the desirability of a program and if there is any difference, based on gender, in the impact. The research questions posed by this study are:

RQ1: With a focus on Cybersecurity Majors, what impact does the title of a major have on the desirability of a program?

RQ2: With a focus on cybersecurity majors, are there differences, based on gender, in the way the title of a program impacts potential students?

The rest of the paper is organized as follows. A critical review of the research literature in the field follows this section. A description of the methodology section entails data collection and analysis description. A discussion section follows the methodology section. Implications of the study are drawn, and limitations are listed. The paper ends with a conclusion section.

## 2. LITERATURE REVIEW

The number of women earning college degrees is on the rise; however, in many IT professions,

women are significantly outnumbered by men. According to the research, cybersecurity is one of the fields where women are catastrophically underrepresented, with only 11% of female professionals worldwide and 14% in North America (D'Hondt, 2016). Cybersecurity professionals admit that the field needs to hire more women, who are not only a high-skilled resource, but also bring in a unique perspective of cybercrime targets (Poster, 2018).

The study of gender differences exists in nearly all fields. Whether one is practicing psychiatry and studying the effects of anxiety (Yang et al., 2021), analyzing real estate transaction negotiations (Andersen, 2021), studying leadership qualities (Alan, 2020), or uncovering intergenerational transmission of gender segregation (van der Vieuten et al., 2018), gender is a common demographic variable used in research.

When focusing specifically on STEM fields, women in STEM have been widely studied (Elliott et al., 2020; Collins & Steffen-Fluhr, 2019; Bird & Rhoton, 2021; Sendze, 2022). Some studies focus on gender representation in STEM fields (Stout et al., 2011), while others focus on the classroom environment and whether the composition of students affects females' interest in courses (Casad et al., 2019; Cheryan et al., 2009; Ramsey et al., 2013). Starr (2018) found that being stereotyped as a nerd or other labels affected the STEM identity of undergraduate female students. Even when women outperform male students, they are still looked upon as lesser than their counterparts (Bloodhart et al., 2020).

Research into specific areas of STEM has also been conducted. Understanding why the students choose a certain major and what the differences are between male and female students' perspective is extremely important for many reasons. For example, certain majors are traditionally considered male- or female-dominated, which impacts the students' decision to enroll in these majors. In an attempt to understand the roots of such gender preferences of various majors, researchers attempted to survey girls in middle and high schools and determine the factors that facilitate their decision to pursue a career in cybersecurity. For example, Jethwani et al (2017) demonstrate the importance of same-sex creative and collaborative settings with a dedicated female mentor in their study of adolescent girls in a STEM program. Similarly, many studies emphasize the importance of female mentors and role models (Horne, 2018).

Regarding the Information Systems (IS) major, the factors leading women to choose such a major have been shown to change over time (Hodges & Corley, 2017). Although females are introduced to STEM earlier in their education, they are not introduced to computing majors until much later (Snyder & Slauson, 2016) and require more mentoring and guidance to select a major that is the best fit (Mishra et al., 2014). A 14-year-old seventh grader adds the following to this discussion:

I've seen the software industry's efforts to recruit more women in college, and sometimes high school. Let me tell you, that's way too late. We're making up our minds now—in seventh grade or even sixth. My teachers have (too often) expounded that during our middle school years we grow more than any other time of our lives outside of infancy. It is the perfect time to present software as a career, at the moment when we are most malleable (Platt, 2014).

Some studies, though, disagree on the benefits of earlier exposure to computing curriculum (e.g., Jung et al., 2017).

Although at some universities cybersecurity is found within the IS or Computer Science (CS) majors (Indiana University of Pennsylvania, n.d.), many have it as a standalone program (Robert Morris University, n.d.; Saint Francis University, n.d.). Despite this, there has not been much scholarly research into the previously identified issues focused on the cybersecurity major even though only 11% of the global cybersecurity workforce as of 2018 is women (Poster, 2018). Some students noticed that even though they perceived the field as being male-dominated, internships and shadowing showed that the playing field was even (Pinchot et al., 2020) as long as one enjoyed critical/analytical thinking and had an investigative mindset (Mishra et al., 2019). One additional factor could be that, with cybersecurity spanning both the IS and CS domains, a struggle between the extroversion of IS-minded students and the introversion of CS-minded students is at play (Reynolds et al., 2017). In any case, the reasons remain widely unknown and warrant additional research to fill this gap.

