INFORMATION SYSTEMS EDUCATION JOURNAL

Volume 22, No. 1
March 2024
ISSN: 1545-679X

In this issue:

iscap
Information Systems & Computing Academic Professionals

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **ISCAP** (Information Systems and Computing Academic Professionals). Publishing frequency is five times per year. The first year of publication was 2003.

ISEDJ is published online (https://isedj.org). Our sister publication, the Proceedings of the ISCAP Conference (https://iscap.us/proceedings) features all papers, abstracts, panels, workshops, and presentations from the conference.

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the ISCAP conference. All papers, whether award-winners or not, are invited to resubmit for journal consideration after applying feedback from the Conference presentation. Award winning papers are assured of a publication slot; however, all re-submitted papers including award winners are subjected to a second round of three blind peer reviews to improve quality and make final accept/reject decisions. Those papers that are deemed of sufficient quality are accepted for publication in the ISEDJ journal. Currently the target acceptance rate for the journal is under 35%.

Information Systems Education Journal is pleased to be listed in the Cabell's Directory of Publishing Opportunities in Educational Technology and Library Science, in both the electronic and printed editions. Questions should be addressed to the editor at editor@isedj.org or the publisher at publisher@isedj.org. Special thanks to volunteer members of ISCAP who perform the editorial and review processes for ISEDJ.

INFORMATION SYSTEMS EDUCATION JOURNAL

Editor Comment:

We are pleased to present our first issue of 2024, including papers on AI in and out of the classroom. We are also delighted to welcome Dr. Kevin Mentzer to the editorial team this year, joining Dr. Dana Schwieger as Associate Editor, along with Drs. Ira Goldstein and Michelle Louch as Cases & Exercises Co-Editors. Thank you to each of these individuals, to our reviewers, and to our Publisher, Dr. Tom Janicki.

Paul Witman, Senior Editor, ISEDJ

Editors

Embracing Artificial Intelligence to Improve Self-Directed Learning: A Cybersecurity Classroom Study

Jim Marquardson
jimarqua@nmu.edu
College of Business
Northern Michigan University
Marquette, MI 49855, USA

Abstract

Generative artificial intelligence (AI) tools were met with a mix of enthusiasm, skepticism, and fear. AI adoption soared as people discovered compelling use cases--developers wrote code, realtors generated narratives for their websites, students wrote essays, and much more. Calls for caution attempted to temper AI enthusiasm. Experts highlighted inaccuracies in some of the generated information. Artists, writers, programmers, and other professionals who create for a living questioned their job security. Educators worried that these tools would harm academic integrity. Nevertheless, the tools persist, and AI enthusiasm shows no sign of abating. The current study focuses on how AI tools can be leveraged to improve self-directed learning in the classroom. In a capstone cybersecurity course, the instructor encouraged students to use ChatGPT 3.5 on a self-directed learning assignment to select topics, find learning resources, and carry out their learning plans. Some students did not use ChatGPT. Those who used ChatGPT found it to be a helpful learning aid. All students reported that they plan to use ChatGPT for self-directed learning after graduating. No student violated academic integrity policies. The results demonstrate that AI tools can enhance self-directed learning, though students should be trained to use them effectively. Recommendations for developing assignments that support academic integrity and rigor in the age of AI are provided.

Keywords: artificial intelligence, self-directed learning, cybersecurity, pedagogy

Recommended Citation: Marquardson, J., (2024). Embracing Artificial Intelligence to Improve Self Directed Learning: A Cybersecurity Classroom Study. *Information Systems Education Journal,* 22(1), pp.4-13. https://doi.org/10.62273/WZBY3952

Embracing Artificial Intelligence to Improve Self-Directed Learning: A Cybersecurity Classroom Study

1. INTRODUCTION

ChatGPT took the world by storm in 2022. Just two months after its launch, ChatGPT achieved 100 million monthly active users (Hu, 2023). The impacts of AI on business, political discourse, economics, and other important areas remain unclear, but AI tools already demonstrate their disruptive potential. Educators must prepare students to embrace change in a world where AI tools become ubiquitous.

Companies are already adjusting their workforce planning to account for AI. For example, IBM plans to pause hiring for roles that AI can replace (Ford, 2023). While many roles cannot be replaced entirely by AI, companies may increase productivity expectations for existing employees (Reddington, 2023). Professionals can position themselves for success by embracing change and honing new AI skills. Therefore, educators should teach the appropriate use of AI tools. People need to learn to use AI tools just like they would any other advanced technology. Academia has an opportunity to prepare students to succeed in the changing world where AI tool use is the norm.

Concerns about academic integrity and rigor complicate AI tool adoption in academia. Using AI, students can find quiz answers, generate essays, and otherwise circumvent assessment of learning. Students may attempt to offload critical thinking to AI tools. Educators must find ways to enhance learning while maintaining academic integrity.

This paper addresses the use of AI in academia by providing a brief overview of AI history and tools, then presents a study of adopting AI in a self-directed learning assignment. Recommendations for adopting AI in the classroom are provided.

2. LITERATURE REVIEW

This section provides an overview of generative artificial intelligence terms, tools, and techniques relevant to the current study. The aim is not to provide an exhaustive explanation of AI, but to give a brief historical context relevant to current AI tools and discuss emerging concerns in academia.

Artificial Intelligence

In 1955, John McCarthy and colleagues coined the term "artificial intelligence" in a research project proposal stating that, "The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it" (McCarthy et al., 1955, p. 1). Defining and creating artificial intelligence proved more challenging than first imagined. Advances in hardware and software yielded tremendous gains in computing power, yet for decades true artificial intelligence felt out of reach. Enthusiasm and funding for AI research waned in the 1970s and 1980s—a period known as the "AI winter" (Haenlein & Kaplan, 2019).

In the 1980s and 1990s, researchers continued to make progress building intelligent systems. For example, in 1997, IBM's Deep Blue system famously beat the world chess champion Gary Kasparov at chess (Campbell et al., 2002). But perhaps because Deep Blue could only play chess and its programmatic logic could be explained in a relatively straightforward way, questions lingered as to whether Deep Blue was truly a manifestation of artificial intelligence.

In subsequent decades, data mining and machine learning demonstrated the power of statistical inference on large datasets. These techniques gained traction in academia and industry. Deep learning is a branch of machine learning that extracts meaningful features from data to construct artificial neural networks (LeCun et al., 2015). These artificial neural networks are then used to make predictions based on new inputs. Researchers used deep learning to drive advances in image recognition, speech recognition, and recommendation systems. Deep learning proved the value of training models on vast quantities of data to improve predictive performance. The models are often evaluated by their accuracy. For example, the percentage of pictures of cats were correctly classified by the machine learning algorithms as cats.

Large Language Models

Large language models (LLMs) are AI tools used to understand and generate human language. In 2017, researchers introduced transformers which allowed LLMs to better capture contextual information than previous techniques (Vaswani et al., 2017). Models using transformers benefit from parallel processing. This architecture improvement coupled with GPU-accelerated computing vastly reduced the cost of training LLMs on large datasets. The "GPT" in ChatGPT stands for "Generative Pre-trained Transformer."

LLMs are composed of parameters—connections between artificial nodes in a neural network. A model's capacity to learn increases as the number of parameters increases. The number of parameters from ChatGPT's underlying models increased from 175 billion in GPT-3 (Brown et al., 2020) to 1.4 trillion in GPT-4 (Katz et al., 2023).

Generative AI
Generative AI systems create new content. Examples of content that generative AI currently creates include poems, videos, study guides, music, and source code (Longoni et al., 2022). Generally, a person gives the generative AI tool a prompt, and the AI tool generates the output. With some tools like ChatGPT, context is retained between prompts until a new chat is started.

Copyright Concerns
Developers train models on vast amounts of data. Some of the data may be copyrighted, and it is currently unclear how intellectual property laws apply to AI-generated work. Some artists lament that AI tools improperly mimic their unique artistic styles (Chayka, 2023). Stability AI trained its Stable Diffusion AI image generation system on data that included copyrighted images from Getty Images (Brittain, 2023). Some of the novel images produced by Stable Diffusion based on user prompts included Getty's watermark—an indication that the output was not merely inspired by existing work, but actually incorporates it in the output.

Information Accuracy
AI tools sometimes provide misinformation. Below are some personal interactions with tools such as ChatGPT, Google Bard, and Bing Chat that yielded unexpected results.

- Two of three chat AI tools incorrectly identified the second layer of the OSI model as the "network" layer.
- ChatGPT generated code to perform XOR decryption with a specific key and ciphertext. ChatGPT also included the result of running the supplied code. The code worked correctly when ran locally, but the plaintext it said it produced from running the code was not correct.
- ChatGPT gave examples of PowerShell code to automate Windows Server administration tasks. Some of the PowerShell modules it recommended do not exist.

AI image generators sometimes produce people with the wrong number of hands, impossible building architecture, and other visual artefacts that ruin the illusion. Tools that produce text sometimes invent information, such as research article titles that do not exist. These incorrect or unexpected outputs are often labelled "hallucinations" (Zhang et al., 2023). However, the term "confabulation" may be more appropriate. The neuropsychological literature describes a confabulation as the unintentional production of false memories without the intent to deceive (Kopelman, 1987).

AI tools currently occupy an interesting space in which they sometimes show brilliance, but also create monumental factual mistakes. For example, ChatGPT (powered by the GPT-4 model) earned a passing grade on the Uniform Bar Exam (Katz et al., 2023). Despite its apparent legal prowess, relying on ChatGPT's output landed one lawyer in hot water. In 2023, the lawyer relied on case law provided by ChatGPT to prepare a brief filed in federal court, but unfortunately, ChatGPT fabricated the case law (Weiser, 2023). The lawyer in question may face sanctions for failing to critically evaluate ChatGPT's output.

User Interfaces
Technically adept people have used machine learning and AI tools for years, but the hardware requirements, cumbersome software configuration, and use of the software proved challenging. Cloud-delivered AI tools offload the significant hardware requirements and configuration complexity.

For several years, companies have deployed chatbots to triage customer problems and provide more efficient customer service, so the idea of chatting with an artificial agent became a common experience. Today, chat-based tools provide an easy user interface for interacting with AI models. ChatGPT's web interface is simple: start a new chat and send a message. Chat prompts can be reframed and retried. Midjourney leverages the group chat application Discord for its user interface. Users enter prompts in the group chat and wait for the server to generate their images.

More technically sophisticated users can access AI services using application programming interfaces (APIs), but many people find value in the chat interfaces alone.

Adoption
Popular theories help shed light on the rapid adoption of AI tools. The Unified Theory of Acceptance and Use of Technology (UTAUT) explains that performance expectancy (i.e., the predicted benefits of using technology), and effort expectancy (i.e., the ease of use) predict adoption (Venkatesh et al., 2012). Anecdotal reports support ChatGPT's ease of use (e.g., Marcus, 2022) and usefulness.

Task-technology Fit (TTF) theory is another useful lens for explaining generative AI's strong adoption. The theory proposes that people adopt technology when task characteristics and technology characteristics align (Goodhue & Thompson, 1995). Examples of tight alignment between real-world tasks and generative AI capabilities abound. For example, programmers need to write code to meet specifications, and ChatGPT can write code (Israelsen, 2023). Real estate agents must create home descriptions, and ChatGPT can generate them based on prompts (Kelly, 2023). People often need to create text, art, code, and other deliverables. Generative AI tools have proven that their technological characteristics align with the task characteristics that people need.

Ethical Considerations
AI users may harbor apprehensions about data privacy, consent, and biases. Prompts, files, and any other data uploaded to AI tools could be tracked to an individual. People may be hesitant to use AI tools for sensitive topics for fear of data leaks. Also, AI model bias might favor different groups which could reinforce stereotypes. People should have the opportunity to provide informed consent when using AI tools. The average consumer can choose to use AI, but in a classroom setting, it can be debated whether a student could provide meaningful consent if required to use AI tools as part of learning exercises. The following section delves deeper into AI adoption concerns in academia.

3. AI ADOPTION CONCERNS IN ACADEMIA

Options of AI tool use in academia are mixed. Some educators advocate for the prohibition of AI tools in academia. Others take an optimistic view of AI tool adoption in academia, arguing that, "with the right approach, [ChatGPT] can be an effective teaching tool" (Roose, 2023, para. 18). This section discusses some of the major concerns and approaches for using AI tools.

Information Accuracy
Harvard University's motto succinctly summarizes the aims of academia—"veritas" meaning "truth." Knowledgeable experts can identify misinformation in AI tool output, but a novice may overly rely on the tools. Educators must teach students appropriate skepticism in the information they consume, especially in the case of current AI tools. Educators should encourage students to verify information, use multiple sources, and think critically when consuming information.

Academic Integrity
Educators cite cheating as a top concern with AI adoption (Blose, 2023). New York City schools initially banned the use of ChatGPT (Rosenzweig-Ziff, 2023), but within months those bans were lifted (Klein, 2023). Because generative AI writes compelling text, it can be difficult to discern whether a student wrote an essay or simply asked ChatGPT to create it. Attempts to catch cheaters have proved challenging. One professor copied student essays into ChatGPT, asked ChatGPT if it had written the essays, and accused many students of cheating (Verma, 2023). However, the version of ChatGPT the professor used lacked the ability to detect plagiarism and eventually the students were exonerated.

Assessment Considerations
If a single essay submission no longer demonstrates mastery of a topic, educators must find alternative assessment methods. Strategies for assessment in the age of AI include requiring submissions of drafts, education on plagiarism, and careful scrutiny of submitted work (Cotton et al., 2023). Other suggestions include oral assessments and applied problem solving through case studies (Malik et al., 2023).

Virtual Assistants
Students can use AI tools to augment course instruction. Instead of waiting for an instructor to answer an email, respond to a forum post, or provide classroom instruction, students can engage with AI tools on demand. One key benefit of AI tools is asynchronous communication (Cotton et al., 2023). Khan Academy, the popular online learning platform, introduced its AI-assisted tutor named Khanmigo which evaluates student work and finds errors in student reasoning (Fried, 2023). While Khanmigo boasts a slim feature set today, it demonstrates the ability for AI tools to intervene in real-time rather than waiting for students to ask for help.

In many cases, AI tool creation and adoption caught many educators flat footed. The rapid improvement in AI models and tools introduces new challenges and opportunities. The current study provides data to inform the adoption and appropriate use of AI tools in academia.

4. METHODOLOGY

A study was conducted in a capstone cybersecurity course in a Midwestern university. One of the course learning objectives was to help students develop lifelong learning skills. This study replicates the classroom assignment more completely described in the article by Marquardson (2020). The major parts of the assignment are summarized in this section.

For the study, students completed a self-directed learning assignment. The assignment had four phases: the proposal, carrying out the learning plan, a presentation, and a reflection. For the proposal, students selected a topic, developed learning objectives, found resources to support their learning objectives, and documented how they would provide evidence of reaching those objectives. Once the instructor approved the plan, students carried out their proposals and learned their topic. Next, students presented a brief presentation of their topic to their peers. Finally, students submitted a reflection that included the learning evidence they promised in the proposal along with thoughts on the learning process.

The instructor encouraged, but did not require, students to use ChatGPT in each phase of the assignment. Students were told to cite ChatGPT in their initial learning plan and the follow-up learning reflections when they directly quoted text it generated. The instructor demonstrated use of ChatGPT in the classroom and highlighted examples where ChatGPT gave incorrect information.

After students submitted the final assignment reflection, they were invited to participate in the study with the promise of using the results to inform classroom discussions. Students did not earn course credit for participation or receive any other benefit. The study required that students complete a single survey with quantitative and qualitative questions. The full survey prompts are included in the results section. The survey included the option to upload ChatGPT logs. Identifying information was not collected unless students opted to upload their ChatGPT chat logs. The chat logs removed full anonymity because the filenames contained the student names, and the topics in the log could be traced to that student's unique topic. In total, 9 participants (8 male, 1 preferred not to indicate gender) answered the survey questions, and 1 participant provided a sample ChatGPT interaction that can be found in Appendix A.

5. RESULTS

Of the 9 students who participated in the study, 7 elected to use ChatGPT. Summary statistics for those who used ChatGPT are included in Tables 1-3. Table 4 contains forward-looking statements about ChatGPT use, and therefore data from all 9 participants are included. The learning topics students chose included threat intelligence sourcing, python programming, Microsoft Active Directory, risk management frameworks, lock picking, web development, web server configuration, vulnerability scanning, JavaScript, and Docker.

Students reported their frequency of use on the self-directed learning assignment. Figure 1 shows the count of responses for all participants broken down by learning phase. Table 1 contains the summary statistics of those who reported using ChatGPT. The means for use in the three phases of the project fell between "Somewhat" and "Much."

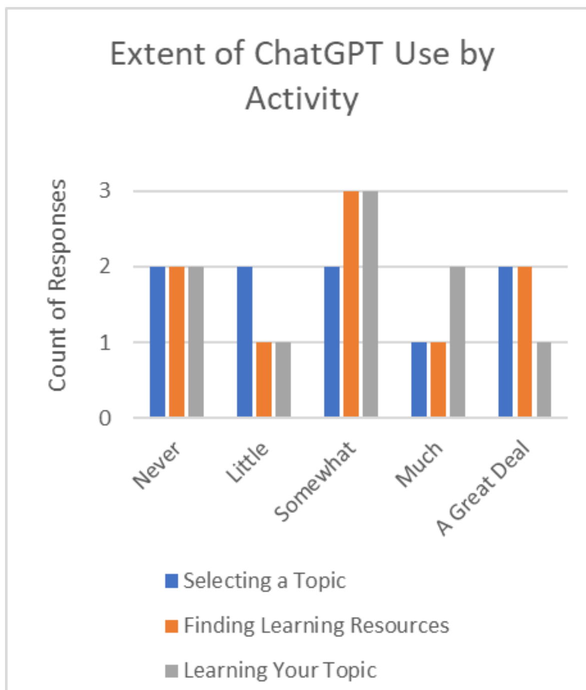


Figure 1: Frequency of ChatGPT Use

How much did you use ChatGPT to help you:	Mean	SD
Select a Topic	3.4	1.3
Find Learning Resources	3.6	1.1
Learn Your Topic	3.4	1.0

Table 1: Frequency of ChatGPT Use, 1=Never, 5=A Great Deal, n=7

Because use of ChatGPT does not necessarily imply usefulness, the survey asked students to assess ChatGPT's helpfulness in completing the self-directed learning assignment. The results in Table 2 indicate agreement that ChatGPT was helpful to some degree in all phases. Students reported that ChatGPT was a good teaching assistant, even favoring asking ChatGPT questions instead of their professor.

Prompt	Mean	SD
ChatGPT helped me select a relevant learning topic.	5.6	1.8
ChatGPT understood my learning goals.	6.0	0.8
ChatGPT helped me find good learning resources.	5.7	1.3
ChatGPT helped me learn the topic.	5.4	1.0
I preferred to ask ChatGPT questions instead of my professor.	5.3	1.3
ChatGPT was a good teaching assistant.	6.0	0.8

Table 2: Helpfulness of ChatGPT on the Self-directed Learning Assignment, 1=Strongly Disagree, 7=Strongly Agree, n=7

Students assessed ChatGPT on several dimensions related to technology adoption. The results are shown in Table 3. ChatGPT scores very high on ease of use and usefulness—key drivers of adoption. ChatGPT also achieved a high friendliness score. Students agreed that ChatGPT gave correct information, but a mean of 5.4 on a 7-point scale indicates that there is some room for increased accuracy. The results indicate that most students encountered some technical problems at some point.

Students answered questions about their intentions to use ChatGPT to learn topics after graduating. The results in Table 4 indicate that students will continue to use ChatGPT to select topics to learn, find learning resources, and learn the topics. All responses were "Agree" to "Strongly" agree, indicating that every participant plans to use ChatGPT for self-directed learning in the future.

Prompt	Mean	SD
ChatGPT was useful.	6.6	0.5
ChatGPT was easy to use.	6.7	0.5
I encountered technical problems while using ChatGPT.	4.9	1.6
ChatGPT was friendly.	6.6	0.5
ChatGPT gave me correct information.	5.4	1.0

Table 3: Opinions on ChatGPT Generally, 1=Strongly Disagree, 7=Strongly Agree, n=7

	Used ChatGPT (n=7)		Did Not Use (n=2)	
Prompt	Mean	SD	Mean	SD
I will use ChatGPT after I graduate to help me choose learning topics to pursue.	6.1	0.7	5.5	0.7
I will use ChatGPT after I graduate to help me understand topics I need to learn	6.0	0.8	6.0	1.4
I will use ChatGPT after I graduate to help me find learning resources.	6.3	0.8	5.5	0.7

Table 4: Anticipated Future Use of ChatGPT to Support Self-directed Learning, 1=Strongly Disagree, 7=Strongly Agree

Qualitative Results

The survey asked students to reflect on their experience and provide written feedback. First, students described their experience using ChatGPT to select a learning topic. One student reported not using ChatGPT at all. Another student said, "Chat GPT has helped me come up with ideas and find books for topics that are slightly specialized in a way that otherwise wouldn't be easy to find." Another reported, "It's really good at helping you get the ball rolling with topics to pick from."

Students reflected on ChatGPT's usefulness for finding learning resources. Results were mixed. One student said, "[ChatGPT gave] some good ideas, but mostly really general obvious answers like finding a YouTube video." Another said, "It does a really good job at linking viable resources to learn from and can tell you what order you might want to learn them in. I feel like this is the main reason I will use ChatGPT in the future." A third responded, "It was ok, I mostly found my resources myself as well." A student described the process by saying, "I ask for suggestions, then for comparisons on the resources I might like, and then I ask it to clarify on the points that I care about."

The survey then asked students to reflect on ChatGPT's support in carrying out the learning plan. The responses showed that students critically evaluated their interactions with ChatGPT. One student said, "When I have a specific question that I can't find elsewhere, I ask ChatGPT. Even when it's wrong some of the words it uses can be crafted into a better Google search." Another stated, "[ChatGPT is a] useful aid for idea generation and helping troubleshoot problems, but not necessarily going to teach you." A third said, "It has done alright, I thought I would be able to follow the learning plan it provided step by step but I find that a lot of stuff is missing most of the time and it hasn't been consistent. At least this has been the case with anything besides code/scripts."

When asked to provide any additional feedback on using ChatGPT on the assignment, students said, "ChatGPT improved my learning," "Frequently unavailable," and "It's pretty great, at least so far."

6. DISCUSSION

The quantitative and qualitative results paint a fascinating picture of AI tool use for self-directed learning. Overall, the results suggest that AI tools can enhance self-directed learning, but students must be aware of potential inaccuracies provided by AI tools.

Students embraced ChatGPT but did not rely heavily on it. They forgave ChatGPT for occasionally giving incorrect and inconsistent information. One would suppose that information accuracy would a top concern for a learning aid, but usefulness was rated higher (6.6/7) than information accuracy (5.4/7).

From an academic integrity perspective, no student engaged in any unethical behavior. Several factors could explain this result. First, students chose their own topics and so the internal drive to learn something that interested them was likely higher than if topics had been assigned to them. Second, ChatGPT could not easily create the learning evidence provided in the reflections. Students included screenshots of applications they build, custom study guides, screenshots of course completions, and more. Third, students presented their work verbally in a peer-to-peer learning environment—something that ChatGPT could only prepare students for by helping them learn.

This self-directed learning assignment was given in a capstone course. Students had completed several previous courses in the domain and therefore had a solid foundation of knowledge. These students were better positioned to identify inaccuracies and critically interpret ChatGPT responses. Novices may have struggled more to determine when they should challenge ChatGPT's responses.

Two limitations of the current study should be acknowledged. First, the sample size is small. The study should be replicated to validate the consistency of the findings. Second, no objective measurements of students' abilities to detect incorrect information from ChatGPT were made. Future research should focus on this question could compare abilities of novice and advanced students to determine the correlation between skill level and ability to detect incorrect information.

7. CONCLUSION

The rapid pace of AI tool development and adoption creates challenges and opportunities for educators. Generative AI produces novel work that makes academic integrity enforcement challenging. Educators must adapt to the changing technological landscape not only to guard against cheating, but to improve learning outcomes.

The current study sheds light on how AI tools can be used to enhance learning. In a self-directed learning assignment, students were encouraged to use ChatGPT to aid them in developing a learning proposal for a topic of their interest, carrying out the learning plan, and reflecting on the learning process. While students noted occasional technical issues and instances of incorrect information, they reported that ChatGPT was easy to use and useful. Every student in this study plans to use ChatGPT for self-directed learning in the future.

Several aspects of the course assignment used in this study support academic integrity and rigor. First, students should be less motivated to cheat because they have the autonomy to choose their own learning topics. The ability to select learning topics should foster a genuine interest in learning.

Second, the assignment is composed of several linked milestones—a learning plan, the learning phase, a presentation, and a reflection. If a student adopts an AI's suggestion for learning objectives, the student is now required to meet those objectives in the next phase. "Cheating" by developing complex learning objectives merely increases the work required in the second phase of the assignment. Likewise, relying too much on AI in the learning phase would leave the students unprepared to present effectively or provide evidence of learning in the reflection submission. Third, the peer-to-peer presentations serve as a kind of self-administered oral examination.

Instructors should prepare students for using AI tools by creating clear assignment guidelines and encouraging students to critically evaluate AI tool output. As AI tools become integrated in more platforms, it is important that students be able to harness their power while avoiding potential pitfalls. It is quite likely that the most productive professionals will be those who judiciously embrace AI to solve problems, so AI tools should be integrated into curriculum.

8. REFERENCES

Blose, A. (2023, April 12). As ChatGPT Enters the Classroom, Teachers Weigh Pros and Cons. *neaToday*. https://www.nea.org/advocating-for-change/new-from-nea/chatgpt-enters-classroom-teachers-weigh-pros-and-cons

Brittain, B. (2023, February 6). Getty Images lawsuit says Stability AI misused photos to train AI. *Reuters*. https://www.reuters.com/legal/getty-images-lawsuit-says-stability-ai-misused-photos-train-ai-2023-02-06/

Brown, T., Mann, B., Ryder, N., Subbiah, M., Kaplan, J. D., Dhariwal, P., Neelakantan, A., Shyam, P., Sastry, G., Askell, A., & others. (2020). Language models are few-shot learners. *Advances in Neural Information Processing Systems*, *33*, 1877–1901.

Campbell, M., Hoane Jr, A. J., & Hsu, F. (2002). Deep blue. *Artificial Intelligence*, *134*(1–2), 57–83.

Chayka, K. (2023, February 10). Is A.I. Art Stealing from Artists? *The New Yorker*. https://www.newyorker.com/culture/infinite-scroll/is-ai-art-stealing-from-artists

Cotton, D. R. E., Cotton, P. A., & Shipway, J. R. (2023). Chatting and cheating: Ensuring academic integrity in the era of ChatGPT. *Innovations in Education and Teaching International*, 1–12. https://doi.org/10.1080/14703297.2023.2190148

Ford, B. (2023, May 1). IBM to Pause Hiring for Jobs That AI Could Do. *Bloomberg*. https://www.bloomberg.com/news/articles/2023-05-01/ibm-to-pause-hiring-for-back-office-jobs-that-ai-could-kill

Fried, I. (2023, April 7). Sal Khan explains why GPT-4 is ready to be a tutor. *Axios*. https://www.axios.com/2023/04/07/sal-khan-chatgpt-gpt4-tutor

Goodhue, D. L., & Thompson, R. L. (1995). Task-Technology Fit and Individual Performance. *MIS Quarterly*, *19*(2), 213–236. https://doi.org/10.2307/249689

Haenlein, M., & Kaplan, A. (2019). A Brief History of Artificial Intelligence: On the Past, Present, and Future of Artificial Intelligence. *California Management Review*, *61*(4), 5–14. https://doi.org/10.1177/0008125619864925

Hu, C. (2023, February 2). ChatGPT sets record for fastest-growing user base—Analyst note. *Reuters*. https://www.reuters.com/technology/chatgpt-sets-record-fastest-growing-user-base-analyst-note-2023-02-01/

Israelsen, A. (2023, March 22). How to use ChatGPT to write code. *Learning and Development*. https://www.pluralsight.com/blog/software-development/how-use-chatgpt-programming-coding

Katz, D. M., Bommarito, M. J., Gao, S., & Arredondo, P. (2023). Gpt-4 passes the bar exam. *Available at SSRN 4389233*.

Kelly, S. M. (2023, January 28). *Real estate agents say they can't imagine working without ChatGPT now*. CNN Business. https://www.cnn.com/2023/01/28/tech/chatgpt-real-estate/index.html

Klein, A. (2023, May 23). New York City Does About-Face on ChatGPT in Schools. *Education Week*. https://www.edweek.org/technology/new-york-city-does-about-face-on-chatgpt-in-schools/2023/05

Kopelman, M. D. (1987). Two types of confabulation. *Journal of Neurology, Neurosurgery & Psychiatry*, *50*(11), 1482–1487. https://doi.org/10.1136/jnnp.50.11.1482

LeCun, Y., Bengio, Y., & Hinton, G. (2015). Deep learning. *Nature*, *521*(7553), 436–444.

Longoni, C., Fradkin, A., Cian, L., & Pennycook, G. (2022). News from generative artificial intelligence is believed less. *Proceedings of the 2022 ACM Conference on Fairness, Accountability, and Transparency*, 97–106.

Malik, A., Khan, M. L., & Hussain, K. (2023). How is ChatGPT Transforming Academia? Examining its Impact on Teaching, Research, Assessment, and Learning. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4413516

Marcus, G. (2022, December 19). AI Platforms like ChatGPT Are Easy to Use but Also Potentially Dangerous. *Scientific American*.

Marquardson, J. (2020). Encouraging Lifelong Learning through Tech Explorations. *Information Systems Education Journal*, *18*(6), 28–37.

McCarthy, J., Minsky, M., & Shannon, C. (1955). *A Proposal for the Dartmouth Summer Research Project on Artificial Intelligence*.

Reddington, C. (2023, May 9). How companies are boosting productivity with generative AI. *GitHub Blog*. https://github.blog/2023-05-09-how-companies-are-boosting-productivity-with-generative-ai/

Roose, K. (2023, January 12). Don't Ban ChatGPT in Schools. Teach With It. *New York Times*. https://www.nytimes.com/2023/01/12/technology/chatgpt-schools-teachers.html

Rosenzweig-Ziff, D. (2023, January 5). New York City blocks use of the ChatGPT bot in its schools. *The Washington Post*. https://www.washingtonpost.com/education/2023/01/05/nyc-schools-ban-chatgpt/

Vaswani, A., Shazeer, N., Parmar, N., Uszkoreit, J., Jones, L., Gomez, A. N., Kaiser, \Lukasz, & Polosukhin, I. (2017). Attention is all you need. *Advances in Neural Information Processing Systems*, *30*.

Venkatesh, V., Thong, J. Y. L., & Xu, X. (2012). Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly*, *36*(1), 157–178.

Verma, P. (2023, May 18). A professor accused his class of using ChatGPT, putting diplomas in jeopardy. *The Washington Post*. https://www.washingtonpost.com/technology/2023/05/18/texas-professor-threatened-fail-class-chatgpt-cheating/

Weiser, B. (2023, May 27). Here's What Happens When Your Lawyer Uses ChatGPT. *New York Times*. https://www.nytimes.com/2023/05/27/nyregion/avianca-airline-lawsuit-chatgpt.html

Zhang, Y., Li, Y., Cui, L., Cai, D., Liu, L., Fu, T., Huang, X., Zhao, E., Zhang, Y., Chen, Y., Wang, L., Luu, A. T., Bi, W., Shi, F., & Shi, S. (2023). *Siren's Song in the AI Ocean: A Survey on Hallucination in Large Language Models*. https://doi.org/10.48550/ARXIV.2309.01219

APPENDIX A
Sample ChatGPT Interaction

A student supplied the following ChatGPT interaction.

Chat GPT Prompt
what does this TCP stream mean: 220 x.shh.sh ESMTP Exim 4.86 Wed, 06 Sep 2017 22:11:43 +0000 ehlo x.shh.sh 250-x.shh.sh Hello x.shh.sh [::1] 250-SIZE 52428800 250-8BITMIME 250-PIPELINING 250-AUTH LOGIN 250-STARTTLS 250-PRDR 250 HELP auth login 334 VXNlcm5hbWU6bWFsbG9yeQ== 334 UGFzc3dvcmQ6ZmxhZy1zcGluc3Rlci1iZW5lZml0LWZhbHNpZnktZ2FtYmlhbg== 535 Incorrect authentication data 421 x.shh.sh lost input connection

Chat GPT Response
This TCP stream appears to be a sequence of commands and responses exchanged between an email client and an email server using the SMTP (Simple Mail Transfer Protocol) protocol. Here's a breakdown of what's happening:

1. The email client sends the command "ehlo x.shh.sh" to the server. This command is used to initiate a session with the server and to identify the client to the server.
2. The server responds with "250-x.shh.sh Hello x.shh.sh [::1]", indicating that it has received the client's greeting and is ready to proceed with the session. The server also provides a list of capabilities it supports, including "SIZE 52428800", "8BITMIME", "PIPELINING", "AUTH LOGIN", "STARTTLS", "PRDR", and "HELP".
3. The email client sends the command "auth login" to the server, indicating that it wants to authenticate itself to the server using the LOGIN method.
4. The server responds with "334 VXNlcm5hbWU6", which is a Base64-encoded message that prompts the client for its username.
5. The email client responds with "bWFsbG9yeQ==", which is a Base64-encoded version of the client's username "malory".
6. The server responds with "334 UGFzc3dvcmQ6", which is a Base64-encoded message that prompts the client for its password.
7. The email client responds with "ZmxhZy1zcGluc3Rlci1iZW5lZml0LWZhbHNpZnktZ2FtYmlhbg==", which is a Base64-encoded version of the client's password "flag-spinner-benefit-falsify-gambian".
8. The server responds with "535 Incorrect authentication data", indicating that the client's login attempt failed.
9. The server sends the message "421 x.shh.sh lost input connection", indicating that the connection has been lost and the session is over.

Based on this TCP stream, we can conclude that the email client attempted to authenticate itself to the server using the LOGIN method, but the authentication failed because the provided credentials were incorrect. We can also see that the server supports a number of other capabilities, such as message size limits, MIME encoding, and encryption.

Student-Driven Programming Instruction: A Follow-Up Study

Deepak Dawar
daward@miamioh.edu
Dept. of Computer and Information Technology
Miami University
Hamilton, Ohio 45011, U.S.A.

Abstract

Learning computer programming is typically difficult for newcomers. Demotivation and learned helplessness have received much attention. Besides the subject's intricacy, low in-class participation has been associated with poor student achievement. This paper presents a follow-up, stage 2 study on the novel instructional technique, Student-Driven Probe Instruction (SDPI), to address low in-class participation in programming courses. Instead of the teacher lecturing/explaining content to the class and asking questions, students were shown a snippet of code or other relevant material and given the option to ask questions beforehand. The study was conducted in two stages: stage 1 pilot and stage 2. This paper presents the results of stage 2, while stage 1 operations and results are discussed briefly. The number of questions asked in class, real-time Trello board postings, and emails/Slack conversations with the instructor were used to track participation. In-class participation showed significant improvement. Average quiz and in-class activity scores showed marginal gains. Results from the end-of-course survey show that students preferred SDPI over the traditional lecture style since it stirred their interest in the content and provided them the confidence to ask questions in class. The study is purely exploratory in nature, and no conclusions can be drawn due to the extremely small sample size of the student population.

Keywords: Class participation, introductory programming, pedagogy, student demotivation.

Recommended Citation: Dawar, D., (2024). Student-Driven Programming Instruction: A Follow-Up Study**.** *Information Systems Education Journal,* 22(1), pp.14-29. https://doi.org/10.62273/ UQWB4192

Student-Driven Programming Instruction: A Follow-Up Study

1. INTRODUCTION

The majority of novices find learning computer programming challenging, and significant failure rates are frequently recorded (Allan & Kolesar, 1997; Beaubouef & Mason, 2005; Bennedsen & Caspersen, 2007; Howles, 2009; Kinnunen & Malmi, 2006; Mendes et al., 2012; Newman, Gatward, & Poppleton, 1970; Sheard & Hagan, 1998; Watson & Li, 2014). Due to the difficulty of the material, many students lose interest (Kim & Lerch, 1997; Rogalski & Samurçay, 1990; Robins, Rountree & Rountree, 2003). A large body of data demonstrates that class engagement enhances student performance and significantly affects GPA (Credé, Roch, & Kieszczynka, 2010). No matter how the course is delivered—synchronously or asynchronously—many studies have shown that active class involvement significantly improves student outcomes (Duncan et al., 2012; Nieuwoudt, 2020).

The author has noticed that only a small percentage of the students tend to ask the majority of the questions after having taught numerous programming courses over a period of several years. A few of the others occasionally engage in conversation, but the majority mostly just observe. This is supported by research done by Bowers in 1986 as well as the data acquired for this examination.

Many approaches have been proposed to address this low level of involvement. Although there is a lot of research on these techniques, pair programming (Dongo et al., 2016; Williams et al., 2002) and gamification (Beavis, 2010; Majuri et al., 2018; Osatuyi et al., 2018; Seaborn & Fels, 2015) are some of the most popular ones. These techniques work well and have been found to have a neutral to positive impact on students' academic results.

The author has employed these techniques, and it appears that they have improved the degree of participation in the class's problem-solving activities. One aspect that these methods had little impact on was the students' comfort level with asking questions. For instance, the author has repeatedly observed that many students return to their usual habit of non-participation when it comes to asking questions after a pair programming or gamification session. Most of the questions were asked by the same students who had been asking them earlier, both before and after these exercises.

Students have been encouraged to ask questions in class using various strategies. The two important ones are giving weight to in-class questions (Berdine, 1986; Smith, 1992) and the Random Selector Model (Allred & Swenson, 2006). Assigning points to students who ask questions is an effective example of an external motivator since it gives them a reason to do so. The achievement or curiosity of the students may or may not be impacted by this. Similarly, cold calling boosts engagement while simultaneously raising the class's stress levels (Moguel, 2004).

One question must be addressed in light of the prevalence of low in-class participation rates: why don't certain students participate or raise questions in class?

Regardless of the physical characteristics of the classroom, a student's own anxieties about coming across as insufficient or incompetent in front of others may also prevent them from participating in class (Fritschner, 2000; Hyde & Ruth, 2002; Weaver & Qi, 2005), especially when it comes to raising questions. Students also stated (Armstrong & Boud, 1983; Wade, 1994) that they were most deterred from asking questions due to their lack of confidence. Because they are worried about what other students would think of them, many students choose not to participate (Fritschner, 2000).

Many students may decide not to participate in class due to the heavy conceptual load (Sweller, 1988, 1994) of computer programming because it is challenging to comprehend multiple concepts at once. Many students begin to believe they cannot excel when this happens frequently. According to Crego et al. (2016), this is referred to as "acquired helplessness." This can lead to even lower confidence levels for students.

Student-Driven Probe Instruction (SDPI) intervention was designed with these considerations in mind. The concept was straightforward but counterintuitive: students were presented with a piece of code or content instead of the instructor leading the class by explaining the material and encouraging questions. The instructor then opened the floor to questions without offering any clarifications. The intention was threefold:

1. Lessen the initial mental strain and allow the students to interpret the information themselves first. As a result, rather than being viewed as something the student must be assessed on, the connection between the student and the subject is purely exploratory.
2. Allow the students' questions to guide the lesson rather than the teacher's. Giving the students greater control through this modification might increase their self-esteem and aid them in letting go of their feelings of inadequacy.
3. Anonymize the questions, i.e., the students who do not want to be identified as having asked a particular question but intend to participate should be afforded that opportunity. This is achieved through anonymous cards in Trello boards and is discussed in section 2. This feature was added during stage 2 based on the student feedback from stage 1.

The technique rests on three central pillars, as shown in Figure 1. It is essential that the instructor maintain a non-judgmental classroom environment during this process, as students are now going to ask the most rudimentary questions. Judging their questions as lofty and not relevant will derail the whole process immediately.

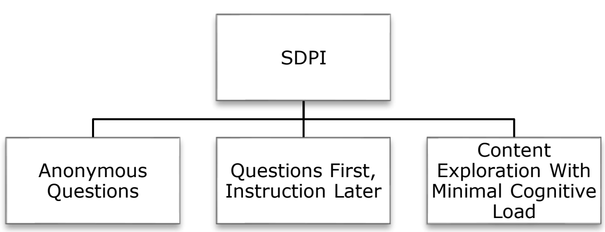


Figure 2: Student-Driven Probe Instructional Technique

Two research questions were addressed in this study:
a) How does the SDPI method affect students' participation in class?
b) If any, how does SDPI affect student grades?

The terms participation and questions asked are interchangeable in this study. The remainder of the paper is organized as follows. The operational features of the approach are discussed in Section 2, along with an explanation of its components. The preliminary findings are presented in Section 3. Section 4 talks about SDPI's advantages and disadvantages. Section 5, which concludes the paper, also briefly outlines the framework for additional research.

2. METHODOLOGY

The study was conducted in two stages.

Stage 1 - Pilot	Single student population P1(12)	
	Pre-mid-term taught with conventional methods.	Post-mid-term taught with SDPI.
Stage 2 - Controlled	Two different student populations Control(13) and Experimental(21)	
	The control group was taught with conventional methods used by the author	The experimental group taught with SDPI

Figure 3: SDPI stages

Stage 1: This stage was done as a pilot project on a single class of the programming course. The author decided it would be too risky to present the SDPI at the start of the course due to its unproven character. The course was divided into two halves for this stage of study. The students were instructed using the traditional method(s) in the first half, during which the topic was taught and student questions solicited. In the second half, SDPI was presented, and the students were just shown a small portion of the code without any explanations. The strategy can be encapsulated as follows:

1. Students will be shown a piece of code/content at the beginning of the class.
2. A certain amount of time is given to the students, generally two minutes, to come up with questions about the content if they have any.
3. It is presumed that all students fully understand the subject matter if there are no queries from the class. The teacher selects a student at random and inquires about the subject matter to test this assumption. This step in the process is crucial because it teaches the students that it is preferable to ask questions than to wait for the instructor to ask them and risk being unable to respond.

4. As the queries come in, they are noted as comments on the source code for later use.
5. The instruction starts and is modeled around the questions whenever enough questions have been asked (often 5–10). The questions are now used as a tool to examine and explain the material.

A sample load is presented below to describe the procedure effectively.

```
import java.io.File;
import java.io.FileNotFoundException;
import java.util.Scanner;
//Q1. What is File?
//Q2. Is the name of the file input.txt or file itself?
//Q3. Where is input.txt stored?
//Q4. Will the Scanner run as long as there is some input in the file?
//Q5. Will the loop stop after the last line is printed?
//Q6. What does throws clause do?
//Q7. Why file in Scanner not the file name?
//Q8.
//Q9.
public class Files {
   public static void main(String[] args){
     try{
       File file = new File("input.txt");
       Scanner in = new Scanner(file);
       while(in.hasNext()){
         String temp = in.next();
       }
     }catch(FileNotFoundException e){
       System.out.println("File Not Found");
     }
   }
}
```

Figure 4: Sample snippet for SDPI stage 1

Figure 3 shows the opening snippet of a particular module. Only after a reasonable number of inquiries about the snippet—in this example, seven—had been made could the instruction start. As soon as a student began to ask a question, it was noted on the source file, which was then shared with the class later.

It is to be noted that stage 1 was a pilot to ascertain whether SDPI should be pursued for further study in a controlled environment. The results were encouraging as class participation rose significantly, and quiz scores improved meaningfully (Dawar, 2022). It is to be noted that if this stage had not produced any meaningful student outcomes, conducting the subsequent stage two study would have been irrelevant.

Two main shortcomings were identified during Stage 1.

1. The first challenge of SDPI stage 1 was in-class data collection. The author had to record (in a matrix) the number of questions asked by each student during every class. This occasionally caused the author to become slightly distracted because they had to simultaneously mark the question in the matrix and write it on the source file so that everyone could see it on a shared computer screen.
2. Some students who did not participate revealed in the after-course interview that they wanted to ask questions but were not comfortable being identified as having asked those questions.

These issues were addressed in stage 2.

Stage 2: This stage study spanned two semesters and involved two sets of students taking the same programming course. These students were divided into control and experimental groups. Students in the control group were taught with the conventional method that the author employs, i.e., the content is explained, and the questions are solicited from students afterward. Students in the experimental group were taught using SDPI, with some of the shortcomings of stage 1 addressed.

One of the major feedback from the stage 1 pilot was that many students did not want to be identified while asking questions, but they wanted to participate. Every student was assigned an anonymous ID on the Trello Board to address this apprehension, such as S1 and S2. During the class, students would type their questions anonymously under their IDs. This would serve a dual purpose – let the intending students participate anonymously while serving as a record of the questions asked by the whole class as well as taking pressure off from the instructor for writing all the questions themselves. A sample is shown in Figure 4. It shows three students with assigned ID's as S1, S2, and S3. These students do not know what ID belongs to whom, thus anonymizing the questions.

Student Population

Despite the lack of clear definitions in the literature, our department's student body includes both traditional and non-traditional students. For the sake of this work, the author defines "traditional" as full-time students who have just graduated from high school. Non-traditional students include those who work full-time, attend school part-time, are older, and are looking for a new career, among other situations.

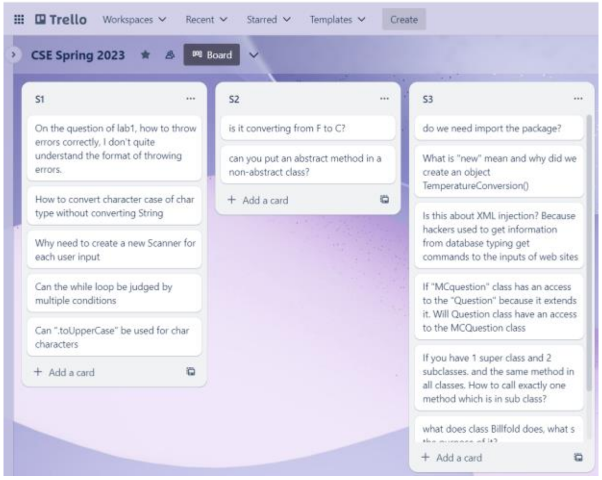


Figure 5: Anonymous Trello Board

The number of students in the stage 1 pilot group was 12. Stage two had 13 students in the control group and 21 students in the experimental group who participated in the study. Students majoring in information technology (IT) can take the course as an elective, but computer science (CSE) students are required to take it.

Data Collected

Numerous factors have been used to evaluate student achievement. Course grades, term grades, and cumulative GPA are the most often utilized metrics (Teixeira, 2016). Student ratings and pre and post-test scores are occasionally used (Omar, Bhutta, & Kalulu, 2009; Felisoni & Godoi, 2018).

For this work, the following data were collected for each participating student:

1. No. of questions asked in class
2. No. of email/Slack contacts with the instructor
3. Quiz scores
4. In-class activity scores
5. Mid-term and final exam scores

3. RESULTS

Findings from the study can be categorized into two groups: quantitative data analysis to examine the potential impacts of SDPI on student engagement and outcomes and student impression of SDPI as revealed by an end-of-course survey.

During the class, each student's total number of questions was kept track of both in the control and experimental groups. The average number of questions asked in class by all participating students is shown in Table 1. In the control or traditional mode of instruction, 65% of the questions were asked by the top 30% of the students. The bottom 45% asked only 15% of the total questions asked by all students, i.e., 45% of the students contributed to only 15% of all the questions asked in the control group. This skew perfectly captures the low participation rates among certain students. This is also consistent with the authors' experience teaching computer programming over the years. The average number of questions asked by the control group was 1.63 per student, while for the experimental group, it was 3.44.

Student No	Average No. of Questions Asked by Each Student in the Control Group	Average No. of Questions Asked by Each Student in the Experimental Group
1	0.0	3.0
2	4.5	8.75
3	3.5	3.25
4	1.25	5.0
5	3.75	5.75
6	0.5	4.0
7	0.25	5.25
8	2.0	5.0
9	2.25	5.75
10	0.75	2.25
11	0.0	3.25
12	2.5	6.75
13	1.5	2.0
14	-	3.25
15	-	1.0
16	-	2.75
17	-	4.25
18	-	3.75
19	-	2.0
20	-	0.5
21	-	4.25
Average	**1.63**	**3.44**

Table 5: Average no. of questions asked by each student in class

As evaluated by the number of questions posed by each student, class involvement dramatically increased with the implementation of SDPI. The average number of questions raised in class rose significantly. This is a significant advancement. Taking a closer look at the table prompts the following inquiries:

1. Why did the number of questions asked increase?
2. Was the increase uniformly distributed among students?

The students had to ask questions for the session to move forward and get the content taught because it wasn't explained. This is unquestionably one of the causes of the sharp increase in inquiries.
In the experimental group, 70% of the questions were asked by 66% of the students. This is a much better distribution than the control group, where 65% of the questions were asked by 30%

of the students. This clearly shows the uniform participation among students achieved with SDPI. This is a significant and advantageous development. This is further supported by data from a course evaluation survey, where most students reported that SDPI increased their level of participation in class. An analysis of variance (ANOVA) test was done for this data. The difference was found to be significant, with a p-value of 0.001. This shows that statistically speaking, participation did increase dramatically. For a detailed ANOVA report, see Appendix C.

Table 2 shows the average instructor contacts by students in the control and experimental groups. These are the follow-up, and sometimes new questions and queries students pose outside of class time. The utility of this metric is to gauge the interest in the content outside the classroom. These are collected because, no matter what, some students prefer asking questions one-on-one with the instructor.

Student No	Average No. of Instructor Contact – Control Group	Average No. Instructor Contact – Experimental Group
1	2	3
2	2.25	2.25
3	1	2.25
4	3.25	4
5	2	2.75
6	1.25	3
7	1.5	1.25
8	1	3
9	1.5	1.75
10	1.5	2
11	0	2.25
12	2	2.75
13	1	0.5
14	-	1.25
15	-	2
16	-	2.25
17	-	3.25
18	-	2.75
19	-	2
20	-	0
21	-	1.25
Average	**1.55**	**2.16**

Table 2: Average instructor contacts by students

Contacts made via email and Slack, a team collaboration tool, were considered. The average contacts for the experimental group increased from 1.55 to 2.33. This means that, outside the class and on average, each student contacted the instructor 1.55 times in the control compared to 2.16 times in the experimental group. This is a significant improvement (a p-value of 0.06), though this improvement also comes with a substantial load for the instructor.

Quiz No.	Average Quiz Scores for Control Group	Average Quiz Scores for Experimental Group
1	19.56	23.25
2	31.2	31.91
3	19.68	21.44
4	35.43	36.82
5	28.06	28.2
Average	**26.78**	**28.34**

Table 3: Average quiz scores

Class Activity No.	Average Activity Scores for Control Group	Average Activity Scores for Experimental Group
1	9.375	9.78
2	18.625	18.8
3	16.866667	19.42
4	18.25	19.87
5	28.4375	28.43
6	12.25	12.9
7	15.5	15.7
8	12.25	15.16
9	32.25	31.45
10	17.4	18.4
Average	**18.10**	**19.01**

Table 4: Average in-class activity scores

Tables 3 and 4 present the average quiz and in-class activity scores obtained by the control and experimental groups. There were five quizzes and ten in-class activities in total, with different points depending on their complexity. Both groups were administered the same quizzes and activities. This is only a marginal improvement in these scores. Hence, this is a mixed yet positive result.

Table 5 shows a comparison between average exam scores for both groups. The final exam was worth 100 points, and the midterm was worth 50. No conclusion can be drawn at this point regarding the impact of SDPI on exam scores. More iterations of SDPI need to be run to see if these results hold or improve.

Group	Control	Experimental
Mid-term Exam Average Score (50)	38.75	44.56
Final Exam Average Score (100)	84.1	83.5

Table 5: Exam scores

End of Course Survey

Regarding SDPI, a final anonymous survey was conducted for the experimental group. Table 6 lists a few survey questions (the whole survey is attached in Appendix B).

Question	Definitely Yes	Probably Yes	Might or Might Not	Probably Not	Definitely Not
1.Made you more participative	53%	14%	4%	23%	4%
2.Improved understanding of material	48%	28%	4%	19%	4%
3.Made you curious about the content	43%	28%	14%	9%	4%
4.Made you pay attention to the material	43%	28%	19%	5%	5%
5.Made you feel confident about asking questions	43%	19%	28%	9%	0%

Table 6: End-of-course survey responses

Nearly 68% of all the students who filled out the survey said that SDPI increased their participation. This is very encouraging, and in line with the results of Stage 1. 76% of the students said that their understanding of the subject had probably increased with the use of SDPI, whereas 19% reported no change.

According to Kidd and Hayden (2015) and Szumowska and Kruglanski (2020), curiosity is a learning catalyst. It is encouraging to see that 71% of the students said that SDPI increased their curiosity about the subject matter. Most students said that SDPI sharpened their attention to the lecture subject.

An important question on their level of stress while using SDPI was posed to the class. Given that a stressful learning environment may result in demotivation and lower learning effectiveness (Bowers, 1986), this was one of the survey's most crucial questions. If having to ask questions in class made students anxious, SDPI would fall short right away. Interestingly, 53% of respondents stated that SDPI decreased their stress levels, 24% said it had no effect, and 23% indicated it had increased their stress levels in the class. The practical constraints of any new intervention can be accommodated by this distribution. It is still necessary to look into the root causes of the higher stress that 23% of the students report experiencing.