### 3. METHODS

#### Data Collection and Analysis

We chose focus groups as the data collection method in this exploratory study. This type of

study fits very well with the unstructured topic of study like the one in this research. In addition, focus groups typically result in various discussion topics brought up by the focus group participants. For our focus groups, we recruited students enrolled in similar cybersecurity courses at two universities: three focus groups. Each group had 15-20 students, mostly majoring in cybersecurity, cyber forensics, and similar areas. Both Graduate and Undergraduate students participated.

The first research question, specific to cybersecurity and related majors, "What impact does the title of a major have on the desirability of a program?" was represented as a main discussion question followed by a group of talking points. If someone mentioned a talking point during the panel discussion, we did not bring it up at a later point. If a talking point was not mentioned, we brought it up. For example, the lead question is followed by six talking points in the following group of questions.

Discussion question: What impact does the title of a major have on the desirability of the program?

- Do you think the program's title influenced your choice of a program?
- Please rank the following major titles in order of desirability (list provided)
- What made you rank the titles in the way that you did?
- Do you feel that the title of the program in which you are enrolled accurately represents the content of that program? If not, what do you feel was misrepresented?
- Do those misrepresentations affect your perception of the overall desirability of the degree program?

The second research question (Are there differences, based on gender, in the way the title of a program impacts potential students?) was answered by analyzing the respondents' demographics.

Each panel discussion was conducted and recorded by at least two researchers to avoid incorrect recording and sound issues. The Multiple researchers then transcribed the recordings the transcribed documents were put together in a master document. Each discussion segment was first used to identify the emerging themes, and then to map the subjects' statements to the themes.

As part of the discussion, the students were given a list of IT majors and asked to rank each major

in terms of its desirability (1=most desirable, 12=least desirable). The names of the majors were obtained by analyzing the college major names and the IT job titles. As the result of this analysis, we came up with twelve majors that accurately reflect the list of the most common IT majors offered by the academic institutions.

#### 4. RESULTS

##### Demographics

Data was collected from 53 individuals; the average reported age was 23.84, with the youngest being 19 and the oldest being 39. 86% of the subjects reported being full-time students. The rest did not respond. 43% of the subjects lived on campus, and 52% responded that they resided off campus. Further information, including the subjects, Year in school, Gender, and Current Major are listed in Tables 1, 2, and 3.

Year in School	Percentage
1	15%
2	8%
3	28%
4	36%
5 - Graduate	2%
No Response	11%

**Table 1: Breakdown by Percent of Subjects by Year in School**

Gender	Percentage
Female	25%
Male	68%
No Response	8%

**Table 2: Breakdown by Percent of Subjects by Gender**

Major	%
Cyber Security	72%
Cyber Security & Digital Forensics	13%
Computer and Information Systems	9%
Computer Science	2%
Cyber (security) and Criminal Justice	2%
MIS & Cyber Security Administration	2%

**Table 3: Breakdown by Percent of Subjects by Major**

##### Desirability of the program by the major titles

The data we collected suggested three emerging themes: (1) Cyber vs. CS, (2) Hands-on Experience, and (3) Accuracy of Representation (Table 4).

Emergent themes	
Theme 1: Cyber vs. CS	<ul style="list-style-type: none"> <li>• The job market is too difficult for CS majors, there are too many of them and too much competition</li> <li>• Computer forensics should be more than just computers</li> <li>• Biased toward forensics as compared to other programs</li> <li>• Adding a forensics major impacted my major choice</li> </ul>
Theme 2: Hands-on experience	<ul style="list-style-type: none"> <li>• All IT classes need to be hands-on</li> <li>• There has to be a class/lab that gives students hands-on experience</li> </ul>
Theme 3: Accuracy of representation	<ul style="list-style-type: none"> <li>• The name of my major does not accurately represent what it actually is</li> <li>• Some majors have different names, but the course work is actually the same</li> <li>• It would help more to see the list of jobs applicable to each degree</li> </ul>

**Table 4: Major Title and Desirability of the Program**

Surprisingly, the students did not mention any gender-related reasons in their decision-making, and gender factors did not show in any of the three themes. In fact, female students included a substantial group of international students who admitted that they did not have any discrepancy between male and female representation in IT jobs. The first theme reflects the deliberations between CS and other majors that the students perceive as more technical, and Cyber and similar fields are perceived as less technical (which is not always the case). Many panel participants (equally male and female) admitted that they had a particular interest in forensics, impacting their major choice. At the same time, several students emphasized that the forensics major should have just as much hands-on training as other IT majors and should be broadened to include not only the IT component but also legal, regulatory, and other components.