Additionally, the students were asked about their preferred mode of instruction between traditional and SDPI. 72% of the students preferred the SDPI method, 24% chose the conventional method, and 4% had no opinion. This is encouraging news for the investigation's future and, in the author's view, a little vote of confidence in SPDI.

4. DISCUSSION

Given the small sample size, it is still too early to generalize the technique's efficacy, but the early results provide some fascinating insights.

Strengths

According to classroom and assessment data and student survey responses, most students found SDPI beneficial even though they thought the method was counterintuitive. This is seen by the considerable increase in class participation with SDPI. The author would like to propose that reducing the inadequacy factor among non-participating students is one cause of this development. Because they are worried that other students may judge their inquiries, many students choose not to engage. SDPI mitigates this factor, as the content isn't explained to begin with, and by introducing anonymous questions. Many students hesitate to raise questions after the instructor introduces a specific idea because they believe their inquiries might be perceived as silly. They want to ask questions but do not want to be identified. Asking anonymous questions in class using Trello boards gives them a pathway to participate. The author believes that SDPI provides students with a broad and open range of inquiries without making them feel inadequate.

Additionally, 79% (combined for both stages) of the participants indicated that they would prefer SDPI over a traditional setting. This clearly shows that students are eager to ask questions given a chance and the right environment, and SDPI offers just that.

Challenges

Getting the students used to the idea that their questions, not the instructor's, will determine the direction of the session is very counterintuitive. During both stage 1 and stage 2, the author struggled for a couple of classes to get everyone on board. In standard classroom settings, students are used to the content being explained first and wait for the instructor to take their questions. In a conventional lecture context, the instructor has the majority of the control, and the students are aware of this mechanism. However, with SDPI, a portion of that power is delegated to the students to create their own questions and guide the lesson in a particular direction. It will likely take some time for students to adjust to this change of power.

The fact that the current version of SDPI lacks a way to evaluate the caliber of student inquiries is another major problem. A question about the feasibility/optimality of a code fragment is considered in the same way as a straightforward query about a symbol in the source code. This is a significant flaw in SDPI as it now exists. Future editions of SDPI will include a weighting system that will divide student questions into groups according to the level of complexity they represent.

Time management in class and how thoroughly the content is covered are two other problems. The author often knows how much content will be covered during the class session because they prepare their lectures in advance. Because the instruction was dependent on the student's questions, it was challenging to cover the targeted topic. The questions consumed time that could have been spent on other topics that day because of their vast breadth. As the author takes a few more classes with SDPI, this problem might be lessened.

5. CONCLUSION AND FUTURE WORK

The results of utilizing SDPI in a controlled setting, an experimental teaching method, were presented in this paper. The goal was to compare the participation rates and student outcomes between traditional teaching and SDPI-based settings. Anecdotally, the results suggest that utilizing SDPI may increase student participation in class. A significant improvement in class participation as measured by no. of questions asked was reported. Additionally, a marginal improvement in the average quiz and in-class activity scores was observed after the introduction of SDPI. The mid-term and final exam scores did not have any observable change.

Even though marginal improvements are reported in the experiment, it is emphasized that no formal conclusions can be drawn at this stage due to the very small sample size of the student population. Hence, it would be premature to consider the SDPI approach as a workable tactic for affecting student grade outcomes at this point. However, the preliminary findings are positive, and if used in conjunction with other methods, SPDI offers a clear path for further study.

6. REFERENCES

Allan, V. H. & Kolesar, M. V. (1997). Teaching computer science: a problem solving approach that works. ACM SIGCUE Outlook, 25(1–2),2–10. https://doi.org/10.1145/274375.274376

Allred, C. & Swenson, M. (2006) Using Technology to Increase Student Preparation for and Participation in Marketing Courses: The Random Selector Model, Marketing Education Review, 16 (1), 15-21. https://doi.org/10.1080/10528008.2006.11488932

Armstrong, M., & Boud, D. (1983). Assessing participation in discussion: An exploration of the issues. Studies in Higher Education, 8, 33-44. https://doi.org/10.1080/03075078312331379101

Beaubouef, T. B. & J. Mason (2005). Why the High Attrition Rate for Computer Science Students: Some Thoughts and Observations. Inroads – The SIGCSE Bulletin, 37(2), 103–106. https://doi.org/10.1145/1083431.1083474

Beavis, C. (2010). Literacy, Learning, and Online Games: Challenge and Possibility in the Digital Age. In Proceedings of the IEEE 3rd International Conference on Digital Game and Intelligent Toy Enhanced Learning. Piscataway, NJ: Institute for Electrical and Electronics Engineers. https://doi.org/10.1111/j.1754-8845.2009.01035.x

Bennedsen, J. & Caspersen, M. E. (2007). Failure rates in introductory programming. ACM SIGCSE Bulletin, 39(2), 32–36. https://doi.org/10.1145/1272848.1272879

Berdine, R. (1986). Why some students fail to participate in class. Marketing News, 20, 23-24. https://doi.org/10.13189/ujer.2018.060201

Bowers, J. W. (1986). Classroom communication apprehension: A survey. Communication Education, 35, 372-378.

Credé, M., Roch, S. G., & Kieszczynka, U. M. (2010). Class Attendance in College: A Meta-Analytic Review of the Relationship of Class Attendance With Grades and Student Characteristics. *Review of Educational Research*, *80*(2), 272–295. https://doi.org/10.3102/0034654310362998

Crego, A., Carrillo-Diaz, M., Armfield, J., & Romero, M., (2016). Stress and Academic Performance in Dental Students: The Role of Coping Strategies and Examination-Related Self-Efficacy Journal of Dental Education, 80 (2) 165-172.

Dawar, D (2022). Question Driven Introductory Programming Instruction: A Pilot Study. Journal of Information System Education, 34(2) 231-242.

Dongo, T., Reed, A. H., & O'Hara, M. (2016). Exploring pair programming Benefits for MIS majors. Journal of Information Technology Education: Innovations in Practice, 15, 223-239.

Duncan, K., Kenworthy, A. L., Mcnamara, R., & Kenworthy, D. A. (2012). The Effect of Synchronous and Asynchronous Participation on Performance in Online Accounting Courses. *Accounting Education*, *21*(4), 431–449. https://doi.org/10.1080/09639284.2012.673387

Felisoni, D. D., & Godoi, A. S. (2018). Cell phone usage and academic performance: An experiment. Computers & Education, 117, 175–187. https://doi.org/10.1016/j.compedu.2017.10.006

Fritschner, L. M. (2000). Inside the undergraduate college classroom: Faculty and students differ on the meaning of student participation. The Journal of Higher Education, 71, 342-362. https://doi.org/10.2307/2649294

Howles, T. (2009). A study of attrition and the use of student learning communities in the computer science introductory programming sequence. *Computer Science Education*, 19(1), 1–13. https://doi.org/10.1080/08993400902809312

Hyde, C. A., & Ruth, B. J. (2002). Multicultural content and class participation: Do students selfdisclose? Journal of Social Work Education, 38, 241-256. https://doi.org/10.1080/10437797.2002.10779095

Kidd, C., & Hayden, B. (2015). The Psychology and Neuroscience of Curiosity, Neuron, 88(3), 449-460. https://doi.org/10.1016/j.neuron.2015.09.010

Kim, J. & Lerch, F. J. (1997). Why is programming (sometimes) so difficult? Programming as scientific discovery in multiple problem spaces. *Information Systems Research* 8(1) 25–50. https://doi.org/10.1287/isre.8.1.25

Kinnunen, P. & Malmi, L. (2006). Why students drop out CS1 course?. In Proceedings of the Second International Workshop on Computing Education Research (pp. 97–108). New York, NY: ACM. https://doi.org/10.1145/1151588.1151604

Majuri, J., Koivisto, J., and Hamari, J. (2018). "Gamification of education and learning: a review of empirical literature," in Proceedings of the 2nd International GamiFIN Conference, GamiFIN 2018, CEUR-WS, (Finland).

Mendes, A. J., Paquete, L., Cardoso, A. & Gomes, A. (2012). Increasing student commitment in introductory programming learning. In Frontiers in Education Conference (FIE) (pp. 1–6). New York, NY: IEEE. https://doi.org/10.1109/FIE.2012.6462486

Moguel, D. (2004). What does it mean to participate in class?: Integrity and inconsistency in classroom interaction. Journal of Classroom Interaction, 39, 19-29.

Newman, R., Gatward, R. & Poppleton, M. (1970). Paradigms for teaching computer programming in higher education. WIT Transactions on Information and Communication Technologies, 7, 299–305. https://doi.org/10.2495/SEHE940351

Nieuwoudt, J. E. (2020). Investigating synchronous and asynchronous class attendance as predictors of academic success in online education. *Australasian Journal of Educational Technology*, *36*(3), 15–25.

Omar, A., Bhutta, M. K. S., & Kalulu, D. (2009). Assessment of Student Outcomes in Management Information Systems Online Course Participation. 10.

Osatuyi, B., Osatuyi, T., and de la Rosa, R. (2018). Systematic review of gamification research in is education: a multi-method approach. CAIS 42, 95–124. https://doi.org/10.17705/1CAIS.04205

Robins, A. V., Rountree, J. & Rountree, N. (2003). Learning and teaching programming: A review and discussion. *Computer Science Education* 13(2) pp. 137–172. https://doi.org/10.1076/csed.13.2.137.14200

Rogalski J. & Samurçay R. (1990). Acquisition of programming knowledge and skills. In J. M. Hoc, T. R. G. Green, R. Samurçay & D. J. Gillmore, eds., Psychology of Programming. London: Academic Press, pp. 157–174.

Seaborn, K., and Fels, D. I. (2015). Gamification in theory and action: a survey. Int. J. Hum. Comput. Stud. 74, 14–31. https://doi.org/10.1016/j.ijhcs.2014.09.006

Sheard, J. & Hagan, D. (1998). Our failing students: a study of a repeat group. ACM

SIGCSE Bulletin, 30(3), 223–227. https://doi.org/10.1145/290320.283550

Smith, D. H. (1992). Encouraging students' participation in large classes: A modest proposal. Teaching Sociology, 20(4), 337-339.

Sweller, J. (1988). Cognitive load during problem solving: Effects on learning. *Cognitive Science*, 12(2), 257–285. https://doi.org/10.1207/s15516709cog1202_4

Sweller, J. (1994). Cognitive load theory, learning difficulty, and instructional design. *Learning and Instruction*, 4(4), 295–312. https://doi.org/10.1016/0959-4752(94)90003-5

Szumowska, E., & Kruglanski, A. (2020). Curiosity as end and means, Current Opinion in Behavioral Sciences, 35, 35-39. https://doi.org/10.1016/j.cobeha.2020.06.008

Teixeira, A. A. C. (2016). The impact of class absenteeism on undergraduates' academic performance: Evidence from an elite Economics school in Portugal. Innovations in Education and Teaching International, 53(2), 1–13. https://doi.org/10.1080/14703297.2014.937730

Wade, R. (1994). Teacher education students' views on class discussion: Implications for fostering critical reflection. Teaching and Teacher Education, 10, 231-243. https://doi.org/10.1016/0742-051X(94)90015-9

Watson, C. & Li, F. W. (2014). Failure rates in introductory programming revisited. In Proceedings of the 2014 Conference on Innovation & Technology in Computer Science Education (pp. 39–44). New York, NY: ACM. https://doi.org/10.1145/2591708.2591749

Weaver, R. R., & Qi, J. (2005). Classroom organization and participation: College students' perceptions. The Journal of Higher Education, 76, 570-601. https://doi.org/10.1353/jhe.2005.0038

Williams, L., Wiebe, E., Yang, K., Ferzli, M., Miller, C. (2002). In support of pair programming in the introductory computer science course Computer Science Education, 12 (3), pp. 197-212. https://doi.org/10.1076/csed.12.3.197.8618

APPENDIX A

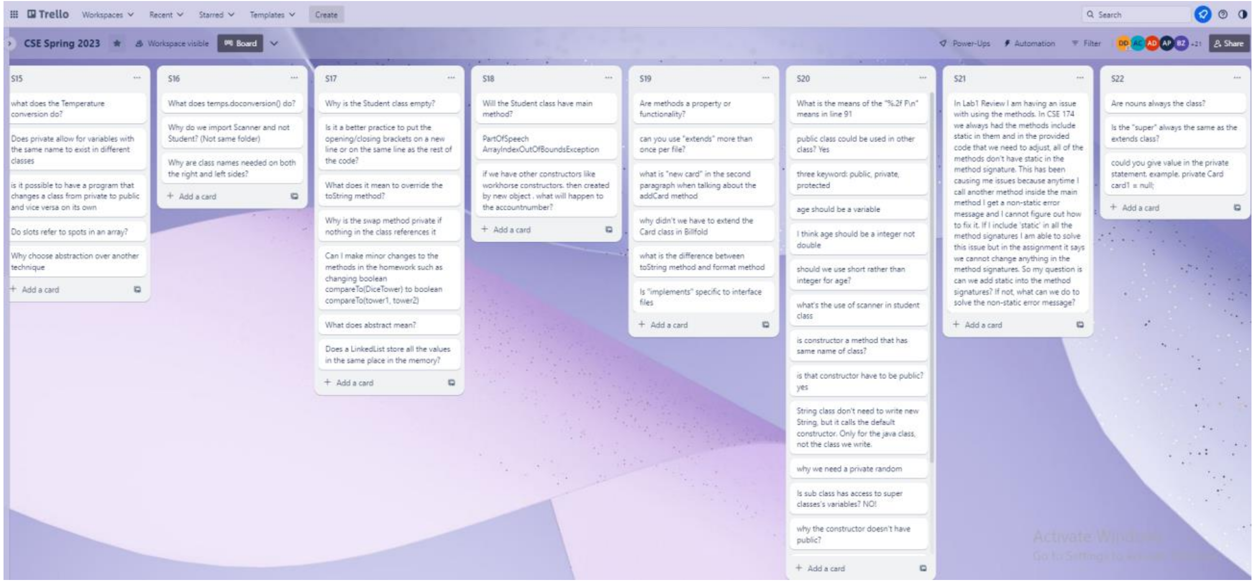


Figure 6: Sample raw data example questions asked by students during the course

APPENDIX B

Survey Instrument for SDPI

Q1 Did the Student-Driven Probe Instructional Approach (SDPI) make you more participative in the class?

- Definitely yes. It made me more participative. (1)
- Probably yes (2)
- Might or might not (3)
- Probably not. I avoided asking questions. (4)
- Definitely not (5)

Q2 During SDPI make you feel confident about asking opening questions?

- Definitely yes. I was confident since I could ask any question about the content. (1)
- Probably yes (2)
- May be (3)
- Probably not. I avoided asking questions. (4)
- Definitely not (5)

Q3 What impact did SDPI have on your stress levels in class?

- It definitely reduced my stress levels. I felt free to ask any type of questions since nothing was explained about the content, to begin with. (1)
- It probably reduced my stress levels. (2)
- It had no impact on my stress levels. (3)
- It increased my stress levels. (4)

Q4 Did the SDPI approach improve your understanding of material?

- Definitely yes. It made me think deeply about the content since I was the one asking the opening questions. (1)
- Probably yes (2)
- Might or might not (3)
- Probably not (4)
- Definitely not (5)

Q5 Did the SDPI approach make you more curious about the content taught in class?

- Definitely yes. By looking at the content that was not explained, I became curious about the content. (1)
- Probably yes (2)
- Might or might not (3)
- Probably not (4)
- Definitely not (5)

Q6 Did the SDPI approach made you pay attention to the material being presented?

- Definitely yes (1)
- Probably yes (2)
- Might or might not (3)
- Probably not (4)
- Definitely not (5)

Q6 Given an option, what mode of instruction would you prefer for this course?

- ○ The SDPI approach wherein the instructor shows you material, and let you begin asking questions to accommodate everyone's questions and curiosity levels. (1)
- ○ The traditional approach wherein the instructor explains the content, and then they proceed to ask you questions about the content just explained. (2)
- ○ No preference (3)

Q7 According to you, what changes should be made to the SDPI format to improve it further?

____

____

____

____

____

End of Block: Questions

APPENDIX C

Analysis of Variance Results

F-statistic value = 11.44715

P-value = 0.00191

Data Summary				
Groups	N	Mean	Std. Dev.	Std. Error
Group 1	13	1.75	1.493	0.4141
Group 2	21	3.8929	1.9535	0.4263

ANOVA Summary					
Source	Degrees of Freedom DF	Sum of Squares SS	Mean Square MS	F-Stat	P-Value
Between Groups	1	36.8712	36.8712	11.4472	0.0019
Within Groups	32	103.0718	3.221		
Total:	33	139.9431			

Figure 7: ANOVA for no. of questions asked in the control and experimental (SDPI) groups

Analysis of Variance Results

F-statistic value = 3.76481

P-value = 0.0612

Data Summary				
Groups	N	Mean	Std. Dev.	Std. Error
Group 1	13	1.5577	0.785	0.2177
Group 2	21	2.1667	0.9465	0.2065

ANOVA Summary					
Source	Degrees of Freedom DF	Sum of Squares SS	Mean Square MS	F-Stat	P-Value
Between Groups	1	2.978	2.978	3.7648	0.0612
Within Groups	32	25.3119	0.791		
Total:	33	28.2899			

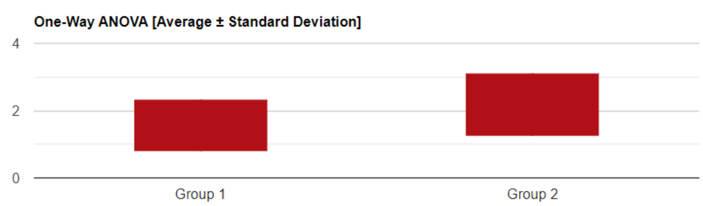


Figure 8: ANOVA for no. of instructor contacts in the control and experimental (SDPI) groups

Analysis of Variance Results

F-statistic value = 0.13262

P-value = 0.72517

Data Summary				
Groups	N	Mean	Std. Dev.	Std. Error
Group 1	5	26.786	7.0451	3.1507
Group 2	5	28.324	6.2887	2.8124

ANOVA Summary					
Source	Degrees of Freedom DF	Sum of Squares SS	Mean Square MS	F-Stat	P-Value
Between Groups	1	5.9136	5.9136	0.1326	0.7252
Within Groups	8	356.7247	44.5906		
Total:	9	362.6383			

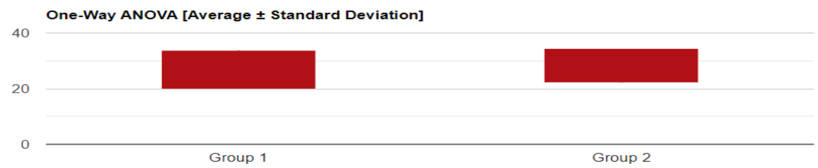


Figure 9: ANOVA for no. average quiz scores obtained in the control and experimental (SDPI) groups

Investigating FinTech Education and Training in Australian Universities

Pak-Lok Poon
p.poon@cqu.edu.au

Santoso Wibowo
s.wibowo1@cqu.edu.au

Srimannarayana Grandhi
s.grandhi@cqu.edu.au

Sau-Fun Tang
s.tang@cqu.edu.au

School of Engineering and Technology
Central Queensland University
Melbourne VIC 3000, Australia

Abstract

For more than a decade, the Financial Technology (FinTech) industry has been growing, and it has reshaped how payments were made and brought new financial service products to the market. FinTech has created innovative disruptions to traditional, long-established financial institutions (e.g., banks and investment firms) in financial services markets. The worldwide blooming of FinTech has caused universities around the globe to teach their students (particularly those in the IT and finance disciplines) about practical and contemporary knowledge on FinTech. This paper discusses our recent survey study to investigate the status quo of offering FinTech education and training by Australian universities. Our study involved two rounds of online data collection (one in November 2021 and the other one in June 2022) from 41 sample universities in Australia. Among our various findings, we observed that, although Australian universities are increasingly aware of the importance of and the demand for FinTech studies, FinTech has still not yet become a mainstream study discipline. This observation indicates that, in Australia, FinTech studies have generally gone through the inception stage and entered the growth stage.

Keywords: financial technology, FinTech, disruptive technology, business innovation, university-industry collaboration, tertiary education.

Recommended Citation: Poon, P.-L., Wibowo, S., Grandhi, S., Tang, S.-F., (2024). Investigating FinTech Education and Training in Australian Universities. *Information Systems Education Journal,* 22(1), pp.30-40. https://doi.org/10.62273/SCRE3126

Investigating FinTech Education and Training in Australian Universities

1. INTRODUCTION

From a business perspective, *Financial Technology (FinTech)* refers to a collection of technologically enabled financial innovations that result in new business models, applications, processes, or products in financial markets and institutions (Lechman & Marszk, 2019; Leong & Sung, 2018; Mention, 2021). Nowadays, FinTech has become a set of emerging and disruptive technologies in the financial services industry (Alt, Beck, & Smits, 2018; Gomber, Koch, & Siering, 2017; Iman, 2020; PwC Australia, 2017; Vermeulen, 2017; Zavolokina, Dolata, & Schwabe, 2016). FinTech, such as automatic teller machines (ATM), Bloomberg, and the SWIFT (Society for Worldwide Interbank Financial Telecommunications) system have been around for decades, but only over the last few years they have revolutionized the way people interact with financial services (Mention, 2021; Pousttchi & Dehnert, 2018; Puschmann, 2017). Artificial intelligence (AI), big data, blockchain, cloud computing, Internet of Things (IoT), open source software (OSS), software-as-a-service (SaaS), serverless architecture, no-code (or low-code) development platform, and hyper automation are often described as the most disrupting technologies in FinTech (Fong, Han, Liu, Qu, & Shek, 2021).

As of July 2023, public traded FinTech firms represented a market capitalization of $550 billion (McKinsey & Company, 2023). Also, as of the same period, there were more than 272 FinTech unicorns, with a combined valuation of $936 billion, representing a sevenfold increase from 39 firms valued at $1 billion or more five years ago (McKinsey & Company, 2023).

Due to the tremendous growth of FinTech, many universities around the globe have recognized the need for FinTech preparedness of their students, and have responded by offering related education and training (see endnote 1) (Earls, 2019; Poon, Pond, & Tang, 2024; Sung, Leong, Sironi, O'Reilly, & McMillan, 2019; University of Sussex, 2021). (To avoid verbosity, when appropriate, we will collectively refer to education and training as "study" or "studies".) In the U.S. and the U.K., driven by student and industry demands, leading business schools in top-tier educational institutions (e.g., Harvard University, Stanford University, New York University, Columbia University, University of Pennsylvania, Massachusetts Institute of Technology, University of Cambridge, University of Oxford, Imperial College London, London School of Economics, and University College London) are now offering FinTech studies to their students. In the past, students were longing to go into investment banking or in the trading side, but now many of them are more interested in business innovation (e.g., FinTech) (Irrera, 2017).

Australian universities are no exception. Nowadays, a number of Australian universities have started to offer FinTech studies to catch this "tech wave". This paper describes our recent survey to investigate how Australian universities offer FinTech studies with a view to equipping our society with the related skills and knowledge.

2. LITERATURE REVIEW

Milner, Thomas, Kobbe, Fowler, Cardon, and Marshall (2023) performed a study in the U.S. They found that most U.S. universities/colleges did not offer undergraduate or postgraduate FinTech education despite 95% of survey respondents reporting that they considered students had a great interest in FinTech education. Milner et al. (2023) also found that most FinTech classes are taught by the Finance departments at the surveyed universities/ colleges, followed by Information Systems departments.

An alumni survey found that: (a) many U.S. business schools do not teach FinTech at all, and (b) for those schools teaching FinTech, they do not teach well (Barrett, 2018). A major reason contributing to this phenomenon is that many business schools have a misunderstanding of FinTech — they think that FinTech is really just about writing apps (Barrett, 2018). Such misunderstanding causes these business schools simply steer clear of FinTech.

Earls (2019) observed that the majority of the existing university FinTech programmes in the U.S. have focused on regulation, security, and understanding the impact of technology on the market. This "high-level" approach does not cover individual technologies in detail, leaving students to learn on the jobs or pursue additional elective coursework.

3. STUDY SETTINGS

Research Questions

Our study focused on the following six research questions:

RQ1: How many Australian universities are offering FinTech studies?

RQ2: For those Australian universities with FinTech studies, what are their offering modes and levels?

RQ3: For those FinTech education programmes, what are their entry requirements?

RQ4: For those FinTech education programmes, what are their programme outcomes?

RQ5: What are the underlying support mechanisms and infrastructures in those universities with FinTech studies?

RQ6: Who are the industrial sponsors or partners associated with the university's FinTech studies?

For the rest of the paper, universities which offer FinTech studies will simply be referred to as "offering universities".

Sample Universities and Data Collection

Our study covered all the universities in Australia but excluded the University of Divinity, which only focuses on offering education on theology, philosophy, and ministry without any relationship with FinTech. After filtering this university, 41 sample universities remained in our study (this includes the Carnegie Mellon University's South Australia campus). Their geographical distributions across different regions (states and territories) of Australia are shown in Table 1 (see endnote 2):

Region	Numbers of Sample Universities
Australian Capital Territory (ACT)	2
New South Wales (NSW)	10
Northern Territory (NT)	1
Queensland (QLD)	8
South Australia (SA)	5
Tasmania (TAS)	1
Victoria (VIC)	8
Western Australia (WA)	5
National (NAT)	1

Table 1: Geographical distributions of sample universities

Information about FinTech studies and research was collected online from each university's website twice (first in November 2021 and then in June 2022) for detailed analysis (see endnote 3). We found that both sets of information were the same with respect to the six research questions (RQ1 to RQ6) stated above.

4. DESCRIPTIVE STATISTICS

RQ1: Number of Offering Universities

Among the 41 sample universities, 16 (39%) of them are offering FinTech studies to various extent. When counting, we adopted the following guidelines:

- A unit (see endnote 4) would only be considered as FinTech-related if it involves teaching technologies in the *specific context of finance or financial services*. If, however, a unit teaches technologies (such as AI, blockchain, or big data) only in a general business context, it would not be considered as FinTech-related.
- A unit would only be considered as FinTech-related if at least a large part of it (rather than just one or two single topics) is related to FinTech.

Across Australia, more than one-third (39%) of the sample universities have recognized the importance of FinTech and responded with this by offering FinTech-related studies. The breakdown of these offering universities into different regions is shown in Table 2.

Region	No. (%) of Offering Universities	Region	No. (%) of Offering Universities
ACT	0 out of 2 (0%)	TAS	0 out of 1 (0%)
NSW	4 out of 10 (40%)	VIC	7 out of 8 (88%)
NT	0 out of 1 (0%)	WA	1 out of 5 (20%)
QLD	3 out of 8 (38%)	NAT	1 out of 1 (100%)
SA	0 out of 5 (0%)		

Table 2: Geographical Locations of Offering Universities

If we ignore the NAT region with only one (offering) university (Australian Catholic University (ACU)), Table 2 shows that the two regions with the highest percentages of offering universities are VIC (88%) and NSW (40%). A plausible reason for this observation is that Melbourne and Sydney are the two largest Australian cities and financial hubs (Heussler, 2017), and they are located in VIC and NSW, respectively. Thus, it is not difficult to see why relatively high percentages of universities in VIC and NSW are offering FinTech studies. With respect to Table 2, we can generalize our observation as follows: ***If a city (or region) has better financial development, those universities in that city (or region) are more likely to offer FinTech studies.***

RQ2: Offering Models and Levels

Among the 16 offering universities in Table 2, we analyzed in detail about their offering modes and levels. Only two of them (one in VIC and one in QLD) offer short professional/executive *training* courses on FinTech to industry practitioners. The design of these two training courses is largely different as shown in Table 3.

Offering University	Course Duration	Target Students
The one in VIC	24 weeks	Anyone who is interested in FinTech
The one in QLD	3 days	Managers who are currently working in the FinTech area or are interested to start the FinTech career

Table 3: Professional/Executive Training Courses on FinTech

All the 16 offering universities provide FinTech *education* at least at one of the following three levels: unit, specialization (or minor), and degree (or major). Table 4 shows the number of universities offering FinTech education at the specialization and degree levels. This table shows that, overall, only small percentages of the offering universities provide FinTech education at the specialization (= 2/16 = 12.5%) or degree level (= 4/16 = 25.0%).

Region	No. of Offering Universities	No. (%) of Universities Offering FinTech Education at:	
		Specialization (or Minor) Level	Degree (or Major) Level
NSW	4	1 (25%)	1 (25%)
QLD	3	1 (33%)	2 (66%)
VIC	7	0 (0%)	1 (14%)
WA	1	0 (0%)	0 (0%)
NAT	1	0 (0%)	0 (0%)

Table 4: FinTech Education at Specialization and Degree Levels

Table 4 shows that only four FinTech degrees are offered in Australia. Furthermore, all these four degrees are at the master's or graduate-diploma level (see endnote 5). We further observed that all but one offering university provide their FinTech master's degrees and graduate diplomas on-campus or in a blended mode. Only one offering university offers an entire online master's degree and graduate diploma in FinTech.

The need and effectiveness of online studies are often subject to debate (Cacault, Hildebrand, Laurent-Lucchetti, & Pellizzari, 2021). Those proponents of online study argue that online students participate in exactly the same classes as on-campus students, so the learning outcomes of online study should not be inferior to those of on-campus study. These proponents also argue that, without online study, many students will be unable to receive college education due to their full-time jobs. However, other people argue that students studying for a degree involving a significant "technical" component (e.g., FinTech) need hands-on practice in a (FinTech) laboratory in the university campus, and acquiring this practice is not feasible for online students.

RQ3: Entry requirements

For three out of the four FinTech master's degrees (and their associated graduate diplomas) offered in Australia, the only prerequisite of entrance is a recognized undergraduate degree of *any* discipline (i.e., not necessarily finance or IT). In some sense, this "generic" prerequisite is not consistent with the fact that FinTech is an interdisciplinary area between finance and IT. Whereas for the remaining master's degree/ graduate diploma:

- either the applicants must have a recognized undergraduate degree in Finance and/or IT; or
- the applicants must have a recognized undergraduate degree in any discipline and have successfully passed the Level I examinations for the Chartered Financial Analyst (CFA) program administrated by the CFA Institute.

RQ4: Programme Outcomes

We analyzed the programme outcomes of the four FinTech master's degrees and their associated graduate diplomas. The programme outcomes of most of these degrees/diplomas tend to lean to the business aspect rather than the technology aspect. Consider, for example, the following programme outcome of the FinTech postgraduate study offered by an offering university:

> "… provide you [students] with the confidence to *lead and innovate teams, start-ups and businesses* … will also gain an *understanding of relevant frameworks* and what it means to be an ethical professional in a disruptive and innovative industry, and establish a competitive career advantage within this lucrative and evolving industry (UNSW, n.d.)."

We speculate that the main reason for the above phenomenon is that the curricula of most FinTech master's degrees/graduate diplomas are primarily designed for (non-technical) business or finance professionals who want to start or advance their FinTech career. This explains why the programme outcomes of these master's degrees/graduate diplomas tend to lean to the business aspect. For those technical-oriented students or professionals who want to study for a degree related to FinTech, they may prefer a more technical one such as a Bachelor of Blockchain Business or a Master of Cybersecurity. Although blockchain and cybersecurity are two core technologies underpinning FinTech, a degree specializing in these technical areas is not considered a FinTech degree in this study.

RQ5: Underlying Support Mechanisms and Infrastructures

We analyzed this research question in three aspects: (a) the establishment of a professorship in FinTech; (b) the establishment of a FinTech research center; and (c) the setup of a FinTech supporting laboratory.

Among the 16 offering universities, we observed the following:

- None of them has established a professorship in FinTech. We argue that, if a university takes FinTech seriously, it will establish a professorship to lead the development (in terms of teaching and research) of this discipline.

  Note that we only counted "full" professorship, which is a level-E academic position in Australian universities. Visiting professors, emeritus professors, adjunct professors, and professorial fellows were excluded.
- Only three (one in QLD and two in VIC) offering universities have established a research center focusing on FinTech.
- Only two (one in QLD and one in VIC) offering universities have established a FinTech supporting laboratory. The offering university in VIC with a FinTech supporting laboratory is Monash University. This university collaborates with The Hong Kong Polytechnic University (in Hong Kong) and CollinStar Capital (a leading Melbourne-based institution and a FinTech expert in Australia) to establish a university-industry joint research laboratory on blockchain and cryptocurrency technologies.

RQ6: Industrial Sponsors or Partners

Business firms are often struggling to attain a competitive edge in this global market fostered by new economies of scale (Alonso, de Soria, Orue-Echevarria, & Vergara, 2010). To overcome this organizational challenge, many firms collaborate with universities as an imperative instrument to make the firms more innovative in business ideas (Awasthy, Flint, Sankarnarayana, & Jones, 2020). On the other hand, universities are also actively looking for industrial collaboration to ensure that their programmes stay relevant and leading edge (Ahmed, Fattani, Ali, & Enam, 2022).

Undoubtedly, when universities and the industry work together to push the frontiers of knowledge, they become a powerful engine for economic growth (Maddocks, 2020; Science/Business Innovation Board, 2012). Silicon Valley in the U.S. is a prominent example. Obviously, the merits of university-industry collaboration also apply to FinTech (IMC, 2023).

Among the 7 offering universities in VIC, we observed such university-industry collaboration in Swinburne University of Technology (SUT) and Monash University. SUT offers a Graduate Certificate and a Master of Financial Technologies. These two postgraduate programmes are co-developed and/or co-delivered with Bendigo Bank, Judo Bank, IBM, and Tableau. In both programmes, these industrial partners will host events, provide platforms and content, pose real-world challenges and applied projects, and bring in practicing professionals as speakers or guest lecturers. Also, as mentioned in our discussion of RQ5 above, Monash University has a partnership with CollinStar Capital when establishing its FinTech supporting laboratory.

A similar university-industry collaboration also exists in the University of New South Wales in NSW. This university is the only one in NSW which offers a Graduate Certificate, a Graduate Diploma, and a Master of Financial Technology, and these programmes are co-developed with industry experts in financial services.

Key Highlights from RQ1 to RQ6

All in all, we have two major observations:

(a) 16 (39%) of the samples are offering universities. This indicates that FinTech studies have generally gone through the inception stage and entered the growth stage (see endnote 6).

(b) Among the 16 offering universities, only few of them offer FinTech education at the specialization or degree level, and even fewer of them have an underlying support mechanism and infrastructure.

It can be concluded that, in the Australian university sector, FinTech has still not yet become a mainstream study per se. Instead, FinTech currently only serves as a "spin-off" discipline of some other traditional disciplines such as finance and financial services.

5. FURTHER OBSERVATIONS

Besides the findings discussed in Section 4, we further noted the following two interesting observations that are worth mentioning.

FinTech-related units: In Table 4, we analyzed the numbers and the percentages of sample universities which offer FinTech education at the specialization and degree levels. Here we focus on FinTech education at the unit level. Among all the FinTech-related units offered, more of them are at the postgraduate level than at the undergraduate level. Consider two examples. First, the 7 offering universities in VIC altogether offer a total of 4 and 13 FinTech-related units at the undergraduate and postgraduate levels, respectively. Second, the 4 offering universities in NSW only offer FinTech-related units at the postgraduate level. This observation is consistent with the general view that the curriculum and content of a postgraduate degree are more focused and specialized than an undergraduate degree (Maddocks, 2020).

Hosting schools: In almost all the offering universities, their FinTech education (at the unit, specialization, and degree levels) and training are offered or hosted by the business schools (e.g., finance) rather than by technical-oriented schools (e.g., information technology). This can be understood as FinTech is not a purely technical area, so people generally think that its teaching should be delivered by business-focused or financial-focused faculty members, who are often resided in business schools rather than in IT schools. However, Barrett (2018) observed that many faculty staff members of business schools find themselves not technically competent enough to teach the "technology" aspect of FinTech (which is new and ever-changing).

This above issue was also confirmed in our study, where several business faculty staff members involving in teaching FinTech told us that they often found it difficult to teach the "technical" aspects of FinTech (e.g., AI, machine learning, virtual reality, big data, blockchain, cryptography, cloud computing, and smart contract) because they do not possess sufficient technical knowledge for teaching. Some studies (Corbacho, Minini, Pereyra, González-Fernández, Echániz, Repetto, Cruz, Fernández-Damonte, Lorieto, & Basile, 2021; Jackson, Dunbar, Sarkis, & Sarnie, 2023) reported that "traditional" higher education structures with specialized disciplines hinder interdisciplinary collaboration. In any case, as FinTech education develops and matures, it would be wise for teaching collaboration between the business and IT faculties (Hendershott, Zhang, Zhao, & Zheng, 2021; Thomas & Milner, 2023).

6. RECOMMENDATIONS

Although FinTech is blooming, it is also facing a shortage of skills. Bridging or closing this gap requires a dedicated effort from both FinTech startups / incumbent firms and universities to make FinTech as visible and accessible as possible. Thus, not only Australian universities should offer more FinTech-related studies, but these studies should be co-developed and supported by industrial partners. There are several merits of this arrangement. First, it makes the content and the curriculum of a FinTech course more industrially relevant and, hence, increase the employability of the graduates. Second, the industrial partners can send in some of their employees to serve as guest speakers, and can bring in some of their real-life projects for the students to work on. Third, the industrial partners can offer internship opportunities to FinTech students.

Recently, we observed that AI and machine learning has been widely used in various financial services applications such as fraud and compliance (Buchanan & Wright, 2021). This FinTech business model is known as *Regulatory Technology* (*RegTech*), which refers to the application of emerging technologies (e.g., AI, machine learning, and big data) to improve the way firms manage regulatory compliance (Becker, Merz, & Buchkremer, 2020; Institute of

International Finance, 2015). RegTech is argued to be a new and vital dimension of FinTech (Butler & O'Brien, 2019). Compared with other current innovations, RegTech is at an early stage of development in the industry (Institute of International Finance, 2016). Because RegTech involves a legal and regulatory element (Mallia-Dare & Meyer, 2020; Wang, 2019), some law faculty staff have been engaging in RegTech research/teaching. For example, the Faculty of Law of Monash University in Australia has established its Centre for Commercial Law and Regulatory Studies, whose one of its focuses is RegTech (Monash University, 2018). Thus, a comprehensive FinTech curriculum should have RegTech as one of its components, and teaching RegTech should be a joint effort among faculty staff members from the IT, business (including finance and accounting), and law disciplines (Al-Hudithi & Siddiqui, 2021; Karkkainen, Panos, Broby, & Bracciali, 2018; Molnár, Tarcsi, Baude, Pisoni, Ngo, & Massacci, 2020).

Nowadays, university job fairs have become regular events on campus. These events provide an excellent opportunity for students to interact and connect with the industry. It is recommended that more FinTech firms should participate in these job fairs. It is even better that more "specialized" job fairs should be organized exclusively for FinTech. This will make FinTech more visible to students.

Teaching FinTech is best supported by a laboratory or hub facility. Take Bond University in QLD as an example. Its business school has established a FinTech hub with 40 Bloomberg terminals and other trading facilities. Students have 24-hour access to Bloomberg's live financial market data. Students can also gain practical experience in executing deals, managing portfolios, and trading financial securities. Our survey found that only few Australian universities have established such laboratories or hub facilities to support their FinTech studies. Thus, it is recommended that more such facilities should be set up to complement FinTech studies.

In 2019–2020, there was a Savvy FinTech Scholarship open to all undergraduate and master's students majoring in commerce, banking, marketing, finance, accounting, actuarial studies, economics, or business studies. Similarly, since 2017, Spotcap (a FinTech firm offering digital-business lending technology to financial institutions) has been offering its FinTech scholarship to alleviate the talent shortage in the FinTech industry by fostering more home-grown expertise (Alois, 2018). But despite this, generally only a very limited number of FinTech scholarships are available and they come from the industry. It is advised that universities should also offer their own FinTech scholarships to promote FinTech education and to attract high-calibre students to this discipline.

7. STUDY LIMITATIONS

Ideally, all the data should be collected within a very short period in each of the two rounds for more accurate comparison and analysis. However, due to the large number of sample universities and related course/unit web pages, data collection spanned about one month to complete in each round (in November 2021 and June 2022). In principle, though unlikely, some changes could have happened in the course/unit web pages amidst our data collection work. We have, however, already made our best effort to shorten the data collection periods in order to minimize any effect that may invalidate the results of our study.

In addition, our study was solely based on the online data collected from the sample university's websites. It is possible that the contents of some of these websites are not up to date. We, however, argue that since our study involved two rounds of online data collection with an eight-month time gap, outdated web pages in the first-round data collection might have been updated by the relevant universities before the start of the second-round data collection. Nevertheless, even if there exist some web pages which were not updated in both rounds of data collection, our results still paint an overall picture of the current situation and development of FinTech studies offered by Australian universities.

8. CONCLUSION

In this paper, we have discussed our recent survey to investigate the current situation and development of FinTech studies offered by Australian universities. Our survey covered all Australian universities, except one which solely focuses on offering education on theology, philosophy, and ministry. On the one hand, our findings show that Australian universities are increasingly aware of the importance of and the demand for FinTech studies. On the other hand, FinTech has still not yet become a mainstream study discipline. Our findings also indicate that, in Australia, FinTech studies have generally gone through the inception stage and entered the growth stage. We recommend that more work and effort need to be put in by Australian universities and industrial partners to promote

FinTech studies and to equip our students with the necessary skills and knowledge for career opportunities in the growing FinTech industry.

9. ACKNOWLEDGEMENTS

This work was approved by the Human Research Ethics Committee at Central Queensland University (reference: 0000023455).

10. ENDNOTES

1. We use the term "education" to refer to studies leading to a formal academic qualification (e.g., a bachelor's degree, a graduate diploma, or a master's degree), and the term "training" to refer to short professional seminars or courses without leading to a formal academic qualification.

2. The geographic distribution of a university is determined based on the location of its head campus. Among these universities, the Australian Catholic University (ACU) does not have an explicit head campus in Australia. For the sake of analysis, we create a new region "national (NAT)" and assign ACU to this region.

3. We performed two rounds of data collection for our another FinTech project with the intention to investigate how FinTech studies offered by the Australian universities evolve over time.

4. In this paper, a *unit* is a syllabus item offered by a university (similar to a subject that students study at high school).

5. In most Australian universities, postgraduate students can choose to only study all the Year-1 units of a master's degree (which often involves two full years of study) and earn a graduate diploma as an exit path.

6. The inception stage roughly corresponds to the first (Innovators) and second (Early Adopters) adopter categories as defined in Rogers' Diffusion of Innovations Theory (DIT), whereas the growth stage roughly corresponds to the third adopter category (Early Majority) of DIT (Rogers, 2003).

11. REFERENCES

Ahmed, F., Fattani, M.T., Ali, S.R., & Enam, R.N. (2022). Strengthening the bridge between academic and the industry through the academia-industry collaboration plan design model. *Frontiers in Psychology*, *13*, 875940. https://doi.org/10.3389/fpsyg.2022.875940

Al-Hudithi, F., & Siddiqui, K. (2021). Designing the guidelines for FinTech curriculum. *Entreprenueurship and Sustainability Issues*, *9*(1), 633–643. https://doi.org/10.9770/jesi.2021.9.1(39)

Alois, J.D. (2018). *Spotcap awards first of its kind fintech scholarship in Australia.* Crowdfund Insider. Retrieved February 23, 2024 from https://www.crowdfundinsider.com/2018/02/128703-spotcap-awards-first-kind-fintech-scholarship-australia/

Alonso, J., de Soria, I.M., Orue-Echevarria, L., & Vergara, M. (2010). Enterprise collaboration maturity model (ECMM): Preliminary definition and future challenges. In K. Popplewell, J. Harding, R. Poler, & R. Chalmeta (Eds.), *Enterprise Interoperability* (pp. 429–438). London: Springer.

Alt, R., Beck, R., & Smits, M.T. (2018). FinTech and the transformation of the financial industry. *Electronic Markets*, *28*, 235–243. https://doi.org/10.1007/s12525-018-0310-9

Australian National Institute of Management & Commerce (IMC). (2023). *FinTech and the Digital Economy.* Retrieved February 23, 2024 from https://www.imc.edu.au/short-courses/micro-credentials

Awasthy, R., Flint, S., Sankarnarayana, R., & Jones, R.L. (2020). A framework to improve university-industry collaboration. *Journal of Industry-University Collaboration*, *2*(1), 49–62. https://doi.org/10.1108/JIUC-09-2019-0016

Barrett, H. (2018). *Business schools have a problem with fintech.* Financial Times. Retrieved February 23, 2024 from https://www.ft.com/content/e336d938-f7ca-11e7-a4c9-bbdefa4f210b

Becker, M., Merz, K., & Buchkremer, R. (2020). RegTech — The application of modern information technology in regulatory affairs: Areas of interest in research and practice. *Intelligent Systems in Accounting, Finance and Management: An International Journal*, *27*(4), 161–167. https://doi.org/10.1002/isaf.1479

Buchanan, B.G., & Wright, D. (2021). The impact of machine learning on UK financial services. *Oxford Review of Economic Policy*, *37*(3), 537–563. https://doi.org/10.1093/oxrep/grab016

Butler, T., & O'Brien, L. (2019). Understanding RegTech for digital regulatory compliance. In T. Lynn, J. Mooney, P. Rosati, & M. Cummins (Eds.), *Disrupting Finance* (pp. 85–102). Cham: Palgrave Pivot.

Cacault, M.P., Hildebrand, C., Laurent-Lucchetti, J., & Pellizzari, M. (2021). Distance learning in higher education: Evidence from a randomized experiment. *Journal of the European Economic Association*, *19*(4), 2322–2372. https://doi.org/10.1093/jeea/jvaa060

Corbacho, A.M., Minini, L., Pereyra, M., González-Fernández, A.E., Echániz, R., Repetto, L., Cruz, P., Fernández-Damonte, V., Lorieto, A., & Basile, M. (2021). Interdisciplinary higher education with a focus on academic motivation and teamwork diversity. *International Journal of Educational Research Open*, *2*, 100062. https://doi.org/10.1016/j.ijedro.2021.100062

Earls, E.M. (2019). *Preparing students for a future in Fintech: The role of Massachusetts public universities.* Retrieved February 23, 2024 from https://files.eric.ed.gov/fulltext/ED598543.pdf

Fong, D., Han, F., Liu, L., Qu, J., & Shek, A. (2021). *Seven technologies shaping the future of fintech.* McKinsey & Company. Retrieved February 23, 2024 from https://www.mckinsey.com/cn/our-insights/our-insights/seven-technologies-shaping-the-future-of-fintech

Gomber, P., Koch, J.-A., & Siering, M. (2017). Digital finance and FinTech: Current research and future research directions. *Journal of Business Economics*, *87*, 537–580. https://doi.org/10.1007/s11573-017-0852-x

Hendershott, T., Zhang, X., Zhao, J.L., & Zheng, Z. (2021). FinTech as a game changer: Overview of research frontiers. *Information Systems Research*, *32*(1), 1–17. https://doi.org/10.1287/isre.2021.0997

Heussler, L. (2017). *How Australia's fintech sector differs from the UK.* Retrieved February 23, 2024 from https://www.fintechbusiness.com/blogs/659-how-australia-s-fintech-sector-differs-from-the-uk

Iman, N. (2020). The rise and rise of financial technology: The good, the bad, and the verdict. *Cogent Business and Management*, *7*(1), 1725309. https://doi.org/10.1080/23311975.2020.1725309

Institute of International Finance. (2015). *Regtech: Exploring solutions for regulatory challenges.* Retrieved February 23, 2024 from https://www.iif.com/Publications/ID/4229/Regtech-Exploring-Solutions-for-Regulatory-Challenges

Institute of International Finance. (2016). *Regtech in financial services: Technology solutions for compliance and reporting.* Retrieved February 23, 2024 from https://www.iif.com/Publications/ID/1686/Regtech-in-Financial-Services--Solutions-for-Compliance-and-Reporting

Irrera, A. (2017). *U.S. business schools embrace `fintech' as students clamor for courses.* Reuters. Retrieved February 23, 2024 from https://www.reuters.com/article/us-usa-students-fintech-idUSKBN18Z20C

Jackson, D., Dunbar, K., Sarkis, J., & Sarnie, R. (2023). Advancing Fintech through a transdisciplinary approach. *iScience*, *26*(9), 107694. https://doi.org/10.1016/j.isci.2023.107694

Karkkainen, T., Panos, G.A., Broby, D., & Bracciali, A. (2018). On the educational curriculum in finance and technology. In S. Diplaris, A. Satsiou, A. Følstad, M. Vafopoulos, & T. Vilarinho (Eds.), *Internet Science, Lecture Notes in Computer Science* (Vol. 10750, pp. 7–20). Cham: Springer.

Lechman, E., & Marszk, A. (2019). *ICT-Driven Economic and Financial Development: Analysis of European Countries.* Academic Press, London.

Leong, K., & Sung, A. (2018). FinTech (financial technology): What is it and how to use technologies to create business value in fintech ways? *International Journal of Innovation, Management and Technology*, *9*(2), 74–78. https://doi.org/10.18178/ijimt.2018.9.2.791

Maddocks, K.G. (2020). *What is the difference between bachelor's and master's degrees?* Southern New Hampshire University. Retrieved February 23, 2024 from https://www.snhu.edu/about-us/newsroom/education/difference-between-bachelors-and-masters

Mallia-Dare, M., & Meyer, B. (2020). *RegTech: How technology can revolutionize compliance.* Business Law Today. Retrieved February 23, 2024 from https://businesslawtoday.org/2020/03/regtech-technology-can-revolutionize-compliance/

McKinsey & Company. (2023). *Fintechs: A new paradigm of growth.* Retrieved February 23, 2024 from https://www.mckinsey.com/industries/financial-services/our-insights/fintechs-a-new-paradigm-of-growth

Mention, A.-L. (2021). The age of FinTech: Implications for research, policy and practice. *The Journal of FinTech*, *1*(1), 2050002. https://doi.org/10.1142/S2705109920500029

Milner, A.E., Thomas, M., Kobbe, E., Fowler, B., Cardon, P., & Marshall, B. (2023). Fintech curricula: A survey of IS, accounting, and finance department chairs. *Issues in Information Systems*, *24*(2), 220–231. https://doi.org/10.48009/2_iis_2023_119

Molnár, B., Tarcsi, Á., Baude, F., Pisoni, G., Ngo, C.N., & Massacci, F. (2020, November). Curriculum guidelines for new Fintech Master's Programmes. In *2020 18th International Conference on Emerging eLearning Technologies and Applications* (*ICETA*), Košice, Slovenia (pp. 470–474). Technical University of Košice.

Monash University. (2018). *Technological innovation in corporate financing: Regulatory challenges for the Fintech era.* Retrieved February 23, 2024 from https://www.monash.edu/law/research/excellence/clars/news-events/monash-law-symposium-technological-innovation-in-corporate-financing-regulatory-challenges-for-the-fintech-era

Poon, P.-L., N. Pond, & S.-F. Tang. (2024). Employment and career prospects of technical-oriented jobs in the FinTech market. *Journal of Information Systems Education*, *35*(2) (in press).

Pousttchi, K., & Dehnert, M. (2018). Exploring the digitalization impact on consumer decision-making in retail banking. *Electronic Markets*, *28*, 265–286. https://doi.org/10.1007/s12525-017-0283-0

Puschmann, T. (2017). Fintech. *Business and Information Systems Engineering*, *59*(1), 69–76. https://doi.org/10.1007/s12599-017-0464-6

PwC Australia. (2017). *Financial services is facing sweeping technological changes that are profoundly impacting the way you do business.* Retrieved February 23, 2024 from https://www.pwc.com.au/financial-services/fintech.html

Rogers, E.M. (2003). *Diffusion of Innovations* (5th edition). Free Press, New York.