Discussion of hands-on training in computer forensics shifted to hands-on experience in all IT fields and led to Theme 2. Female students were not active in this discussion, but the male group considered it vital having more dedicated labs and providing more hands-on experience. The group of working students was especially vocal in this discussion.

Theme 3 emerged as the majority of respondents of both genders admitted that the major representation was either inaccurate in the title, or they had different expectations about the major, which changed after they enrolled. In such rapidly evolving fields as cybersecurity and computer forensics, the major titles change constantly to reflect the field. For example, in one of the participating institutions, the title of the major changed twice in the past five years. Being a slow process, curriculum development does not always catch up with these changes.

### Major Rankings

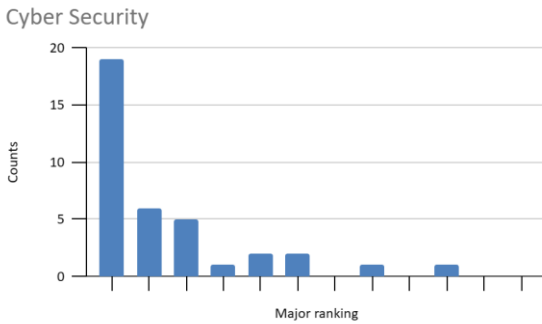
Subjects were asked to rank possible names for their program/major. They were given a list of 12 options and were to rank them, with 1 being the highest. Results show a clear preference for the name "Cyber Security" with a mean ranking of 3.00, this also had the highest number of #1 rankings with 19. The closest mean to that was 5.16 for "Cyber Security and Forensics" which had the 2nd highest #1 rankings with 14.

Looking at the counts of the titles, shown in table 5, we find only two titles with the count of #1 ranking in double digits. The title "Cyber Security" had the second highest count for #1 with 14. The counts of the rankings for all of the proposed program names can be seen in Table 5, Appendix A. Just as "Cyber Security" and "Cyber & Forensics" are obvious #1 choices, "Governance & Risk" and "Computer Engineering/Computer Security" had the highest number of the lowest rankings.

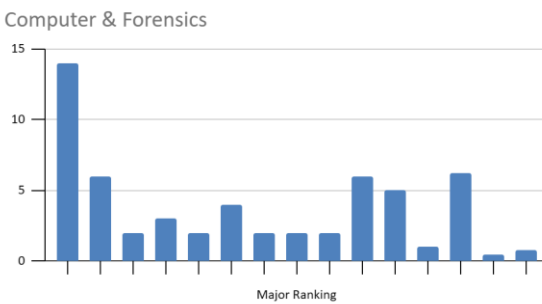
The mean rankings show a similar result with clear preferences for "Cyber Security" and "Cyber & Forensics", as shown in Table 6, Appendix A. This table shows the mean ranking for each proposed degree title and then the percentage of subjects who selected that title as their number 1 rank. The final column shows the percentage of subjects who chose that major title as their number 1, number 2, or number 3 ranking. Looking at the percentage of subjects who selected each title as their first choice and then the percentage who selected each title as their first, second, or third choice, we still get the same preferences. However, the difference between the top two is less when we include the top 3 choices.

Comparing the distribution of the counts for these top two choices, we see a difference in that "Cyber Security" has a high number of high rankings, while "Cyber & Forensics" has a flatter distribution and a cluster of lower rankings, indicating a somewhat negative view of this name

for the major (Figure 1 & Figure 2).



**Figure 1: Cyber Security Rankings**



**Figure 2: Cyber & Forensics Rankings**

Not all subjects were currently enrolled in a Cybersecurity-related major; some subjects (N=6) who participated in the focus groups and ranking were in more generic Computer-related fields, such as CIS, Computer Science, or Software Engineering. A review of the data with only the Cybersecurity-related majors showed similar results. Table 7, Appendix A shows a reduced and consolidated set of data. The numbers were exactly the same as the overall numbers.