Science/Business Innovation Board. (2012). *Making industry-university partnerships work: Lessons from successful collaborations.* Retrieved February 23, 2024 from http://sciencebusiness.net/sites/default/files/archive/Assets/94fe6d15-5432-4cf9-a656-633248e63541.pdf

Sung, A., Leong, K., Sironi, P., O'Reilly, T., & McMillan, A. (2019). An exploratory study of the FinTech (financial technology) education and retraining in UK. *Journal of Work-Applied Management*, *11*(2), 187–198. https://doi.org/10.1108/JWAM-06-2019-0020

Thomas, M. & Milner, A. (2023). *Fintech: How and is it being taught in academia?* Graduate Research Showcase, 92. Retrieved February 23, 2024 from https://kb.gcsu.edu/cgi/viewcontent.cgi?article=1115&context=grposters

University of New South Wales. (n.d.). *Master of Financial Technology (Online).* Retrieved February 23, 2024 from https://studyonline.unsw.edu.au/ppc/financial-technology?utm_campaign=MFinTech-Brand-BM-Financial-Technology&utm_source=Google&utm_medium=ppc&utm_term=%2Bunsw%20%2Bfinancial%20%2Btechnology&LeadChannel=PPC&LeadSource=Google&VendorAccountCampaignType=Search&Keyword=%2Bunsw%20%2Bfinancial%20%2Btechnology&CampaignSourceCode=MFinTech-Brand-BM-Financial-Technology&VendorId=7&gad=1&gclid=EAIaIQobChMInO-byoG7gQMVixJ7Bx2F DQ2HEAAYASAAEgIs9PD_BwE

University of Sussex. (2021). *Benefits of studying a FinTech degree.* Retrieved February 8, 2023 from https://isc.sussex.ac.uk/blog/benefits-of-studying-a-fintech-degree

Vermeulen, N. (2017). *Redrawing the lines: FinTech's growing influence on financial services.* PwC. Retrieved February 23, 2024 from https://www.pwc.com/jg/en/publications/pwc-global-fintech-report-17.3.17-final.pdf

Wang, A. (2019). The role of Regtech in augmenting regulatory compliance: Regulating technology, accountability and liability. *University of New South Wales Law Journal Student Series.* Retrieved February 23, 2024 from http://classic.austlii.edu.au/au/journals/UNSWLawJlStuS/2019/10.html

Zavolokina, L., Dolata, M., & Schwabe, G. (2016). The FinTech phenomenon: Antecedents of financial innovation perceived by the popular press. *Financial Innovation*, *2*, 16. https://doi.org/10.1186/s40854-016-0036-7

Editor's Note:

This paper was selected for inclusion in the journal as a 2023 ISCAP Conference Meritorious Paper. The acceptance rate is typically 15% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2023.

A Pragmatic Approach to Investigating the Digital Existence of Food Bank Users

Yaprak Dalat Ward
y_dalatward@fhsu.edu

James G. Ward
jgward@fhsu.edu

Fort Hays State University
Hays, KS 67601, USA

Li-Jen Lester
lester@shsu.edu
Sam Houston State University
Huntsville, TX 77341, USA

Abstract

This study investigated the digital existence of the food bank users in a university town in Texas, and subsequently, aligned with the research's pragmatic focus, the researchers designed a training model for these food bank users. Two research questions guided the study: What are the digital existence levels of the food bank users, and what training model would best serve these food bank users? Data were collected by means of a survey from 230 individual food bank users representing households. Additional data included observations and conversations with food bank staff, and documents and materials from the site which provided deeper insights. The study found that the food bank users 1) had little to no broadband connectivity; 2) possessed limited digital devices which revealed significant barriers to their digital existence; and 3) had feelings of desperation, vulnerability and isolation. Regarding training offered at no cost, the food bank users did not show much interest, which was attributed to the food bank users' insufficient digital knowledge. The three-level training model was designed with the following objectives: 1) Prepare participants for training; 2) introduce the concept of *digital;* and 3) teach basic computing and cybersecurity skills. To implement this training, an interactive learner-centric model was created demonstrating collaboration among university instructors, volunteer students and the food bank staff. The study concluded that to exist in digital societies affordable broadband connectivity, needs-based devices, and continual support and training were needed for such underserved groups.

Keywords: digital existence, underserved populations, training model, computing skills, cybersecurity, food insecure

Recommended Citation: Ward. Y.D., Ward, J., Lester, L., (2024). A Pragmatic Approach to Investigating the Digital Existence of Food Bank User. *Information Systems Education Journal,* 22(1), pp.41-52. https://doi.org/10.62273/YYEJ3977

A Pragmatic Approach to Investigating the Digital Existence of Food Bank Users

1. INTRODUCTION

Digital technologies dictate that organizations, public and private, become *technology takers*, defined as "assent to the behavior transforming benefits of modern technologies" (Flanding, Grabman, & Cox, 2019, p. xv). If organizations are unable to adopt and adapt to technological advancements by modifying behaviors (Flanding, Grabman, & Cox), dislocation becomes unavoidable. Similarly, individuals are likely to share the same fate if they are unable to keep pace with technologies.

Today, adopting and adapting to technology is no longer a one-time option but an iterative process which makes the "keeping up with the technology" process challenging, particularly for underserved populations with limited digital tools. As the gap between the digital haves and have nots continues to widen, the have nots are left to fend for their existence, often times waiting for a *warm expert* (Bakardjieva, 2005), a non-professional assisting the digitally poor, to come to their aid. In fact, not too long ago, the COVID-19 pandemic demonstrated how debilitating it was when left with little to no technology and no help. The pandemic lockdowns not only isolated people physically and mentally but also exacerbated the challenges faced by those with limited digital resources, causing additional distress. Added to the digital stress was yet another level of concern: To be able to survive as a human being by overcoming hunger and food scarcity.

Following the digital crisis of the pandemic, despite government plans in *broadband policy universal* and *universal access and service* (UAS) to be achieved by 2025, "the number of economies with a broadband plan has slightly decreased over the past year as plans have expired and haven't been renewed in some countries" (Broadband Commission for Sustainable Development, 2022, p. 20). These changes of plans result in limiting the underserved individuals' access to essential areas such as public services, education, employment, and citizenry (Broadband Commission for Sustainable Development; National Digital Inclusion Alliance [NDIA], 2023).

In addition, the issue of cybersecurity has also become more critical than ever no matter what the economic status of an individual is. In the case of the digitally poor, because "home computer systems are largely administered by end-users with little security knowledge" (Zang-Kennedy, Chiasson, & Biddle, 2016, p. 1), additional liabilities leave the socially underserved defenseless. In a survey taken by the underserved populations in the city and county of San Francisco found that "a large number of respondents were unable to comment on cybercrime impact because they did not understand basic cybersecurity concepts" (Sultan, 2023, p. 5).

The Significance of the Research

The significance of this research derived from two interrelated problems. First, an underserved group, food bank users, were experiencing hunger and food scarcity with unpredictable consequences. Second, left on their own, their "inability to interact with the online world fully, when where and how an individual needs to" (Digital Poverty Alliance, 2023, para.1) created obstacles for their existence.

At the time of this study, while many studies were available on topics such as digital divides, digital have and have nots, digitizing food banks, or how to train elderly in technologies, there was no research on food bank users and their digital situation inclusive of designing a pilot training model. This study aimed to fill this gap.

Based on the research problem, a food bank in a Texan town located near a research university was identified as the research site. The proximity was critical due to the training implementation plan which required the participation of instructors, students and food bank staff.

Further, because of the pragmatic focus of the study (Patton, 2015), it was important to understand the digital barriers of the food insecure to be able to develop a pilot training model with an implementation plan.

In this study, the United States Department of Homeland Security (2023), FEMA description of *underserved populations and communities* was utilized:

> People who are socioeconomically disadvantaged; people with limited English proficiency; geographically isolated or

educationally disenfranchised people; people of color as well as those of ethnic and national origin minorities; women and children; individuals with disabilities and others with access and functional needs; and seniors. (para, 1)

2. LITERATURE REVIEW

According to the 2021 UNESCO Science Report, "digital technologies are transforming society as we know it. This rapid upheaval has been termed the Fourth Industrial Revolution (or Industry 4.0)" (para. 2). While the world is "investing heavily in the digital economy" (UNESCO, 2023, para.10), there are organizations which are unable to adopt these technologies let alone adapt their behaviors to these changes. There are also minority groups who are left to survive on their own. One of the groups is the food insecure who not only experience hunger and food scarcity but also unpredictable consequences of such scarcity. When these individuals experience *digital poverty* (Digital Poverty Alliance, 2023), it also impacts their existing economic poverty. Unable to keep pace with the technological advances, they are affected in countless ways and unless the problem is taken care of, they continue to remain in poverty.

Digital Existence

There is no doubt that digital societies and modern economies depend on digitally competent citizens. Digital inclusion requires having affordable broadband connectivity, digital devices based on needs, access to technical support and training (NDIA, 2023). At present, the problems of affordable connectivity and basic computing skills for all citizens still continue to be a hindrance and still continue to be minimized or at best ignored, generating a new form of discrimination (Dalat Ward & Ar, 2023; George, Dalat Ward, & Jones, 2022).

While the issue of digital divide should be treated as an emergency by government change leaders, many proposals include long-term plans and do not go beyond future-oriented recommendations rather than urgent actions (Dalat Ward & Ar, 2023). One example is the 2021 the *American Jobs Plan* "a new infrastructure bill…$2 trillion over the next eight years…Part of the spending proposed in the bill is to go toward expanding broadband internet access" (Ross, 2021, p. 1). Another example is a recently reported NDIA plan: "Over 220 organizations around the country will soon have access to over $73 million in dedicated funds to help support outreach and enrollment in the Affordable Connectivity Program (ACP)" (Tesfaye, 2023, para. 1).

There is also a great concern when it comes to issues related to digital inequity and digital divide. These issues are considered a violation of human rights as declared by the United Nations General Assembly Human Rights Council: "*Emphasizing* that access to information on the Internet facilitates vast opportunities for affordable and inclusive education globally, thereby being an important tool to facilitate the promotion of the right to education, while underlining the need to address digital literacy and the digital divide, as it affects the enjoyment of the right to education…" (United Nations, 2016, p. 2). Reviewing the human rights issue from the *pyramid of digital needs* (Mheir, 2017) aspect, it is easy to see how digitally neglected the underserved populations are. Made up of five layers, and similar to *Maslow's Hierarchy of Needs* (Maslow, 2008), the needs range from basic digital needs (the bottom of the pyramid) to self-actualization (the tip of the pyramid). While the digitally privileged individuals, employed or not, are able to meet their digital needs with ease and move up the pyramid easily, the *digital have nots* are mostly bound to remain at the bottom layer of the pyramid unable to meet their basic digital needs such as "editing a document on a word processor, browsing the web, making a phone call…taking a digital picture or getting driving directions from…GPS" (Mheir, para. 1). It is critical that these needs be addressed so individuals can digitally exist effectively and efficiently and make the progress they want as citizens.

Food Insecurity

Digital divide impacts numerous underserved groups who also experience hunger and food insecurity. It is important to distinguish between the terms *hunger* and *food insecurity*.

According to the United States Department of Agriculture (USDA) Economic Research Service (2023) *hunger* and *food insecurity* are closely related, and while "hunger refers to a personal, physical sensation of discomfort, food insecurity refers to a lack of available financial resources for food at the level of the household" (para. 1). The food insecure are people whose "access to adequate food for active, healthy living is limited by lack of money and other resources" (USDA Economic Research Service, 2023, para.1). Similar descriptions are provided by the Food and Agriculture Organization (FAO) of the United Nations (2023) "while many people may not be 'hungry' in the sense that they are suffering physical discomfort caused by a severe lack of dietary energy, they may still be food insecure" and stresses the goal of making it imperative that "no one suffers from hunger" (para. 1).

Such insecurity can be incapacitating showing a myriad of effects on households and individuals in "coping mechanisms — such as choosing between paying for food and health care, or food and utilities" (Feeding Texas, 2023, para. 3). The alarming message is that personal food insecurity can lead to "damage to cognitive abilities and interference with growth in children and disease management in adults" (Feeding Texas, para. 3). Based on an individual's economic instability, individuals can move in and out of food insecurity which could cause additional levels of stress and trauma.

Coupled with hunger and unpredictability, trying to adopt and adapt to technological advancements can have debilitating effects leading to further isolation. When food insecure individuals are in a survivability mode, tackling unpredictability and economic instability, their adaptation to technologies cannot be their priority. Their concerns are to feed their family member(s) and deal with the stress that comes with the hunger. In fact, based on the 2021 USDA Economic Research Service data "10.2 percent of households were food insecure at least some time during the year, including 3.8 percent (5.1 million households) that had very low food security" (para. 2).

Regarding the general food insecurity in Texas, according to Feeding Texas (2023) data, "13% of Texas households — 1 in 8 Texans — experience food insecurity. That's 1.4 million Texas households and nearly 4 million individuals. Texas is one of just 9 states with higher food insecurity than the national average" (para. 1). Regarding children and elderly, these data reveal that 20% of household children experience hunger, 1 in 4 African American household children go hungry, 11% of households with seniors are food insecure. Moreover, rural communities are hit hard as well.

3. METHODOLOGY

This study had a pragmatic approach "to seek practical and useful answers that can solve, or at least provide direction in addressing concrete problems" (Patton, 2015, p. 152). The purpose was to investigate the digital existence of the food bank users in Texas and with a focus on "practical consequences and useful applications" (Patton, p. 152), design a pilot training model with an implementation plan.

The two core inquiry questions were: 1) What are the digital existence levels of the food bank users in Texas; and 2) What pilot training model would best serve these food bank users?

Research Site

First, because the purpose was to understand the digital existence of the food bank users, *purposeful sampling* (Creswell & Guetterman, 2019) was used. For this research, the criterion to identify participants was to identify groups who were food insecure. These groups were identified in a community food bank in a university town in Texas situated near a research university. One of the researchers was working at the nearby university which made it convenient for the study.

The food bank's proximity to the university was also critical. The food bank had just moved to a newly located site with added services and was open to innovative programs. Since implementing the training would require instructors and students to collaborate with the community bank, it would make it more convenient for the instructors and students to visit the bank.

The eligibility criteria for identifying this particular food bank included 1) the staff being able to work with the researchers and discuss the general demographics of the food bank users without revealing their identities; 2) being able to distribute a survey to the food bank users; 3) being open to holding training sessions with the help of instructors, volunteer students and food bank staff; 4) having a dedicated physical space in the food bank for training; and 5) having at least 10 computers to be used for training. Once the food bank was confirmed for appropriateness and accessibility, permission was obtained for the study.

The town where the foodbank and university were located, had a population of 45, 941 according to the 2020 Decennial Census (United States Census Bureau, 2023). The two largest employers of the town were 1) the Texas Department of Criminal Justice with 4, 372 employees; and 2) the university with 2, 417 employees. It is important to note that many of the food bank users were unable to find well-paid jobs due to their low levels of education and lack of digital skills.

Population

The individuals using the food bank services were considered *food insecure* (FAO of the United Nations, 2023), defined as part of a socioeconomically disadvantaged group fighting hunger and food scarcity.

All food bank users were required to register prior to receiving services and the director had access to their information. The director provided the researchers with general information on the demographics of the food bank users without revealing their identities. One insight was that the food bank users were economically and socially disadvantaged and appeared to be digitally poor, "the inability to interact with the online world fully, when where and how an individual needs to" (Digital Poverty Alliance, 2023, para. 3.).

Because the town had seven prison units (minimum and maximum security), the researchers were informed by the food bank staff that many of the food bank users had an incarcerated family member or two serving time in one of the units (Huntsville City Gov.,2023).

Data Collection

First, a survey was developed to collect both numerical and textual data to investigate the digital existence of the food bank users. In addition to the survey, the principal researcher was able to visit the site multiple times and gain deeper understanding by means of observations, conversations, documents and audiovisual materials. Finally, based on these data, a training model was developed.

Survey: A paper survey (Appendix A) was developed by the researchers and consisted of three sections. The aim of the survey was to collect data on the digital existence of the food bank users as well as identify their training needs which would answer the two core questions: 1) What are the digital existence levels of the food users in Texas and what can be learned? 2) What training model would best serve these food bank users?

The first two sections of the survey were made up of checklists and the third section, entitled, "other," required textual responses. The reason for using checklists for the survey was for the participants to respond with ease and to be able to increase the return rate of the survey.

The first section asked individuals to report the number of digital devices in their households including television, cellular phone, desktop computer, laptop computer, tablet and printer, and access to the Internet.

The second section listed the training opportunities offered at no cost for both adults and children at the foodbank site. This section entailed marking the opportunities which they needed and/or wanted depending on their household needs. For adults, the following opportunities were listed on the survey: 1) *Computing Fundamental Workshop: Emailing, Microsoft Office Suite (Word, Excel, PowerPoint)*; and 2) *Don't Be a Cybersecurity Victim; 3) Save money – Building a Computer.* For children, the opportunities were as follows:1) *Building a Robot*; 2) *Flying a Drone*; and 3) *Be a Cybersecurity Investigator!*

The third section of the survey, "other," was left blank for participants to fill out – whatever they wanted to share and convey.

Additional Data: Additional data collection was made up of observations (field notes), conversations (the food bank director, staff), documents (notes from electronic exchanges and meetings), audiovisual materials (photographs, videos from the site, newspaper clippings) (Creswell & Guetterman, 2019).

4. FINDINGS

Survey

A total of 230 individuals representing households completed the survey. Based on the responses, 76% households had cellular phones; 56% owned televisions; 18% had desktop computers; 24% had laptop computers; 21% had tablets; 17% had printers in their homes; and finally, 30% of households had Internet connectivity (Table 1). It was noteworthy that all households surveyed had access to at least one of the listed devices.

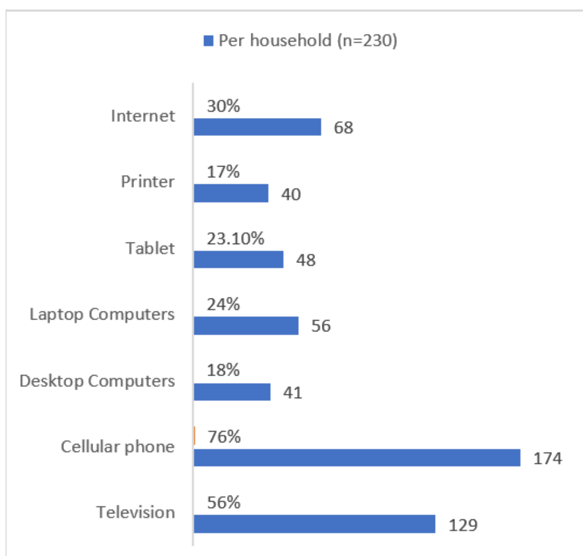


Table 1. Devices / Access per Household

The second section of the survey revealed significantly low interest levels in training for both adults and children. Data revealed that 36% individuals expressed interest in a session entitled *Computing Fundamental Workshop: Emailing, Microsoft Office Suite (Word, Excel, PowerPoint)*; 16% were interested in a session entitled *Don't Be a Cybersecurity Victim*; and 11% were interested in a session entitled *Save Money-Building A Computer* (Table 3). The low interest levels in training opportunities were attributed to limited levels of digital knowledge and the concept of digital.

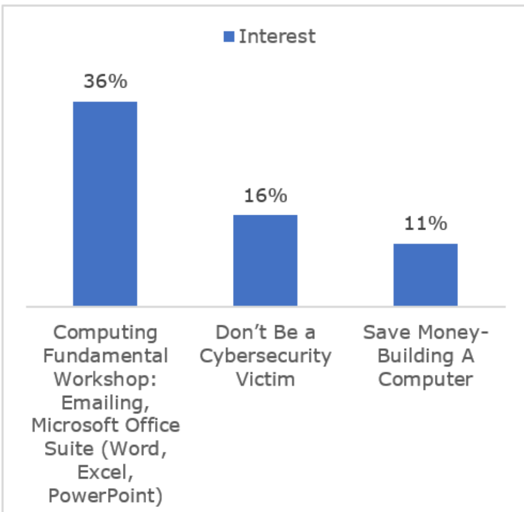


Table 2. Adult Training Interest

The adults responding on behalf of their children indicated that only 7.4% of their children were interested in a session entitled *Building a Robot*; 4.8% were interested in *Flying a Drone*; and 1.7% were interested in a session entitled *Be a Cybersecurity Investigator!* (Table 4). Low interest levels in the training opportunities were attributed to participants' limited levels of digital knowledge.

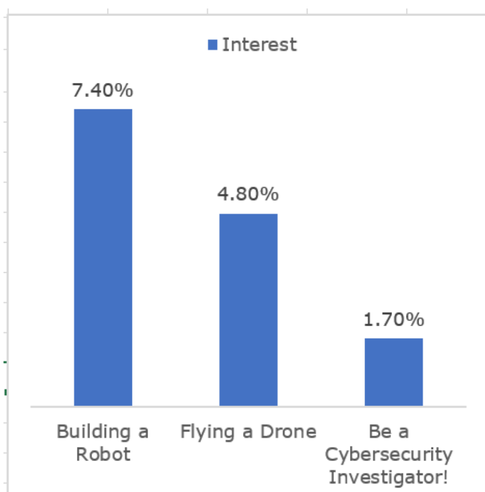


Table 3. Children Training Interest

In the "other" section of the survey, in which participants revealed their thoughts, a total of 32 responses were received. Knowing the context in which these words appeared, working independently, each researcher used the *key-word-in-context* (KWIC) method which "entailed locating all occurrences of particular word or phrases in the text" (Guest, MacQueen, & Namey, 2012, p. 10). These responses were *less structured elicited free-flowing texts* (Guest, MacQueen, & Namey). In a way these words and phrases were similar to a telegraphic speech used by children acquiring their first language described as: "…a concise message characterized by the use of three-word short phrases or sentences made up of main content words such as nouns and verbs and void of function words and grammatical morphemes" (Gabig, 2013, p. 2076).

To secure reliability, once the researchers completed their individual analysis, they used the *member checking* (Creswell & Guetterman, 2019) technique to discuss and confirm their individual thematic analysis. Based on the consensus, the researchers agreed on three groups of emotions including desperation, vulnerability, isolation. The researchers also agreed that these responses were symptoms of hopelessness and revealed warning signs, describing a threatening situation (Frijda, 1986).

Additional Data

One of the researchers was able to observe the site and the food bank users. The site was new and was open to innovations. The site also had a room with computers (donated by a tech company) and could be used for training. Based on the conversations at the research site, the researcher was able to gain a deeper understanding of the food bank. Although not planned, one of the researchers was also able to talk to a few food bank users who confirmed the desperate situation. As young families, they mentioned their frustration and hardship of not having access to the Internet and not being able to afford the devices their families needed. Additionally, the conversations gave information on the modus operandi of the organization, their new location, their services and their concerns. Furthermore, phone calls and emails with the food bank director all confirmed the digital poverty levels of the food bank users and the necessity of training. The local newspaper also covered the training plan in collaboration with the university and published an article with the following headlines, *Local food bank finds new* *location, services*" (Mullins, 2023). This researcher also prepared a video recording of the training room with 12 computers connected to a network.

These additional data further guided the design of the training model. Rather than directly starting with basic computing and cyber security skills, it became clear that preparing the individuals mentally and motivating them was critical for their readiness.

5. TRAINING MODEL

Subsequently, acting on the practical value of the research, a three-level training model (Table 4) was designed to serve the food bank users. This model would be piloted and consequently, improvements would be made so that it would serve as a sustainable training model for this food bank and be shared with other food banks. This goal was also supported by one of the United Nations Sustainable Development Goals (SDGs), "Goal 4: Quality Education. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, Department of Economic and Social Affairs, 2023, para 1).

Sessions	Training Topics + Duration
Session 1 **Engaging** - preparing the participants for readiness	Profile information + Needs Value-focused thinking Motivational beliefs and emotions Behavioral changes (minimum 4 hours)
Session 2 **Framing** - the meaning of digital	Digital terminology Digital needs (minimum 5 hours)
Session 3 **Shifting** - adopting and adapting to technology	Basic computing (Microsoft Suites) Cybercrime /cybersecurity (minimum 15 hours)

Table 4. Training Model for Food Bank Users

The first level of the training model would prepare the participants for the training and was entitled "Engaging." The goal was to prepare the participants to adopt and adapt to technologies (Flanding, Grabman, & Cox, 2019). At this level, the participants would be encouraged to know the reasons for the training so they could "jump in enthusiastically" (Place, 2018, para. 4) and become intrinsically motivated rather than be obligated to attend in order to receive food services. The aim of this level was to cover profile information, personal needs, *value-focused thinking* (Keeney, 1992, p. 5), *motivational beliefs and emotion* (Boekaerts, 2010), and *behavioral changes* (Schöner & Kelso, 1988). Behavior changes were particularly critical in the context of adapting to technologies.

The second level of training was entitled "Framing" and entailed understanding the concept of "digital" including digital terminology and digital needs. The aim was to bring awareness to the digital existence levels of the participants. This would enable them to understand their digital existence and to identify their needs.

The third level of training was entitled "Shifting" and intended to cover the basic computer skills together with the meaning of cybercrime and cybersecurity. It was important to make participants aware of cyber-crimes and develop their cyber security skills to protect them and their family members. Giving them the confidence was fundamental. According to Ahmad Sultan (2023) "Research and government intervention efforts aimed at improving online security have not effectively reached underserved populations" (p. 23). The report stressed an important point regarding the underserved populations who "suffer from poor cybersecurity outcomes, including being victimized by cyber-scams and avoiding the use of online services due to the threat of cybercrime (p. 23).

Moreover, the training would also offer the option of building computers since building one's computer is "often cheaper than buying a readymade one, because you can focus on the features you do need and leave out the ones that you don't" (Nield, 2023, para. 2). In addition, research indicates that there is an *educational value* in putting together a computer as confirmed by Nield "Spending time putting together has the added benefit of giving you a great insight into the inner workings of a PC -- by the time you've finished, you'll know the purpose of each internal component and how they all fit together through the motherboard" (para. 4).

The training model would be based on face-to-face sessions and stretched out to four to five days to give the participants ample time to digest new knowledge and make sense of their repeated firsthand experiences. There was no budget planned for the training as services were all donated.

The Implementation Plan

The implementation plan was based on an interactive learner-centric model (Figure 1) developed by the researchers. The model showed a partnership between instructors and students from the nearby research university and the food bank staff. The model was based on collaboration and encouraged all three groups to work towards concentrating on social injustice issues related to the food bank users. The food bank users were located in the center of the implementation model as the focus of the training. Instructors, volunteer students, and food bank staff were located as service providers continually collaborating with each other.

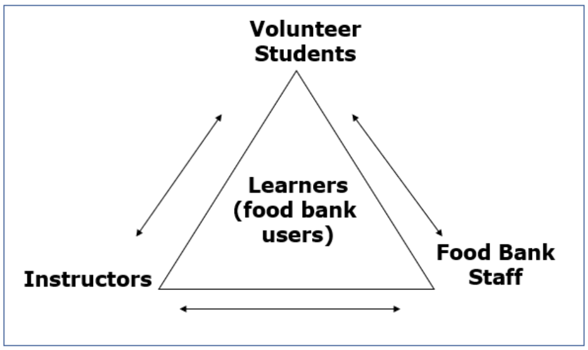


Figure 1. Interactive Learner-centric Model

For the instructors, this training would serve as a community service, as part of the academic tripartite model including teaching, scholarship, and service. For students, it would be part of their service learning (SL) defined as "a vehicle for connecting students and institutions to their communities and the larger social good, while at the same time instilling in students the values of community and social responsibility" (Neururer & Rhoads, 1998, p. 321).

The role of the instructors would be to train and coach the students and supervise their training. They would also provide feedback and guidance to the food bank staff. Student who wanted to volunteer would be open to various majors such as Computer Science, Informatics, Counseling, Education, Psychology, Social Work, Sociology and other related fields. As service providers, students would conduct the training, act as coaches to the participants as well as serve as go-to-persons. The third group in the interactive model was the food bank staff who would continually liaise with the instructors and students. Additionally, they would oversee SL activities.

Training volunteer students for their roles was also fundamental. This would provide students with an awareness of the context, for authentic relationships, and for active learning conversations (ALCs), defined as "an approach to working with and developing people that uses work on an actual project or problem and learn how to learn from their action" (Yorks, O'Neil, & Marsick, 1999, p. 3). Moreover, a community activity such as this one would promote change for students defined as *transformative learning* (Mezirow & Taylor, and Associates, 2009): "an approach to teaching based on promoting change, where educators challenge learners to critically question and the integrity of their deeply held assumptions about how they relate to the world around them" (p. ix).

Training students would include the following learning objectives: 1) understand service learning, active learning and transformative learning, 2) discover self-awareness, 3) develop intercultural communication, 4) explain and analyze the culture of food insecure, 5) recognize and develop cognitive and affective empathy, and 6) understand "mind, brain, education" (Tokuhama-Espinosa, 2010).

Following training, upon measuring the impact and discussing the consequences, the long-term goal would be to sustain an active training program; maintain collaboration between the university and the community by means of community service and service learning. This goal would also help support the United Nations *Sustainable Development Goal 4: Quality Education* (United Nations, Department of Economic and Social Affairs, 2023).

Authors' Note: After this paper was submitted for review, one of the authors conducted a pilot session to train three participants at the site of the food bank. Two students served as trainers and one author who was the instructor served as their guide and mentor. The session aimed to assess the effectiveness and reception of the training approach. Feedback from the attendees indicated that the session was an eye-opener, significantly boosting morale and instilling a sense of hope. Following this positive response, the authors are planning to proceed with the full training implementation in the near future. Furthermore, based on this experience, the authors will be writing a paper to document and share insights gained from the full training implementation.

The Training Site

The food bank would serve as the training site for both the students and the food bank users. For the food bank users, it was convenient to have the training in the same building where they received services.

For the volunteer students, based on SL, it was essential to work in a real-life setting away from their classrooms. An active participation in such an environment would help students make more sense of their actions, promoting reflections.

Because the training room had 12 computers (Figure 2), it was essential to start with small groups, cohorts of 12. Small groups would allow the trainers to encourage more interactions and attend closely to the needs of the participants.

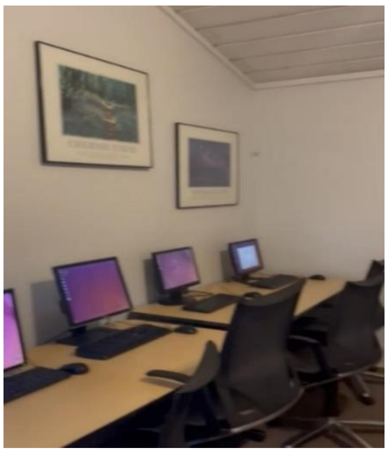


Figure 2. Partial View/Training Site

6. CONCLUSIONS

This study highlighted the importance of bridging the digital divide and ensuring that all underserved individuals, regardless of their location and situation have equal access to technological resources and opportunities. It acknowledged that technological progress should not exacerbate existing disparities but should instead strive for inclusivity and equality for all individuals.

First, prior to engaging in this study, while the researchers were aware of the issues related to digital inequity based on previous research, they were taken aback as they did not expect to find barriers to this extent, particularly one major barrier - limited and at times no access to the Internet in households. The implication of this barrier is such that not having access or having limited access to the internet can have unthinkable domino effects on the digital existence of such groups leading to risks in digital societies.

Second, prior to collecting data, the researchers developed a simple list of training opportunities with the assumption that the group could easily select their sessions based on their needs. However, they did not expect to find such low interest levels. This particular finding resulted in another significant implication, highlighting the fact that the participants were not able to select appropriate training as they did not have an awareness of their needs nor understood their gaps based on their close to-non-existent knowledge of advanced technology.

Third, while a few participants were grateful for the opportunities, many used phrases related to negative thoughts and feelings noted in the survey. This was expected due to the participants' ongoing unpredictability battle. However, noting words like isolation, vulnerability, desperation gave a deeper understanding of another level of threat. If a society ignores the well-being of its citizens, including their digital wellness, the results could threaten the wellness of the society as a whole.

To conclude, these findings emphasize the potential risks and challenges to present day digital societies. All recommendations and policy plans proposed by governments during the pandemic need to be urgently reevaluated and expeditated as technology continues to advance at an unprecedented pace with no breaks.

7. LIMITATIONS

This research was limited to one foodbank in a university town in Texas and therefore, the findings can only be generalized to similar contexts.

8. RECOMMENDED RESEARCH

Regarding further research, one recommendation would be to investigate other food banks, locally and globally, and compare findings. Another recommendation would be to investigate how universities could partner and collaborate with food banks to build sustainable training models to support and promote *Sustainable Development Goal 4: Quality Education* (United Nations, Department of Economic and Social Affairs, 2023, para 1).

9. REFERENCES

Bakardjieva, M. (2005). *Internet society: The Internet in everyday life*. SAGE Publications Ltd.

Boekaerts, M. (2010). The crucial role of motivation and emotion in classroom learning. In H. Dummont, D. Istance, & F. Benavides (Eds.), *The nature of learning: Using research to inspire practice*. OECD.

Broadband Commission for Sustainable Development. (2022). The State of Broadband report. https://broadbandcommission.org/report-type/state-of-broadband-report/

Creswell, J. W., & Guetterman, T.C. (2019). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research.* Pearson Education, Inc.

Dalat Ward, Y., & Ar, A. Y. (2023). The Digital (in)equity crisis during the COVID-19 Pandemic: Narratives from the field. In S. Maddanu & E. Toscano (Eds.), *Sociology of Pandemic: Inequalities, social justice and democracy.* Routledge.

Digital Poverty Alliance. (2023). How we define digital poverty. https://digitalpovertyalliance.org/

Feeding Texas. (2023). Hunger in Texas. https://www.feedingtexas.org/learn/hunger-in-texas/

Flanding, J. P., Grabman, G. M., & Cox, S. Q. (2019). *The technology takers: Leading change in the digital era*. Emerald Publishing.

Food and Agriculture Organization of the United Nations. (2023). Hunger and food insecurity. https://www.fao.org/hunger/en/

Fridja, N. H. (1986). *The emotions*. Cambridge University Press.

Gabig, C. S. (2013). Telegraphic Speech. In: Volkmar, F.R. (eds) Encyclopedia of Autism Spectrum Disorders. Springer, New York, NY. https://doi.org/10.1007/978-1-4419-1698-3_1123

George, B., Dalat-Ward, Y., & Jones, E. (2022, March). *Digitization and Equity: Digital Inequities in Education and Strategies to Improve Digital Inclusion*. In El-Amin, A (Eds.), Implementing Diversity, Equity, Inclusion, and Belonging in Educational Management Practices (pp. 260-267). IGI Global. DOI: 10.4018/978-1-6684-4023-0.ch015

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). Applied thematic analysis. SAGE Publications, Inc.

Huntsville City Gov (2023). https://www.huntsvilletx.gov/1/Internal

Keeney, R. L. (1992). *Value-focused thinking: A path to creative decision making*. Harvard University Press.

Maslow, A. H. (2008). *Towards a psychology of being* (3rd ed.). Wiley.

Mezirov, J., & Taylor, E. W., and Associates. (2009). *Transformative learning in practice: Insights from community, workplace, and higher education*. Jossey-Bass.

Mheir, F. (2017, January 28). *The pyramid of digital needs* [Post]. LinkedIn. https://www.linkedin.com/pulse/pyramid-digital-needs-farid-mheir/

Mullins, D. H. (2023, May 3). Local food bank finds new location, services. *Huntsville Item*. https://www.iteonline.com

National Digital Inclusion Alliance. (2023). Definitions. https://www.digitalinclusion.org/definitions/

Neururer, J., & Rhoads, R. A. (1998). Community service: Panacea, paradox, or potentiation. *Journal of College Student Development*, *39*(4), 321-330.

Nield, D. (2023). The advantages of building your own computer. CHRON. https://smallbusiness.chron.com/advantages-building-own-computer-69583.html

Patton, M. Q. (2015). *Qualitative research & evaluation methods* (4th ed.). SAGE Publications, Inc.

Place, T. (2018, July 30). 4 ways to achieve employee buy-in for your training initiative. https://trainingindustry.com/articles/content-development/4-ways-to-achieve-employee-buy-in-for-your-training-initiative/

Ross, M. (2021, March 3). Biden promises affordable Internet for all Americans by 2029 with $100b infrastructure investment. https://www.newsweek.com/biden-promises-affordable-internet-all-americans-2029-100b-infrastructure-investment-1580214.

Schöner, G. & Kelso, J.A.S. (1988). A dynamic pattern of behavioral change. *Journal of Theoretical Biology*, *135*(4), 521-524.

Sultan, A. (2023). *Improving cybersecurity awareness in underserved populations*. Center for Long-term Cybersecurity.

Tesfaye, T. (2023, March 27). The first round of ACP outreach grants are here, and more are coming. ACP Digital Inclusion News. https://www.digitalinclusion.org/blog/2023/03/27/the-first-round-of-acp-outreach-grants-are-here-and-more-are-coming/

Tokuhama-Espinosa, T. (2010). *The new science of teaching and learning: Using the best of mind, brain, and education science in the classroom*. Columbia University Teachers College Press.

UNESCO. (2023). UNESCO science report 2021: Digital societies: A common agenda. https://www.unesco.org/reports/science/2021/en/digital-societies

United Nations. (2016). United Nations General Assembly. Digital Human Rights. https://www.un.org/techenvoy/content/digital-human-rights

United Nations Department of Economic and Social Affairs. (2023) Sustainable Development Goal 4: Education. https://sdgs.un.org/goals/goal4

United States Census Bureau. (2023). Huntsville Decennial Census. dehttps://www.census.gov/search-results.html?searchType=web&cssp=SERP&q=Huntsville%20city,%20Texas

United States Department of Agriculture Economic Research Service (2023). Food security and nutrition assistance. https://www.ers.usda.gov/topics/food-nutrition-assistance/food-security-in-the-u-s/key-statistics-graphics/#householdtype

United States Department of Homeland Security. (2023). FEMA. Glossary. https://www.fema.gov/about/glossary

Yorks, L., O'Neil, J., & Marsick, V. J. (1999). Action learning theoretical bases and varieties of practice. *Advances in Developing Human Resources*, *1*(2), 1-18.

Zang-Kennedy, L., Chiasson, S., & Biddle, R. (2016). The role of instructional design in persuasion: A comics approach for improving cyber security. *International Journal of Human Computer Interaction on Persuasive Interactive Systems*, https://doi.org/10.1080/10447318.2016.1136177

APPENDIX A

Survey Questionnaire

Trinity River Food Bank
Technology Household Survey

Would you like to participate ***free*** workshops? Please check the ones applied to your needs.

☐ Adults: Computing Fundamental Workshop Emailing, Microsoft Office Suits (Word, Excel, PowerPoint...etc.)
☐ Adults: Save Money – Build Your Computer
☐ Adults: Cybersecurity Training
☐ Kids: Building a robot
☐ Kids: Flying a Drone
☐ Kids: Be a Cybersecurity Investigator

What time would you be available to attend the workshops?

☐ Adults: 10:00 AM – 12:00 PM (Weekdays)
☐ Adults: 12:00 – 2:00 PM (Weekdays)
☐ Adults: 4:00 – 6:00 PM (Weekdays)
☐ Adults: 6:00 – 8:00 PM (Weekdays)
☐ Adults: 9:00 AM – 11:50 AM (Saturdays)
☐ Adults: 1:00 PM – 5:00 PM (Saturdays)
☐ Kids: 10:00 AM – 12:00 PM (Weekdays)
☐ Kids: 12:00 – 2:00 PM (Weekdays)
☐ Kids: 6:00 – 8:00 PM (Weekdays)
☐ Kids: 9:00 AM – 11:50 AM (Saturdays)
☐ Kids: 1:00 PM – 5:00 PM (Saturdays)

What kind of digital devices do you have at your household?

☐ Smart TV: How many? ☐
☐ Smart Phone (Cellar Phone): How many? ☐
What phone provider do you used? ____________________
☐ Desktop Computer System: How many? ☐
What's the operating system (Windows, Apple, or Linux)? ____________________
☐ Laptop: How many? ☐
What's the operating system (Windows, Apple, or Linux)? ____________________
☐ Tablet: How many? ☐
What's the operating system (Windows, Apple, or Linux)? ____________________
☐ Printer: How many? ☐
☐ Internet Router to provide Wifi?
☐ Others ____________________

How many members do you have in your household? And how old are they?

☐0 - 3 years-old _____ ☐4 – 6 years-old _____ ☐7 – 10 years-old ____ ☐11 – 14 years-old _____
☐15 – 19 years-old ___ ☐20 – 25 years-old ___ ☐26 – 30 years-old ___ ☐31 – 40 years-old _____
☐41 – 50 years-old ___ ☐51 – 60 years-old ___ ☐61 – 70 years-old ___ ☐71 and older _________

Please provide any comment regarding your technological needs:

An Eye Toward the Softer Side of CC2020 Computing Curricula: Professional, Legal, and Ethical Artificial Intelligence Issues

Christine Ladwig
cladwig@semo.edu
Department of Marketing

Dana Schwieger
dschwieger@semo.edu
Department of Management

Southeast Missouri State University
Cape Girardeau, MO 63701, USA

Abstract

Hollywood screenwriters worry about Artificial Intelligence (AI) replacements taking over their jobs. Famous museums litigate to protect their art from AI infringement. A major retailer scraps a machine-learning based recruitment program that was biased against women. These are just a few examples of how AI is affecting the world of work, learning, and living. MIS and computer science students are among the professional groups who are embarking into careers with nebulous frontiers obscured by the outcroppings brought on by AI. Computer Science and Information System curriculum task forces have recognized the increasing ethical and professional implications developers' work can have beyond the scope of the programmers' code. In this article, the authors examine the professional, legal, and ethical implications of copyrights and algorithmic bias resulting from development of AI-enhanced applications and offer suggestions for addressing these topics in courses considering changes to the CC2020 and IS2020 Model Curriculum frameworks.

Keywords: Artificial Intelligence, Copyright infringement, Teaching strategies, Risk management, Programming bias, CC2020 Computing Curricula, IS2020 framework

Recommended Citation: Ladwig, C., Schwieger, D., (2024). An Eye Toward the Softer Side of CC2020 Computing Curricula: Professional, Legal, and Ethical Artificial Intelligence Issues. *Information Systems Education Journal,* 22(1), pp.53-88. https://doi.org/10.62273/FFDJ1170

An Eye Toward the Softer Side of CC2020 Computing Curricula: Professional, Legal, and Ethical Artificial Intelligence Issues

1. INTRODUCTION

Artificial Intelligence (AI) is changing the landscape of development, for the good, the bad, and the in-between (Bolukbasi, Chang, Jou, Saligrama, & Kalai, 2016; Hogan, 2019; Nelson & Reed, 2023). As awareness of the potential devastating effects that can result from AI enhanced systems expands, so does the need for protective measures. Governments and industrial leaders are calling for AI development guidelines; for example, in October 2022, the U.S. White House issued its *Blueprint for an AI Bill of Rights*, intended to provide guidance in the design and execution of machine learning systems (OSTP, 2022). On April 11, 2023, the Cyberspace Administration of China (CAC) revealed its draft generative artificial intelligence services policy (Ye, 2023). And on June 14, 2023, European lawmakers passed a landmark Artificial Intelligence Act that provides guardrails for AI development including classification levels for AI risk, "greater privacy standards, stricter transparency laws, and steeper fines for failure to cooperate" (Sharp, 2023, p. 1). While these guardrails are still evolving, it is important that future system developers be familiar with their underlying implications. Such rapid advancements generate various unknowns in many areas including: software development, human resources, privacy, security, ethics, regulatory implications, copyrights, education, etc. Due to the potential impact on the MIS and computer science professions, there are many critical factors — technical, ethical, regulatory, and professional — that should be considered when developing and updating course curricula.

Recent updates to the computing disciplines curriculum guidelines (CS2020; IS2020) have recognized the increasing importance of ethics and professionalism. For example, Section 6.5 of the Computing Curricula 2020 framework addresses the importance of incorporating professionalism and ethics, indicating that "it should be a permanent element of any computing curriculum" (CC2020 Task Force, 2020, p. 76). The framework suggests that concepts could be taught in dedicated courses either inside or outside the computing discipline or distributed over the body of curricula.

The Organizational Domain in the IS2020 framework has likewise been modified to include two required competency areas: "IS Management and Strategy/Ethics" and the "Use and Implications for Society" (IS2020 Task Force, 2020, p. 57). In making this change to the framework, the task force noted, "As IT is being deployed increasingly outside the traditional business organization context, and also incorporated closely to products and services for consumers, there are new ethical challenges to comprehend and address" (p. 57).

Therefore, in this paper, the authors discuss two nascent areas with significant ethical and professional considerations that could be efficiently highlighted in the MIS and/or computer science classroom: programming bias and copyright infringement protection for both programmer-developed and AI-developed works. The authors additionally provide exercises and an example of a CC2020 Competency Statement that may be used to incorporate these topics into computer science, information system, technology management, and/or business curriculums.

2. FRAMEWORKS FOR THE STUDY OF AI ISSUES

Two recent developments — one related to computer science education guidelines, and another connected to the current rise of Artificial Intelligence use — may be used by educators to incorporate important AI issues into the classroom:

1) The 2020 Computing Curriculum Task Force (CC2020) recently released a revised "template for specifying the subject matter of baccalaureate computing education" building upon the different educational frameworks provided in the IT2017 report (CC2020 Task Force, 2020, p. 47). The CC2020 guidelines move from knowledge-based learning to competency-based learning (Ormond, 2021) and define competency as the combination of knowledge (know-what), skills (know-how), and dispositions (know-why) (K-S-D) *in task* (CC2020 Task Force, 2020, p. 13). When the K-S-D construct is tied to the performance of a task, CC2020 indicates that this "frames the

skilled application of knowledge and makes dispositions concrete" (CC2020 Task Force, 2020, p. 48). The *task* therefore becomes the embodiment of the purpose for the competency, and "competency statements" — task descriptions that align with the relevant knowledge elements, skill level and disposition — become the learning delivery platform. The IS2020 task force adopted the CC2020 competency approach to developing their framework as well (IS2020 Task Force, 2020, p. 39). Thus, using the original CC2020 framework as a guide, the authors created a sample competency statement (Appendix A) for the risk management of legal and ethical issues in machine learning which may be used in conjunction with the exercises included in Appendices B and C.

2) In October 2022, the U.S. White House Office of Science and Technology Policy issued a *Blueprint for an AI Bill of Rights* consisting of "five principles that should guide the design, use, and deployment of automated systems to protect the American public in the age of artificial intelligence" (OSTP, 2023, p. 1). The Blueprint notes that AI technologies "can drive great innovations, like enabling early cancer detection or helping farmers grow food more efficiently", but conversely, the same advancements are "too often developed without regard to their real-world consequences and without the input of the people who will have to live with their results" (OSTP, 2023, p. 1). Using the AI Bill of Rights as a guide, the authors suggest additional content and strategies for addressing the "danger zone" issues associated with the meteoric rise of AI system use.

In Sections 3 and 4, the authors describe two (of the many) professional, ethical, and legal considerations — software copyrights and algorithmic bias — that raise significant issues for industry as the rapid advancement of AI continues.

3. IT RISK MANAGEMENT ISSUE: SOFTWARE COPYRIGHTS

As students prepare to enter the computer science and MIS industries, it is important that they understand intellectual property and the legal conventions protecting it, especially as AI begins to play a role in the generation of products and content. Software is an example of intellectual property (IP), or an intangible original work that has value for its developer. It is essential that entities safeguard their IP investments by applying legal protections such as copyrighting and patenting. Because software is considered a "literary work" under U.S.C. §101 of the Copyright Act, a program's written code can be protected from being copied and used without the developer's permission.

The U.S. Copyright Act (1976) allows copyright holders to:

- Make copies of their software,
- Distribute the work (sell it)
- Make "derivative works", and
- Share or perform the work in public.

As soon as the software is expressed as an operational program, it is automatically copyrighted with the developer as its owner. However, officially registering the software for a copyright with the U.S. Copyright Office and the Library of Congress is a good idea, as it gives the developer more legal protection in case someone tries to steal the software or use it without the developer's permission (also known as "infringement"). A copyright lasts for the lifetime of the author, plus 50 years in many countries, and for 70 years in others, including the United States. Obtaining a copyright is relatively inexpensive ($45-$125) and usually only takes about three months. Copyrightable software includes a vast array of programs and components, such as graphical user interfaces, mobile phone apps, video conferencing software, animated graphical sequences, soundtracks or sound effects, and social media platforms.

Although software is primarily protected by copyrights, patents can be used to protect the underlying "ideas, procedures, and operational/computing methods" behind the software (Rouse, 2013). However, patents are more costly and the application process more complex.

Copyright Exceptions: First Sale Doctrine & Fair Use

Under the First Sale Doctrine, the user/owner of a purchased or legally obtained copy of a work is entitled to sell that copy without infringing copyright. The legal owner is not allowed, however, to make and sell copies of the owned copy — or even to give them away. Copyright law will sometimes allow a legal owner to make archival copies for personal use. For instance, you are permitted to make a single copy of a legally obtained computer software program in case the original is lost or damaged, but that back-up copy must be destroyed or transferred if you ever sell the original copy.

The Fair Use rule is a part of copyright law that allows for the limited use of copyrighted material without permission from the rights holder. In *Galoob v. Nintendo*, the 9th Circuit Court held that modification of copyrighted software for personal use was fair (Farris, 1992). At issue in *Galoob* was use of the *Game Genie* accessory, a device that could alter the output of video games in the Nintendo Entertainment System. The Court determined that the Genie did not make derivative works of Nintendo's games (which would violate their software copyright) and qualified as non-commercial fair use. In *Sega v. Accolade*, the 9th Circuit held that making copies during reverse engineering is a fair use, when it is the only way to get access to the "ideas and functional elements" in the copyrighted code, and when "there is a legitimate reason for seeking such access" (Reinhardt, 1992). More recently in 2021, The U. S. Supreme Court ruled in *Google LLC v. Oracle America, Inc.* (2021) that the reuse of application programming interfaces (APIs), including representative source code, can be transformative and fall within fair use. However, they did not rule on whether such APIs are copyrightable.

Copyright Infringement and AI

If not complex enough, the legal environment of software and program copyright now faces a new era of issues as developer products are being used to support artificial intelligence or create new works generated by AI. Lawsuits have been launched regarding copyrights potentially infringed by AI-enhanced programs, either in the use of copyrighted training materials or the expression of substantially similar copyrighted content in AI generated works. On March 16, 2023, the U.S. Copyright office launched an Artificial Intelligence Initiative to examine copyright law issues created by the rise of machine learning. The study is intended to examine "the scope of copyright in works generated using AI tools and the use of copyrighted materials in AI training" (U.S. Copyright Office, 2023).

With sophisticated AI technologies training on vast quantities of human-created content and producing expressive materials, the danger of copyright infringement is omnipresent. There are a number of concerning issues evolving from the current AI landscape, including: (1) Is AI-generated content copyrightable? (2) If AI-generated content is copyrightable, who owns that copyright? (3) Does AI-generated content infringe copyrighted materials, such as those used for training the program? (4) If AI-generated content does infringe copyrighted material, who is liable?

In addressing the first and second questions, the Copyright Office has stated that "it is well-established that copyright can protect only material that is the product of human creativity" (U.S. Copyright Office, 2023, p. 2). Works generated through an AI prompt would be made by a non-human machine, and therefore not be eligible for registered copyright protection. But, what about human manipulation of that AI generated work? How much human intervention is required to move the AI content over the threshold of including human authorship? And what about the developers of the complex algorithms and code that comprise the AI enhanced program — should these individuals be recognized as the authors of the AI generated works?

In addressing the third question, there is already evidence that AI enhanced programs are potentially infringing copyrighted material by training on — and then using in generated works — existing copyrighted material. In 2021, Microsoft, its subsidiary GitHub, and its business partner OpenAI were sued in a class action lawsuit which alleged that "the companies' creation of AI-powered coding assistant GitHub Copilot relies on 'software piracy on an unprecedented scale.'" (Vincent, 2023). It is well known that many text-to-image AI, like the open-source program Stable Diffusion, are also created by scraping copyrighted material from the web. (Scraping is a technical approach to extract text and images from a web page for use as raw material for training.) Although AI firms contend that these actions are a copyright fair use exception, experts suggest that this is far from settled law (Vincent, 2023).

Regarding the fourth question — liability for AI infringement — plaintiffs in legal actions are assigning the companies behind the AI enhanced programs with this responsibility. Author Ellen Glover (2023) details the lawsuit filed by Getty Images (of the Getty Museum) against Stability AI (Stable Diffusion) for "copying and processing millions of [Getty] images that are protected by copyright, as well as their associated metadata, without getting permission or providing compensation." According to Ben Zhao, a computer science professor at the University of Chicago, "The large majority of independent artists make their living through commissioned works. And it is essential for them to keep posting samples of their art. But the websites they post their work on are being scraped by AI-enhanced programs in order to learn and then mimic that particular style. Artists are literally being replaced by models that have been trained on their own work" (Glover, 2023, p. 3).

Similarly, Hollywood writers were on strike in April 2023, with a primary complaint of potential copyright infringement of their existing works. Their fears were based in studios taking their prior generated scripts and using AI to generate new stories and writings for film and television — without the human writers' involvement. Because the studios hired the writers to create the material originally (known as "works for hire"), they could train AI on these prior scripts without potentially infringing the copyrights that they hold. The ethics of these actions, however, are highly questionable. So, although the state of the law is currently dynamic regarding the questions of copyrightability and infringement, it is vital that programmers maintain an understanding of the vital role this issue has, and will continue to have, as the AI generation of content accelerates in scope. And in addition to copyright issues, they must also consider the potential for inherent bias unintentionally introduced, and magnified, in AI supported programs by algorithm training data.

4. IT RISK MANAGEMENT ISSUE: PROGRAMMING AND/OR TRAINING DATA BIAS

The prevalence of AI algorithms in areas in which life-altering decisions may occur, e.g., healthcare, transportation, job placement, school admission, loans, etc., is escalating. Although great efforts have been made to develop accurate AI algorithms to assist decision-makers in making high-quality consistent decisions, that is not always the case (Parikh, 2021). Whether intended or not, bias may be incorporated into a program due to the nature of the data used to develop and/or train the system (Sparkes, 2022). Stories of racial and gender bias have been known for some time (Caliskan, Bryson, & Narayanan, 2017; Sparkes, 2022) and embedded gender bias has even been found in general text references and correlations between pronouns and roles on Internet news searches (Bolukbasi, et al., 2016.)