Looking at the subjects' current major title in comparison to their top rankings the results showed that of the 6 subjects not in a Cyber-related major, only 2 (33%) selected "Cyber Security" as their top pick. Of the remaining 46 students, 20 (43%) selected "Cyber Security" as their top pick. Of the 20 Cyber area subjects who selected the title "Cyber Security, most of them, 16 (80%) selected the same title, "Cyber Security" as their top pick. The majority of subjects who selected "Cyber Security" as their top pick (N=38) were not in a major with that title. (N=22/58%)

While only 13 subjects self-reported as women, 11 of those students were in a Cyber-related major. Table 8, Appendix A compares the rankings organized by Gender.

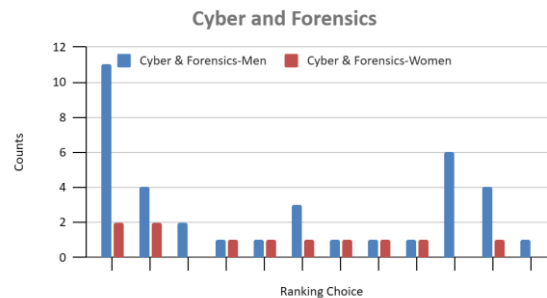
Mostly, the results are very similar across genders with one minor difference. The "Information Systems Security" title has the second lowest mean for women and, in fact, is very close to the mean ranking for the "Cyber Security" mean ranking, while zero men selected this as their top pick. Interestingly, none of the subjects had "Information Systems Security" as their current major title. Table 9, Appendix A shows the ranking of each title by the respective overall mean ranking score for all subjects and broken out by gender.

While the number 1 ranking is still the same across genders, the second and third-ranked titles are flipped by gender.

Looking at the distribution of the rankings for the "Cyber Security" and "Cyber and Forensics" titles (Figure 3 & Figure 4) by Gender we find clear differences in the distribution, even in the overall mean rankings were similar.



**Figure 3: Cyber Security Ranking by Gender**



**Figure 4: Cyber & Forensics Title by Gender**

The biggest difference is the large higher (negative) rating of the "Cyber and Forensics" title by the men and a much less pronounced low (positive) ranking of "Cyber Security" by the women.

## 5. DISCUSSION

Students across two universities clearly preferred "Cyber Security" as a title for a major that covers

this topic area. Out of 12 different titles, the mean ranking for "Cyber Security" was 3.0. Their second choice was "Cyber and Forensics" with a mean rank of 5.16. The third choice, "Information Systems Security" had a mean rank of 5.21. "Cyber Security" was the clear favorite. A look at the distribution of the rankings showed that "Cyber Security" had many high rankings, including 19 #1 rankings, and no low rankings, while "Cyber and Forensics" had almost as many high rankings (14) but had more low rankings. "Information Systems Security" had rankings clustered in the middle, with only 1 #1 ranking and no low rankings.

Most of the students were already in majors in this field. Most of the students, except those with the title "Cyber Security" selected a different major title than their own. The strength of this title goes beyond that of familiarity and brand identity for the students.

The word "Forensics" was in three of the majors listed. All three of those had some higher rankings, but also some much lower rankings. It appears that the word Forensics is a polarized word in the title. Interestingly enough, the title "Forensics" appeared to have much lower negative connotation with women than men. This resulted in a slightly higher (lower mean score) ranking of "Cyber and Forensics" for women than for men. "Information Systems Security" had a much higher ranking for women than men, resulting in it being ranked in second place for women instead of third place for men. While the overall ranking only changed one place, the overall means were different for this title by gender, with women ranking it at 3.09 and men at 5.40.

## 6. CONCLUSIONS

A survey across two universities of undergraduate and graduate students in Information and Security-related majors resulted in ranking data on 12 different major titles. "Cyber Security" was the clear preferred choice, even if it was a different title than the major they were currently enrolled in. A negative connotation for the word "Forensics" was evidenced with a stronger bias in men. While the program title is obviously not the only indicator of the desirability of the program, it does predict the program desirability. The marketing of such majors might be improved by focusing on this title.

Three themes emerged from an analysis of multiple focus group sessions; 1) Theme 1: Cyber vs. CS; 2) Hands-on experience; 3) accuracy of representation.

In our rapidly changing field, it is imperative that the titles of Majors keep pace with the changing vocabulary and connotations associated with old titles. The students are aware of the job market and the current requirements, as well as the titles of the most demanded job. They map these titles to the titles of the majors. For example, Cybersecurity was the favorite field, mainly due to the presence of the catchy word "cyber" in the title. At the same time, Information Systems Security popularity rankings were substantially lower. While there were slight differences in the rankings of some major titles by gender, overall there appears to be little gender bias in the titles of academic majors in this area.