Programming Bias in Employment and Hiring

Researcher Hogan (2019, p. 2) found that "most hiring algorithms will drift toward bias by default" and that "deeper disparities" in predictive algorithms must be addressed. For instance, the author discussed recruiters using algorithmic ad generators and job boards to advertise to relevant potential applicants. These services are interested in attracting the most clicks for their clients' dollars but may be "delivered in a way that reinforces gender and racial stereotypes" (Hogan, 2019, p. 2). The author also noted that some personalized job boards automatically learn patterns in recruiters' preferences as they correspond with job seekers and dynamically adjust algorithms to solicit similar applicants. Thus, by directing ads to potential candidates matching the dynamically adjusted algorithm, dissimilar potential applicants are inadvertently excluded. In addition, applicant screening tools often model past hiring decisions which may, in turn, further support an unintended bias. Amazon reportedly canceled further development of an AI program intended to help human resources vet resumes. The machine learning tool was trained on observing patterns in resumes submitted to the company over a 10-year period that inherently reflected the dominance of males in the tech industry (Dastin, 2018).

To address the increasing use of AI in employment and the potential risks for bias and discrimination, the Equal Employment Opportunity Commission ("EEOC") published guidance in 2022 regarding artificial intelligence and employer obligations under the Americans with Disabilities Act ("ADA"). Then in May 2023, the EEOC issued similar guidance (the "Recent Guidance"), this time regarding employers' use of AI in their "selection procedures" (e.g., hiring, promotion, and termination) and the potential for disproportionate adverse effects (i.e., "disparate impact") on applicant groups who are protected under Title VII of the Civil Rights Act of 1964 ("Title VII"). The Recent Guidance explains that the "Uniform Guidelines on Employee Selection Procedures" from 1978 still apply — even though the technology has changed significantly — and will help employers understand how to use AI in hiring and avoid legal violations (Nelson & Reed, 2023).

The EEOC also confirms that "employers may be held responsible for algorithmic decision-making tools that create a disparate impact, even if the tools are designed or administered by another entity, such as a software vendor." Therefore, an employer using AI to make hiring decisions may be liable under Title VII if "the AI discriminates on a protected basis, such as gender or race, even if an outside vendor developed the AI." The Recent Guidance encourages employers who learn that an AI tool is creating a disparate impact to "take steps to reduce the impact or select a different tool in order to avoid engaging in a practice that violates Title VII."

Algorithmic Bias in Healthcare
Unintended bias may also have life threatening results (Feiner, et al., 2007; Jamalia, et al., 2022; Larrazabal, et al., 2020; Sparkes, 2022). Medical researchers have found that algorithmic bias may not only be inadvertently programmed into an AI system but may possibly be amplified as well (Larrazabal, et al, 2020; Zou & Schiebinger, 2018). Studies have found that some pulse oximeters have a tendency to overestimate oxygen levels for people having lower oxygen saturation levels and darkly pigmented skin (Feiner, et al., 2007; Jamalia, et al., 2022).

In a large-scale study conducted by Larrazabal, et al., (2020) on medical imaging datasets, the authors ran multiple different gender-imbalanced ratios of training data on the AI system and found that training deep learning-based CAD medical imaging systems on gender-imbalanced datasets had the potential to affect pathology results in minority groups (Larrazabal, et al., 2020). When the authors used diverse and balanced datasets to train the AI system, the system performed the best on test data (Larrazabal, et al., 2020).

In their 2019 paper "Artificial intelligence and algorithmic bias: implications for health systems," researchers Panch, Mattie, and Atun first defined "algorithmic bias" in healthcare as the "application of an algorithm that compounds existing inequities in socioeconomic status, race, ethnic background, religion, gender, disability, or sexual orientation and amplifies inequities in health systems." This definition suggests that some forms of bias have been active in medical information and decisions even before the application of AI systems. "Algorithmic bias is not just a technical issue" say Panch, Mattie, and Atun, "teams developing algorithms should be explicitly aware of the specificities of the health system context for which they are developing algorithms, by considering differential needs of different groups–-best achieved through multi-disciplinary data science teams and by appropriate regulation and evaluation of algorithms and the data science process itself." The authors suggest creating a "human-in-the-loop" system to counteract algorithmic bias; program outputs can thereby be vetted with the human as the ultimate decision maker (Panch, et al., 2019).

5. INCORPORATING PROFESSIONAL SKILLS AND CONTENT IN ALIGNMENT WITH COMPETENCY FRAMEWORKS

AI and its intrinsic effects have sprung into the educational limelight with lightning speed. Many educators are struggling to incorporate rapidly advancing current AI topics, such as algorithmic bias and copyright issues, into skill-heavy course syllabi. However, the overarching CC2020 Computing Curriculum guidelines and subsequent program directed models (e.g., IS2020, IT2020, etc.), provide a list of competencies in which these concepts can be addressed.

In Appendix A, the authors provide an example of a competency statement, based upon the CC2020 guidelines, that faculty can modify and implement to address these subsequent issues. The following section provides content and strategies supporting the *AI Bill of Rights* and the proposed competency statement to address the professional and ethical aspects of copyrights and algorithmic bias. Table 1 illustrates the alignment of the IS2020 competency realms (IS2020, 2020, p. 51) with the U.S. White House's *Blueprint for an AI Bill of Rights*. Additional classroom suggestions and exercises, including the proposed competency statement, are provided in Appendices A, B, and C.

Tactics to Address the IS Competency Realms
Listed below are suggested skills and strategies that faculty can incorporate into their courses to address bias and copyrights in relation to the IS2020 competency realms.

IS Foundations Realm: This competency, representing IS as a whole, is usually addressed in an introductory course covering general IS concepts. Faculty can ensure that concepts such as AI, data management, data governance, data bias, ethics, copyrights, data privacy, data security, and legal implications are addressed. The authors provide a Moral Machine exercise in Appendix B that faculty can assign to generate awareness in students of their own biases. In addition, the White House's Blueprint as well as other frameworks can be presented.

IS2020 Realm	White House Blueprint
IS Foundations	Overview
Data (Data & Info Mgt.)	Data Privacy & Protections Algorithmic Discrimination Protections
Technology (IT Infrastructure)	Safe & Effective Systems
Development (Design, Devpt. & Programming)	Algorithmic Discrimination Protections
Organizational Domain (Ethics, society, IS Mgt & Strategy)	Notice & Explanations Human Alternatives Consideration & Fall Back
Integration (Project Mgt & IS Practicum)	All

Table 6: White House Blueprint Mapped to IS2020 Competency Realms

Data Realm (Data/Information Management/Business Analytics): This competency may be covered in multiple courses and may include addressing data preprocessing techniques such as data cleaning, dimension reduction, variable selection, data sampling, data transformation, and balancing data (Azevedo, 2022). Discussions of the different types of data bias (e.g., propagated current state, inaccurate data focus, under-represented populations, sampling, selection, analytics, confirmation, etc.) can be included (Lawton, 2020). Techniques and tools available to reduce those biases can also be introduced such as: subpopulation analysis, comparing model results over time, IBM's open source AIF360 toolkit, IBM Watson OpenScale, Google's What-IF Tool (Dilmegani, 2022; IBM Developer Staff, 2018), Microsoft's Fairlearn, and TensorFlow's open-source standardized data sets and data tools. Faculty can incorporate discussion about bias and the importance of developing good algorithms and training data.

Technology Realm (IT Infrastructure): Discussions about the current use and future direction of AI could be incorporated into multiple courses to address the optional competency aspect of "Emerging Technologies". In addition, discussion about copyrights, copyrighted material and AI training data, and the outputs generated by AI algorithms can be addressed as well.

Awareness of Copyrights: Along with a discussion on the content on copyrights provided in Section 3, faculty can incorporate an exercise on code theft and copyright infringement provided in Appendix C.

Development Realm: In the systems analysis and design and application development courses, faculty can incorporate a mindset of quality assurance by eliminating bias and copyright infringement at the start of the development process. As students being to develop the requirements for their systems, they could be asked to list the types of issues that would occur, where and how those issues would arise, delineate the steps they would take to eliminate the identified issues, and describe how they would audit the system for those issues. Quality assurance procedures and methodologies could be addressed when having students evaluate the results generated by AI algorithms may provide an opportunity to incorporate quality control procedures and methodologies into the classroom. The algorithm must first be tested to determine whether or not the ideal results are returned for the real problem of interest or if the results address a similar, but different, problem (Bembeck, et al., 2021). Once the ideal result is returned, then a "blind taste test" can be run on the algorithm to test for bias (Uzzi, 2020). With the blind test, the AI algorithm is first trained on the entire data set and then trained again on the same data set with data suspected of introducing bias removed. If the results are different, then the suspected variable should be evaluated to determine if the variable provides a valid explanation for the model's performance or introduces bias into the decision-making (Uzzi, 2020).

Organizational Domain Realm (Ethics, society, IS Management and Strategy) Governance Policies: *The Economics and Regulation of Artificial Intelligence and Emerging Technologies* published by the Brooking Institute, recommended that, to reduce inherent bias built into AI, policymakers should define bias in respect to its real-world results, use the definition to assist the industry in investigating biased algorithms, and insist that organizations develop internal accountability structures to prevent bias before it happens. This methodology could be incorporated into faculty discussions on IT governance policies and procedures, accountability structures, documentation, and the establishment of structures for preventing bias (Bembeck, et al., 2021).

Need for Compliance with Industry Regulations: Future developers may develop software in a variety of industries. It is impossible to address the specific regulations and requirements of each industry. However, by reviewing some of the requirements outlined by a regulatory body affecting almost every industry, students are made aware that additional factors outside the software's specific functional requirements may need to be assessed and compliance issues addressed.

AI has been used in workplace employment decisions to assist with such activities as advertising job openings, screening applicant resumes, determining salary offers, establishing terms and conditions of employment, monitoring worker performance, and making promotion decisions (Bogen, 2019; EEOC, 2022; Nelson & Reed, 2023). U.S. employers "can be held liable for using procedures that overly favor a certain group of applicants" (Hogan, 2019, p. 2). In response to the growing use of AI in human resource decision-making, the EEOC published a technical assistance document to provide guidance (2022). EEOC guidelines indicate that decision-making tools could be considered unlawful for:

- **Not providing reasonable accommodations** for fair and equitable treatment of all employees.
- **Screening out individuals**, either intentionally or unintentionally, for not meeting a particular standard resulting from algorithmic decisions made resulting from a disability. For example, the disability may affect the accuracy of the algorithm's assessment of the individual or prevent or hinder the individual from participating in the screening process (EEOC, 2022)
- **Violating ADA restrictions on disability-related inquiries.** For instance, if an applicant for a position has a significant gap in their employment history due to their disability, the algorithm may screen the employee out of the process if the algorithm is not programmed to handle such employment abnormalities (EEOC, 2022).
- **EEOC compliance by vendor-purchased software** must be ensured to prevent companies using the software from being held liable for violations.

The EEOC (2022) offered several recommendations to software developers to reduce the chances of making biased decisions resulting from the use of an algorithmic tool. Instructors can fashion discussion around governance policy development associated with the following topics:

- **Inquiring of vendors** about whether or not the AI algorithms were developed with individuals with disabilities in mind.
- **Involving experts** on various types of disabilities in the algorithm and software development process.
- **Addressing as many different kinds** of disabilities as possible to minimize bias**.**
- **Ensuring that user interfaces are accessible and/or alternative formats** are made available.
- **Testing the system** to ensure that individuals with disabilities are not disadvantaged by the algorithm.
- **Providing clear instructions for requesting accommodations** to disabled individuals using the system.
- **Providing an explanation of the algorithm in use** and the data assessed so that accommodations can be requested if necessary.
- **Limiting utilization of algorithms** in decision making. Utilizing an algorithmic decision-making tool only for making decisions that will not be affected by a disability.

The U.S. White House's *Blueprint for an AI Bill of Rights*

The White House Office of Science and Technology Policy issued the *Blueprint for an AI Bill of Rights* consisting of "five principles that should guide the design, use, and deployment of automated systems to protect the American public in the age of artificial intelligence" (OSTP, 2023, p. 1). Table 1 illustrates the alignment of these statements with the IS2020 required competency realms. Faculty can use the five principles, summarized below, as talking points for classroom discussion with the sections listed below or independently:

1. **Safe and Effective Systems** designed and developed to address potential risks, prevent algorithmic bias, and proactively protect individuals from unintended, yet foreseeable use, inappropriate use of data, and compounded harm of the algorithm's reuse. Systems should be developed with consultation from diverse communities,

evaluated and audited by independent parties, and the steps taken to mitigate potential harm should be reported.

2. **Algorithmic Discrimination Protections** against unfair treatment arising from "race, color, ethnicity, sex, religion, age, national origin, disability, veteran status, genetic information or any other classification by law" (OSTP, 2022, p. 1). Proactive and continuous steps should be taken to guard against discrimination including equity assessments, representative datasets, ensuring accessibility, and organizational oversight.
3. **Data Privacy and Protections** should be built into systems by default and data collected that is strictly necessary for use in the context intended. Enhanced protective measures should be enacted for sensitive domains including data collected about health, work, education, criminal justice, finance, and youths.
4. **Notice and Explanations** should be clearly articulated regarding the overall automated system function, the parties responsible for the automated system, explanations of the outcomes, and how and why an outcome that impacts an individual was determined.
5. **Human Alternatives, Consideration and Fallback** should be provided as appropriate. Human alternatives to the automated system should be provided to ensure accessibility. Individuals should have access to "timely human consideration and remedy by a fallback or escalation process" (p. 1). People who interact with AI systems should receive appropriate training for ensuring consistent fair treatment and addressing equity issues. Governance processes developed to carry out these processes should be developed and made publicly available.

6. CONCLUSION

Artificial Intelligence is poised to change the way in which organizations operate, job roles are carried out, programmers develop software, and faculty teach classes. While the field develops at a rapid pace, faculty should prepare MIS and computer science students for an AI-enhanced world with multiple risks and unknowns. In this paper, the authors address a few "danger zones" of the AI-enhanced world by reviewing relevant literature on software copyrights and programming bias and suggest course content strategies for addressing these issues using the frameworks provided by the CC2020 Task Force, the White House's *Blueprint for an AI Bill of Rights*, and the EEOC's recommendations for addressing possible bias introduced by AI supported technologies.

7. REFERENCES

Azevedo, A. (2022). Data Preprocessing: 6 Techniques to clean data. *Scalable Path*. Retrieved August 19, 2023, from https://www.scalablepath.com/data-science/data-preprocessing-phase

Bembeck, E., Nissan, R., & Obermeyer, R. (2021). To stop algorithmic bias, we first have to define it. *Brookings*. Retrieved on June 13, 2023, from https://www.brookings.edu/research/to-stop-algorithmic-bias-we-first-have-to-define-it/

Bogen, M. (2019). All the ways hiring algorithms can introduce bias. *Harvard Business Review*. Retrieved on May 29, 2023, from https://hbr.org/2019/05/all-the-ways-hiring-algorithms-can-introduce-bias#:~:text=Many%20hope%20that%20algorithms%20will%20help%20human%20decision-makers,points%20like%20university%20attendance%20or%20performance%20evaluation%20scores

Bolukbasi, T. Chang, K.W., Jou, J., Saligrama, V., & Kalai, A. (2016). Man is to computer programmer as woman is to homemaker? Debiasing word embeddings. *Advances in Neural Information Processing Systems,* (29). Retrieved on May 29, 2023, from https://arxiv.org/pdf/1607.06520v1.pdf

Caliskan, A., Bryson, J. J., & Narayanan, A. (2017). Semantics derived automatically from language corpora contain human-like biases. *Science*, *356*(6334), 183–186. https://doi.org/10.1126/science.aal4230

CC2020 Task Force (2020). Computing Curricula 2020 (CC2020). Retrieved on May 29, 2023, from https://www.acm.org/binaries/content/assets/education/curricula-recommendations/cc2020.pdf. DOI: 10.1145/3467967

Dastin, J. (2018). Amazon scraps secret AI recruiting tool that showed bias against women. *Reuters*. Retrieved June 1, 2023, from https://www.reuters.com/article/us-amazon-com-jobs-automation-insight-idUSKCN1MK08G

Dilmegani, C. (2022). Bias in AI: What it is, Types, Examples & 6 Ways to Fix it in 2023.

AI Multiple. Retrieved August 19, 2023, from https://research.aimultiple.com/ai-bias/

Farris, J. (1992) U.S. Court of Appeals, Ninth Circuit. Lewis Galoob Toys, Inc. v. Nintendo of America.(964 F 2d 965). Retrieved on May 29, 2023, from https://h2o.law.harvard.edu/cases/4459

Feiner, J. R., Severinghaus, J. W., & Bickler, P. E. (2007). Dark skin decreases the accuracy of pulse oximeters at low oxygen saturation: the effects of oximeter probe type and gender. Anesthesia and analgesia, *105*(6 Suppl), S18–S23. https://doi.org/10.1213/01.ane.0000285988.35174.d9

U.S. Equal Employment Opportunity Commission (EEOC). (2022). The Americans with Disabilities Act and the Use of Software, Algorithms, and Artificial Intelligence to Assess Job Applicants and Employees. ADA, 29 CFR Part 1630 & app. Retrieve on June 8, 2023, from https://www.eeoc.gov/laws/guidance/americans-disabilities-act-and-use-software-algorithms-and-artificial-intelligence

Glover, E. (2023). AI-generated content and copyright law: What we know. *Builtin*. Retrieved June 14, 2023, from https://builtin.com/artificial-intelligence/ai-copyright

Hogan, M. (2019). All the ways hiring algorithms can introduce bias. *Harvard Business Review*. Retrieved June 2, 2023, from https://hbr.org/2019/05/all-the-ways-hiring-algorithms-can-introduce-bias

IBM Developer Staff (2018). AI Fairness 360. Open Source@IBM. . Retrieved on August 19, 2023, from https://www.ibm.com/opensource/open/projects/ai-fairness-360/

IS2020 Task Force (2020). IS2020 A Competency Model for Undergraduate Programs in Information Systems. Retrieved on August 2, 2023, from https://www.acm.org/binaries/content/assets/education/curricula-recommendations/is2020.pdf
DOI: 10.1145/3460863

Jamalia, H, Castillo, L. T., Morgan, C. C., Coult, J., Muhammad, J. L., Osobamiro, O. O., Parson, E. C., & Adamson, R. (2022). Racial disparity in oxygen saturation measurements by pulse oximetry: Evidence and implications. *Annals of the American Thoracic Society*. *19* (12). 1951-1964. https://10.1513/AnnalsATS.202203-270CME

Larrazabal, A. J., Nieto, N., & Peterson, V. (2020) Gender imbalance in medical imaging datasets produces biased classifiers for computer-aided diagnosis. *PNAS, 117*(23) 12592-12594. https://doi.org/10.1073/pnas.1919012117

Lawton, G. (2020). 8 Types of bias in data analysis and how to avoid them. TechTarget: Business Analytics. Retrieved on August 19, 2023, from https://www.techtarget.com/searchbusinessanalytics/feature/8-types-of-bias-in-data-analysis-and-how-to-avoid-them

Nelson, S. M. & Reed, M. (2023). EEOC issues guidance on use of AI in employment decisions. *The National Law Review, 13*(159), Retrieved on June 8, 2023, from https://www.natlawreview.com/article/eeoc-issues-guidance-use-ai-employment-decisions

Ormond, J. (2021). ACM and IEEE-CS release Computing Curricula 2020, Global Guidelines for Baccalaureate Degrees in Computing. *Association for Computing Machinery News Release*. Retrieved on June 8, 2023, from https://www.acm.org/media-center/2021/march/computing-curricula-2020

Office of Science and Technology Policy. (2022). *Blueprint for an AI Bill of Rights*. Retrieved on June 14, 2023, from https://www.whitehouse.gov/ostp/ai-bill-of-rights/#safe

Panch T, Mattie H, & Atun R. (2019). Artificial intelligence and algorithmic bias: implications for health systems. *Journal of Global Health*. *9*(2):010318. doi: 10.7189/jogh.09.020318. PMID: 31788229; PMCID: PMC6875681.

Parikh, N. (2021). Understanding bias in AI-enabled hiring. *Forbes*. Retrieved on June 1, 2023, from https://www.forbes.com/sites/forbeshumanresourcescouncil/2021/10/14/understanding-bias-in-ai-enabled-hiring/?sh=737a60c17b96

Reinhardt, S. (1992). U.S. Court of Appeals, Ninth Circuit. SEGA Enterprises Ltd. v. Accolade, Inc. (977 F 2d 1510). Retrieved on May 29, 2023, from https://h2o.law.harvard.edu/cases/4486

Rouse, M. (2013). Software patent. *Techopedia.* Retrieved on May 29, 2023, from https://www.techopedia.com/definition/22199/software-patent

Sharp, A. (2023). EU lawmakers pass landmark AI regulation Bill. *FP*. Retrieved on June 14, 2023, from https://foreignpolicy.com/2023/06/14/eu-ai-act-european-union-chatgpt-regulations-transparency-privacy/

Sparkes, M. (2022). How can we prevent AI from being racist, sexist, and offensive? *New Scientist*, *255*(3302). p. 14.

Supreme Court of the U.S. (2021). *Google LLC v. Oracle America, Inc.* Retrieved on May 29, 2023, from https://www.supremecourt.gov/opinions/20pdf/18-956_d18f.pdf

Upcounsel. (2020). What is a software patent? *Upcounsel*. Retrieved on May 29, 2023, from https://www.upcounsel.com/software-patent

Uzzi, B. (2020). A simple tactic that could help reduce bias in AI. *Harvard Business Review.* Retrieved on May 29, 2023, from https://hbr.org/2020/11/a-simple-tactic-that-could-help-reduce-bias-in-ai

U.S. Copyright Office. (2023). *Artificial Intelligence Initiative; Issue No. 1004* - March 16, 2023. Retrieved on June 14, 2023, from https://copyright.gov/newsnet/2023/1004.html

Vincent, J. (2022). The lawsuit that could rewrite the rules of AI copyright. *The Verge.* Retrieved on June 14, 2023, from https://www.theverge.com/2022/11/8/23446821/microsoft-openai-github-copilot-class-action-lawsuit-ai-copyright-violation-training-data

Ye, J. (2023). Generative AI services. *Reuters*. Retrieved on June 14, 2023, from https://www.reuters.com/technology/china-releases-draft-measures-managing-generative-artificial-intelligence-2023-04-11/

Zou J, Schiebinger L. (2018). AI can be sexist and racist - it's time to make it fair. *Nature*. 559(7714):324-326. doi: 10.1038/d41586-018-05707-8. PMID: 30018439.

Editor's Note:

This paper was selected for inclusion in the journal as a 2023 ISCAP Conference Distinguished Paper. The acceptance rate is typically 7% for this category of paper based on blind reviews from six or more peers including three or more former best papers authors who did not submit a paper in 2023.

APPENDIX A
Sample Competency Statement

In 2020, the Association for Computing Machinery (ACM) and the IEEE Computer Society (IEEE-CS), with input from several other groups including the Education Special Interest Group of Information Systems and Computing Academic Professionals (EDSIG/ISCAP), published the Computing Curriculum 2020 (CC2020). The CC2020 report summarizes and brings together "the current state of curricular guidelines for academic programs that grant baccalaureate-level degrees in computing, as well as propose a vision for future curricular guidelines" (CC2020, 2020 p. 12).

The central theme of the report focuses on the inclusion of competencies in computing education. According to CC2020, "A competency is a collection of specific components of knowledge, skills, and dispositions. The knowledge dimension of competency encompasses concepts that are technical (computing concepts), foundational and professional (indicative of a workplace), and domain specific (the task setting)." CC2020 believes that "competency statements" — task descriptions that align with the relevant knowledge elements, skill level and disposition — are a key method of expressing a model of knowledge aligned with skills and professionalism (CC2020, 2020, p.48).

The CC2020 provided several component tables to help guide instructors in writing competency statements. In Table 4.1 of the report (shown below), the elements of computing knowledge are featured. (CC2020, 2020, p.49).

Table 4.1 illustrates thirty-four abbreviated knowledge areas partitioned into an ordered sequence of six categories. While the table is incomplete, it does provide an example of high-level vocabulary for computing knowledge rooted in the collective wisdom of different computing communities. This summary of computing knowledge areas represents a well-understood and consistent vocabulary from which computing competency statements can evolve.

Table 4.1. Elements of Computing Knowledge

Users and Organizations	Systems Modeling	Systems Architecture and Infrastructure	Software Development	Software Fundamentals	Hardware
Social Issues and Professional Practice Security Policy and Management IS Management and Leadership Enterprise Architecture Project Management User Experience Design	Security Issues and Principles Systems Analysis & Design Requirements Analysis and Specifications Data and Information Management	Virtual Systems and Services Intelligent Systems (AI) Internet of Things Parallel and Distributed Computing Computer Networks Embedded Systems Integrated Systems Technology Platform Technologies Security Technology and Implementation	Software Quality, Verification and Validation Software Process Software Modeling and Analysis Software Design Platform-Based Development	Graphics and Visualization Operating Systems Data Structures, Algorithms and Complexity Programming Languages Programming Fundamentals Computing Systems Fundamentals	Architecture and Organization Digital Design Circuits and Electronics Signal Processing

In Table 4.2 of the report, the elements of foundational and professional knowledge are recorded. "The thirteen elements of foundational and professional knowledge listed in Table 4.2 represent a subset of the professional listings derived from the IT2017 report and subsequently from Appendix D in this report. Computing professionals are commonly expected to demonstrate high levels of skill in applying this knowledge which deserves explicit attention in baccalaureate programs" (CC2020, 2020 P49).