Future research might look at hiring agents in the industry to see if similar bias and rankings exist.

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**APPENDIX A**

Counts of the Ranking for each value

Name	1	2	3	4	5	6	7	8	9	10	11	12
Cyber Security	19	9	7	3	2	3	2	2	1	1	0	0
Cyber Admin	1	3	8	7	1	5	5	5	5	3	2	3
Cyber Management	2	7	1	6	9	3	4	7	4	3	2	2
Cyber & Forensics	14	6	2	3	2	4	2	2	2	6	5	1
Digital Forensics	3	4	3	6	5	3	3	3	4	8	4	2
Computer Forensics	0	3	10	6	3	4	3	2	5	0	5	6
Information Security	1	3	7	6	6	7	7	4	3	3	1	0
Information Systems Security	1	5	5	6	8	9	8	2	1	2	0	0
Information Assurance	1	4	1	4	3	3	4	4	8	6	6	5
Govern, Risk	1	3	2	2	4	4	2	2	5	5	7	12
CS/CS	3	3	5	2	3	2	4	4	5	4	8	4
CE/CS	4	4	3	0	3	0	1	9	3	4	5	10

**Table 5: Counts of ranking choices by Major title**

	Name	Average	% #1	% #1-3
1	Cyber Security	3.00	38%	22%
2	Cyber Admin	6.29	2%	8%
3	Cyber Management	6.04	4%	6%
4	Cyber & Forensics	5.16	28%	14%
5	Digital Forensics	6.58	6%	6%
6	Computer Forensics	6.55	0%	8%
7	Information Security	5.69	2%	7%
8	Information Systems Security	5.21	2%	7%
9	Information Assurance	7.73	2%	4%
10	Govern, Risk	8.39	2%	4%
11	CS/CS	7.23	6%	7%
12	CE/CS	7.76	8%	7%

**Table 6: Average rank and % of choices for #1 and #1 through #3 for Major**

Name	Count of #1 picks	Mean	% #1	% #1-3
Cyber Security	19	3.0	38%	22%
Cyber & Forensics	14	5.16	28%	14%
Information Systems Security	1	5.21	2%	7%

**Table 7: Comparison of Cyber Security, Cyber & Forensics and Information Systems Security rankings**

Proposed Program Title	Average		%#1		% #1-#3	
	Male	Female	Male	Female	Male	Female
CE/CS	7.77	7.11	8%	9%	6%	10%
Computer Forensics	6.54	6.60	0%	0%	9%	8%
CS/CS	7.11	6.80	6%	9%	7%	8%
Cyber & Forensics	5.33	5.09	31%	18%	16%	10%
Cyber Admin	6.40	6.55	3%	0%	7%	5%
Cyber Management	6.31	6.09	3%	9%	6%	3%
Cyber Security	2.69	3.80	39%	36%	25%	15%
Digital Forensics	6.75	5.90	8%	0%	6%	8%
Govern, Risk	8.83	7.55	0%	0%	3%	5%
Information Assurance	8.17	7.00	0%	9%	2%	8%
Information Security	5.77	5.36	3%	0%	6%	10%
Information Systems Security	5.40	3.90	0%	9%	6%	13%

**Table 8: Mean Major Title Rankings and % selected as top and top 3 by Gender**

Proposed Program Title	Mean			Rank		
	All	Male	Female	All	Male	Female
Cyber Security	3.00	2.69	3.80	1	1	1
Cyber & Forensics	5.16	5.33	5.09	2	2	3
Information Systems Security	5.21	5.40	3.90	3	3	2
Information Security	5.69	5.77	5.36	4	4	4
Cyber Management	6.04	6.31	6.09	5	5	6
Cyber Admin	6.29	6.40	6.55	6	6	7
Computer Forensics	6.55	6.54	6.60	7	7	8
Digital Forensics	6.58	6.75	5.90	8	8	5
CS/CS	7.23	7.11	6.80	9	9	9
Information Assurance	7.73	8.17	7.00	10	11	10
CE/CS	7.76	7.77	7.11	11	10	11
Govern, Risk	8.39	8.83	7.55	12	12	12

**Table 9: Mean Rankings by Gender and Overall Rankings by Gender**