Table 4.2. Elements of Foundational and Professional Knowledge

Knowledge Elements	Meaning
Analytical and Critical Thinking	A mental process of simplifying complex information into basic parts and evaluating results to make proper decisions
Collaboration and Teamwork	Apportion challenging tasks into simpler ones and then work together to complete them efficiently
Ethical and Intercultural Perspectives	Ethical perspectives of the different viewpoints someone uses to view a problem in the context of individual human values
Mathematics and Statistics	Use of numbers and theories abstractly especially in the collection and analysis of numerical data
Multi-Task Prioritization and Management	Processing several issues or tasks at once while arranging them according to importance to do specific one first
Oral Communication and Presentation	Conveying a message orally using real-time presentations with visual aids related audience interests and goals
Problem Solving and Trouble Shooting	A logical and orderly search for the source of a unit problem and making the unit operational again
Project and Task Organization and Planning	A process to provide decisions about a project concerning organization and planning to achieve a successful result
Quality Assurance / Control	Use of techniques, methods, and processes to identify and prevent defects according to defined quality standards
Relationship Management	A strategy to maintain an ongoing level of engagement usually between a business and its customers or other businesses
Research and Self-Starter/Learner	Someone who begins or undertakes work or a project without needing direction or encouragement to do so
Time Management	An ability to use a person's time in an effective or productive manner to work efficiently
Written Communication	Use of a written form of interaction between people and organizations that provides an effective way of messaging

"As CC2020 defines skill — the proficient applying of knowledge — Table 4.3 summarizes an ordered sequence of six cumulative levels of skill (cognitive skill) together with abbreviated definitions. These levels correlate with Bloom's taxonomy that permits the adoption of a commonly agreed vocabulary as described in the 2001 revisions to Bloom's taxonomy of educational objectives. The table lists the cognitive skills as verbs" (CC2020, 2020, p. 50).

Table 4.3. Levels of Cognitive Skills Based on Bloom's Taxonomy

Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Exhibit memory of previously learned materials by recalling facts, terms, basic concepts, and answers.	Demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, and giving descriptions.	Solve problems in new situations by applying acquired knowledge, facts, techniques, and rules in a different way.	Examine and break information into parts by identifying motives or causes; make inferences and find evidence to support solutions.	Present and defend opinions by making judgments about information, validity of ideas, or quality of material.	Compile information together in a different way by combining elements in a new pattern or by proposing alternative solutions.

"Dispositions define the third dimension of competency. Table 4.4 displays eleven prospective dispositions derived from the literature. Disposition, as an intrinsic component of competency, represents the opportunity to express institutional and programmatic values expected in the workplace. Dispositional expectations enrich the description/assessment of competency and/or the related pedagogy. Ascribing a disposition to a competency indicates a clear commitment to self-reflection and examination that distinctly distinguishes a competency from a learning outcome" (CC2020, 2020, p. 50).

Table 4.4. Prospective Elements of Dispositions

Element	Elaboration	Element	Elaboration
Adaptable	Flexible; agile, adjust in response to change	Professional:	Professionalism, discretion, ethical, astute
Collaborative:	Team player, willing to work with others	Purpose-driven:	Goal driven, achieve goals, business acumen
Inventive:	Exploratory. Look beyond simple solutions	Responsible:	Use judgment, discretion, act appropriately
Meticulous:	Attentive to detail; thoroughness, accurate	Responsive:	Respectful; react quickly and positively
Passionate:	Conviction, strong commitment, compelling	Self-directed:	Self-motivated, determination, independent
Proactive:	With initiative, self-starter, independent		

The authors have taken the focus of this article — professional, legal and ethical issues in machine learning — and created a competency statement which may be used to orientate the task of identifying the salient issues and creating awareness of potential resolutions.

Competency Title: Risk Management of Legal and Ethical Issues in Machine Learning				
Competency Statement Analyze machine learning scenarios and identify legal and ethical issues that would place business organizations at risk; propose solutions/resolutions/safeguards.				
Knowledge Element [Table #4.1 & 4.2](CC2020, 49; 50) (CC2020, 51)				**Skill Level** [Table 4.3]
Social Issues and Professional Practice				Analyzing
Data and Information Management				Applying
Intelligent Systems (AI)				Analyzing
Software Design				Applying
Analytical and Critical Thinking				Analyzing
Ethical and Intercultural Perspectives				Applying
Written [and/or Oral] Communication				Creating
Disposition(s) [Table 4.4] (CC2020, 51)				
Adaptable	Inventive	Professional	Responsible	Responsive

Knowledge Elements:
(1) Social Issues and Professional Practice: It is important for computer scientists to understand the relevant social, ethical, and professional issues that surround their activities. According to the ACM Code of Ethics and Professional Conduct, a computing professional should “contribute to society and to human well-being, acknowledging that all people are stakeholders in computing” and “avoid harm” (ACM Code, 1.1 and 1.2). The Code also requires the computer scientist to “be fair and take action not to discriminate” (ACM Code 1.4). By analyzing the issues in the two exercises included in Appendices B (The Moral Machine) and C (Not OK: AI Copyright Infringement), students will gain awareness of the ethical issues of programming bias and intellectual property theft, and work through potential solutions to these issues.

(2) Data and Information Management: Computer science and MIS students may be responsible for managing and mining significant amounts of data, and the way in which they use that data to create products and algorithms is becoming increasingly important. Students as computing professionals

engaged in system development will have a personal responsibility for programs and data use that may adversely affect the public. Again, by analyzing the issues in the two exercises included in Appendices B (The Moral Machine) and C (Not OK: AI Copyright Infringement), students will gain awareness of how proper data management is critical to protecting individual rights and preventing bias and discrimination. Once aware of the potential issues, students can apply this knowledge in designing safeguards which may be utilized in the design of data management and use.

(3) Intelligent Systems (AI): Another professional responsibility of computing professionals is embodied in the ACM Code 2.5: "Give comprehensive and thorough evaluations of computer systems and their impacts, including analysis of possible risks." This Code note especially highlights that "extraordinary care should be taken to identify and mitigate potential risks in machine learning systems." Therefore, this knowledge component in the competency focuses on awareness of the potential risks that AI enhanced programs pose through their operation, and the computer professional's responsibility to establish preventative measures to protect users. The content of this article, and the two exercises included here — one on programming bias and one on copyright infringement — detail the dangers that may be associated with AI enhanced programs, and ask students to critically think through potential remedies and safeguards.

(4) Software Design: Students should be able to identify issues in software and program design that may be problematic for users and their respective organizations. Programming bias in AI algorithms, and copyright infringement by AI enhanced programs, are significant issues for organizations that either create products or use AI to generate content. Using the two exercises in Appendices B and C, as well as the White House's Blueprint for an AI Bill of Rights, students should be able to identify risks in software design and apply this awareness to creating safeguards that will mitigate these risks.

(5) Analytical and Critical Thinking: Using the exercises on programming bias and copyright infringement, students will analyze the potential legal and ethical risks inherent in AI enhanced programs use and propose potential solutions and safeguards. By creating awareness and understanding of these complex issues, students will be able to evaluate risks and apply this knowledge to make proper decisions. Knowledge of intellectual property law and employment law, as well as current regulatory guidelines as included in this article's content, should aid students in identifying whether their organization's practices are aligned with compliance — and if not, what steps could be taken to refocus a company's operations to ensure that ethical and legal tenants are adhered to.

(6) Ethical and Intercultural Perspectives: Once again using the exercises included in Appendices B and C, students may apply their knowledge of law and ethical issues regarding AI programming and copyright issues in ensuring that policies and decisions include safeguards against discrimination and IP violations. This will be especially important as the AI industry sees more and more applications in narrow artificial intelligence, and critical as we may someday realize the development of strong AI and general artificial intelligence.

(7) Written Communication: This Competency Statement requires the student to identify legal and ethical issues within the topics of programming bias and copyright infringement, and propose solutions/resolutions/safeguards. In the Moral Machine Exercise (Appendix B), students are asked to share their opinions of the reasons for cultural bias found by the MIT team by posting to collaboration boards or otherwise submitting written and/or oral communication on the focused issues. In the Not OK: AI Copyright Infringement Exercise (Appendix C), students are also asked to analyze and present, either in writing or verbally, the ethical issues in the "taking" of computer science professor Tim Davis's copyrighted code. Students are also asked to propose solutions and/or safeguards to these complex issues.

Appendix B
Moral Machine Exercise

As originally envisioned, AI was thought of to eliminate bias and promote Diversity, Equity & Inclusion. Increasing use of weak AI has certainly led to positives and efficiencies in modern society, yet it has also uncovered a darker side — including use characterized by perpetuating stereotypes, incorporating bias, and failing to eliminate discriminatory practices.

The focus of this exercise is to create awareness in computing students with regard to the insidious way bias can creep into their programming, coding, and product designs. Such discrimination is not only harmful to users, but it can generate significant professional and legal liability for program developers and businesses.

In the Moral Machine Experiment, MIT researchers sought to test how people around the world would decide significant moral dilemmas. The project gathered data on millions of humans' moral decisions, and this data was used to train machine-learning algorithms. The intent — built around autonomous vehicle decisions — was to determine what may potentially influence human machine learning programming. The results surprised the social psychologists involved in the experiment; significant cultural biases were unearthed that could be regionalized, and conversely certain trends were globally apparent. There were findings that aligned with developed vs. developing countries; the extent of economic inequality in a region; and individualist and collectivist cultures. The data revealed that programmers should be aware of how bias can influence outcomes when they are creating products or services — especially when human lives are on the line.

The authors have created a lesson around the Moral Machine Experiment. Although the data gathering phase of the project ended in 2020, the exercise is still available for use by individuals, and may be found at the following link: https://www.moralmachine.net. One of the authors uses the Moral Machine lesson in an ethics course, so we have created a Nearpod Lesson that may be accessed in self-paced mode by students anywhere in the world. Nearpod is a hybrid learning tool that combines multimedia learning with digital assessments; the program is highly interactive and may be used in self-paced or a live-action mode. Students can access the self-paced lesson by going to www.nearpod.com, and enter the access code under "Join a lesson" when prompted. They can re-enter the lesson anytime using the same code. Instructors who would like an editable copy of the lesson can sign up for a free Nearpod account, and then access the editable link below and add the lesson to their library. Once in your library, an instructor can change the lesson, set up their own self-paced version, or add a "live" session to their classroom. There is also a significant reporting feature in Nearpod. The slides from the exercise are additionally included (following the links) here if the instructor would prefer to use the exercise resources outside the Nearpod app.

Nearpod Editable Link for Educators:

https://np1.nearpod.com/sharePresentation.php?code=b59aba4c7b642572f5b4bf9f05446e00-1&oc=user-created&utm_source=link

The Moral Machine

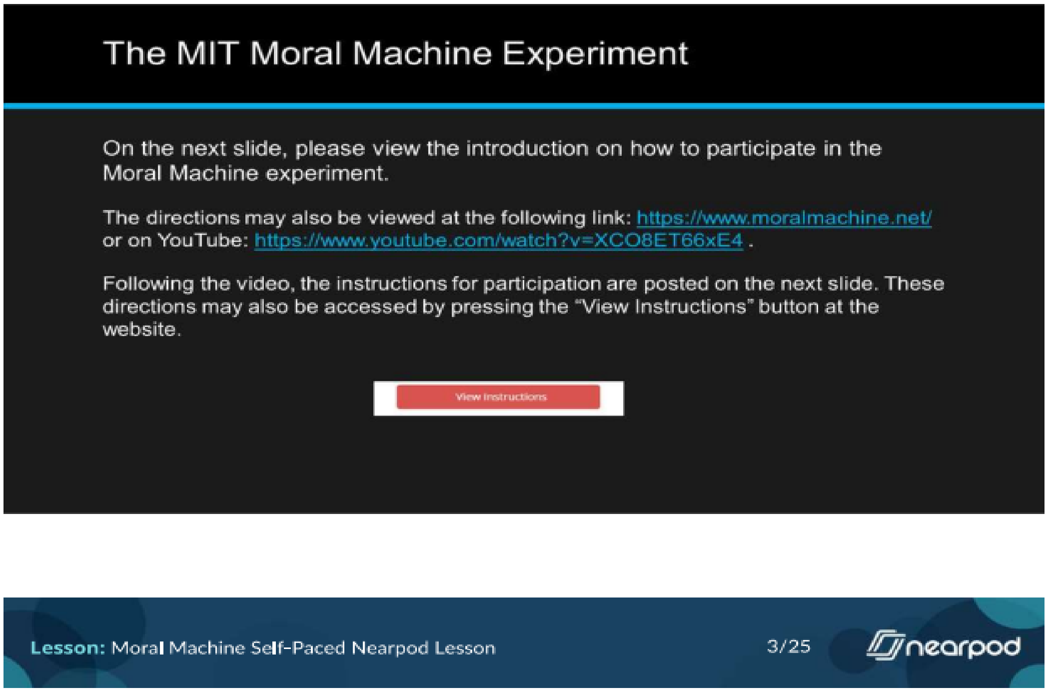
Lesson: Moral Machine Self-Paced Nearpod Lesson 1/25 nearpod

The MIT Moral Machine Experiment

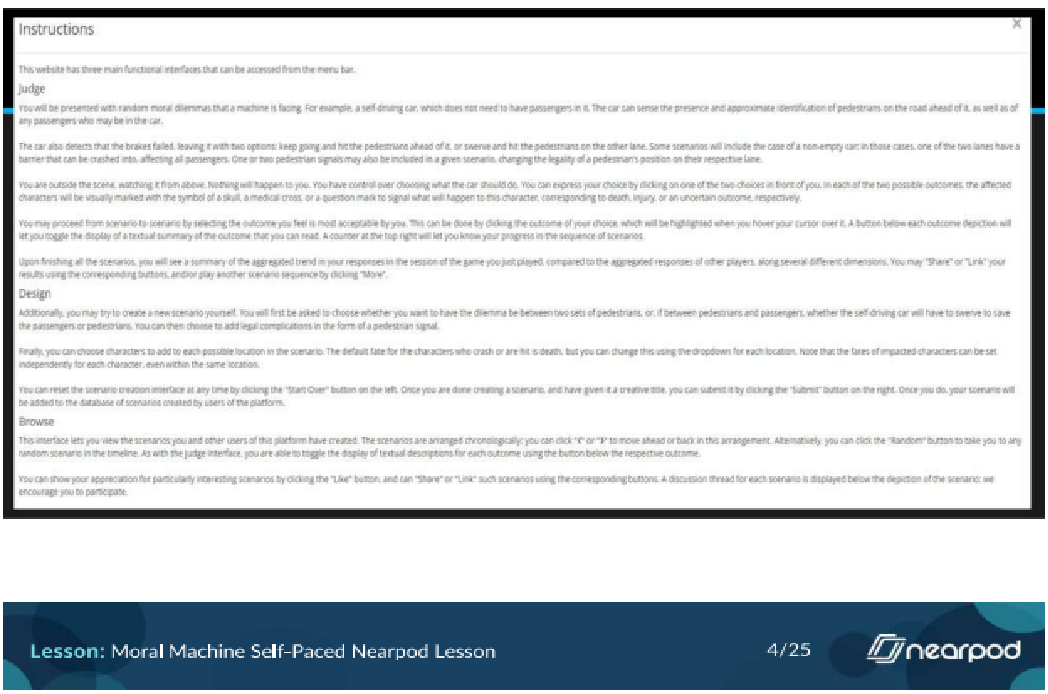
- The Moral Machine is an online platform developed by Iyad Rahwan's Scalable Cooperation group at the Massachusetts Institute of Technology (MIT).
- The project tested human responses in over 200 countries to moral dilemmas and collected information on the decisions that these people made between two destructive outcomes.
- The project has gathered data on millions of humans' moral decisions, and this data was used to train machine-learning algorithms.
- As artificial intelligence plays an increasingly significant role in autonomous driving technology, research projects like Moral Machine are intended to help find solutions for challenging life-and-death decisions that will face self-driving vehicles.

Lesson: Moral Machine Self-Paced Nearpod Lesson 2/25 nearpod

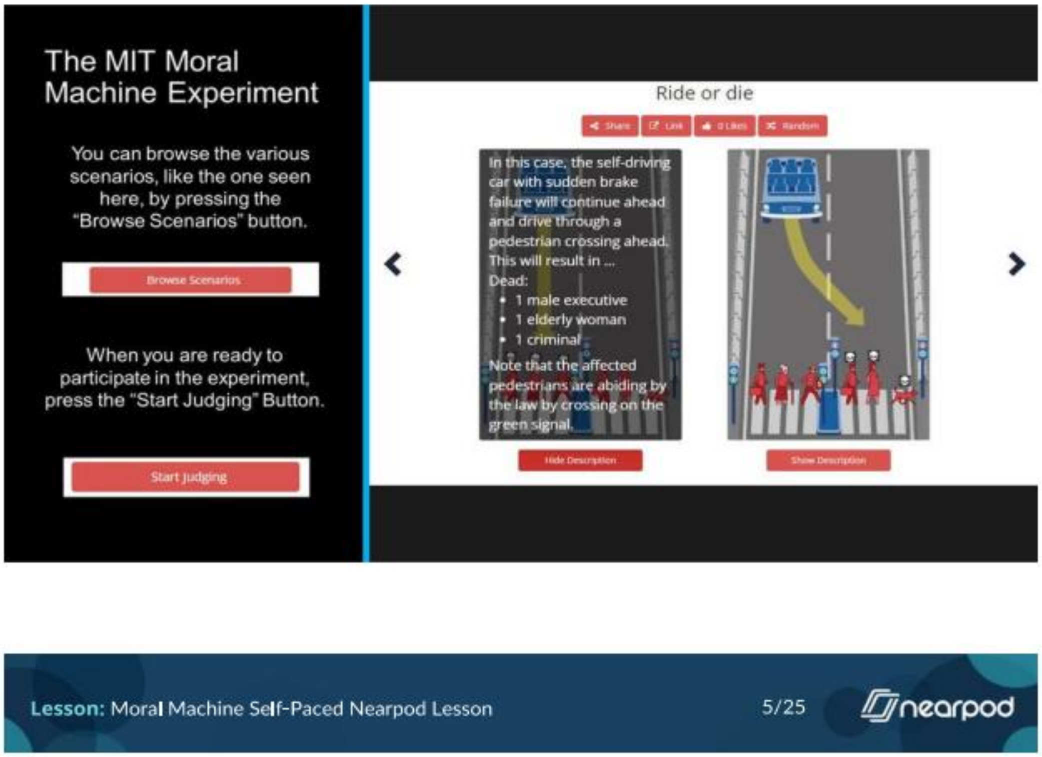
\

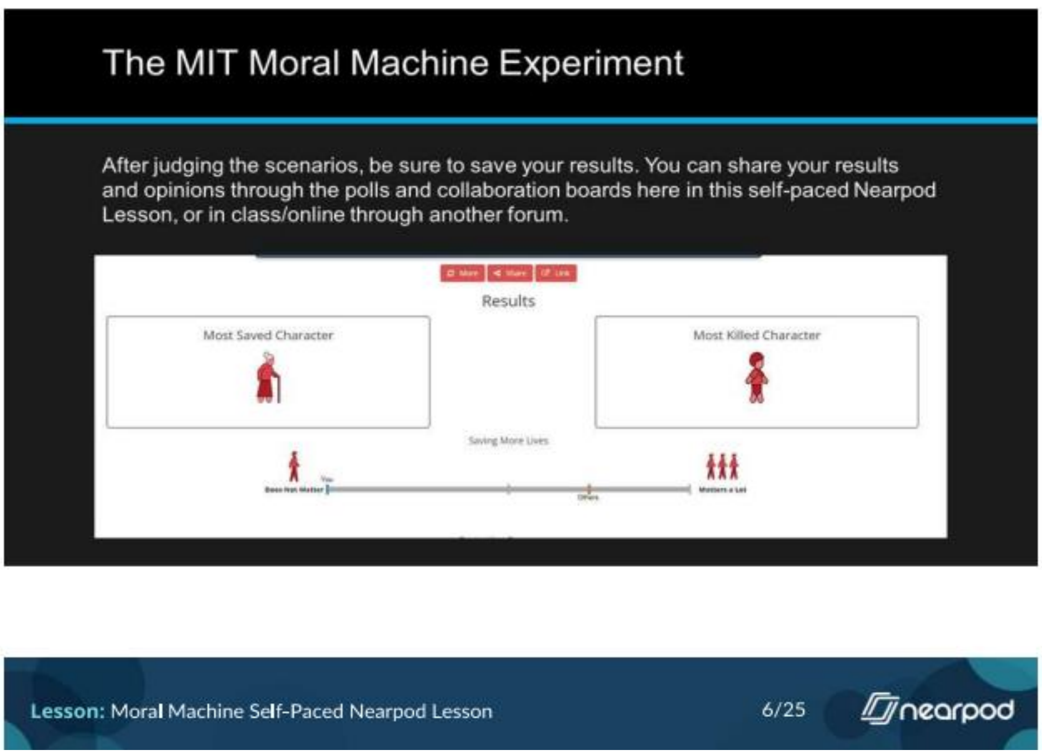


The MIT Moral Machine Experiment
On the next slide, please view the introduction on how to participate in the Moral Machine experiment.
The directions may also be viewed at the following link: https://www.moralmachine.net/ or on YouTube: https://www.youtube.com/watch?v=XCO8ET66xE4 .
Following the video, the instructions for participation are posted on the next slide. These directions may also be accessed by pressing the "View Instructions" button at the website.
View Instructions
Lesson: Moral Machine Self-Paced Nearpod Lesson
3/25
nearpod

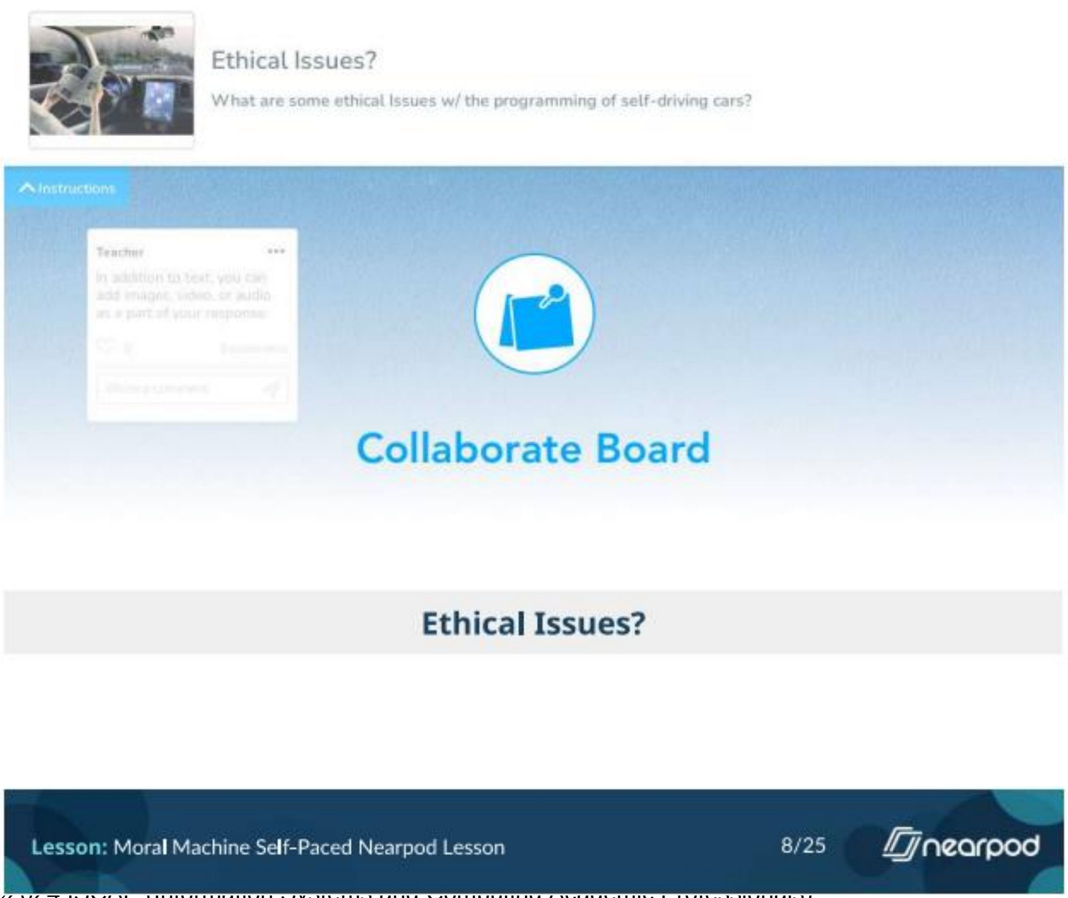


Instructions
This website has three main functional interfaces that can be accessed from the menu bar.
Judge
You will be presented with random moral dilemmas that a machine is facing. For example, a self-driving car, which does not need to have passengers in it. The car can sense the presence and approximate identification of pedestrians on the road ahead of it, as well as of any passengers who may be in the car.
The car also detects that the brakes failed, leaving it with two options: keep going and hit the pedestrians ahead of it, or swerve and hit the pedestrians on the other lane. Some scenarios will include the case of a non-empty car: in those cases, one of the two lanes have a barrier that can be crashed into, affecting all passengers. One or two pedestrian signals may also be included in a given scenario, changing the legality of a pedestrian's position on their respective lane.
You are outside the scene, watching it from above. Nothing will happen to you. You have control over choosing what the car should do. You can express your choice by clicking on one of the two choices in front of you. In each of the two possible outcomes, the affected characters will be visually marked with the symbol of a skull, a medical cross, or a question mark to signal what will happen to this character, corresponding to death, injury, or an uncertain outcome, respectively.
You may proceed from scenario to scenario by selecting the outcome you feel is most acceptable by you. This can be done by clicking the outcome of your choice, which will be highlighted when you hover your cursor over it. A button below each outcome depiction will let you toggle the display of a textual summary of the outcome that you can read. A counter at the top right will let you know your progress in the sequence of scenarios.
Upon finishing all the scenarios, you will see a summary of the aggregated trend in your responses in the session of the game you just played, compared to the aggregated responses of other players, along several different dimensions. You may "Share" or "Link" your results using the corresponding buttons, and/or play another scenario sequence by clicking "More".
Design
Additionally, you may try to create a new scenario yourself. You will first be asked to choose whether you want to have the dilemma be between two sets of pedestrians, or, if between pedestrians and passengers, whether the self-driving car will have to swerve to save the passengers or pedestrians. You can then choose to add legal complications in the form of a pedestrian signal.
Finally, you can choose characters to add to each possible location in the scenario. The default fate for the characters who crash or are hit is death, but you can change this using the dropdown for each location. Note that the fates of impacted characters can be set independently for each character, even within the same location.
You can reset the scenario creation interface at any time by clicking the "Start Over" button on the left. Once you are done creating a scenario, and have given it a creative title, you can submit it by clicking the "Submit" button on the right. Once you do, your scenario will be added to the database of scenarios created by users of the platform.
Browse
This interface lets you view the scenarios you and other users of this platform have created. The scenarios are arranged chronologically; you can click "‹" or "›" to move ahead or back in this arrangement. Alternatively, you can click the "Random" button to take you to any random scenario in the timeline. As with the Judge interface, you are able to toggle the display of textual descriptions for each outcome using the button below the respective outcome.
You can show your appreciation for particularly interesting scenarios by clicking the "Like" button, and can "Share" or "Link" such scenarios using the corresponding buttons. A discussion thread for each scenario is displayed below the depiction of the scenario; we encourage you to participate.
Lesson: Moral Machine Self-Paced Nearpod Lesson
4/25
nearpod

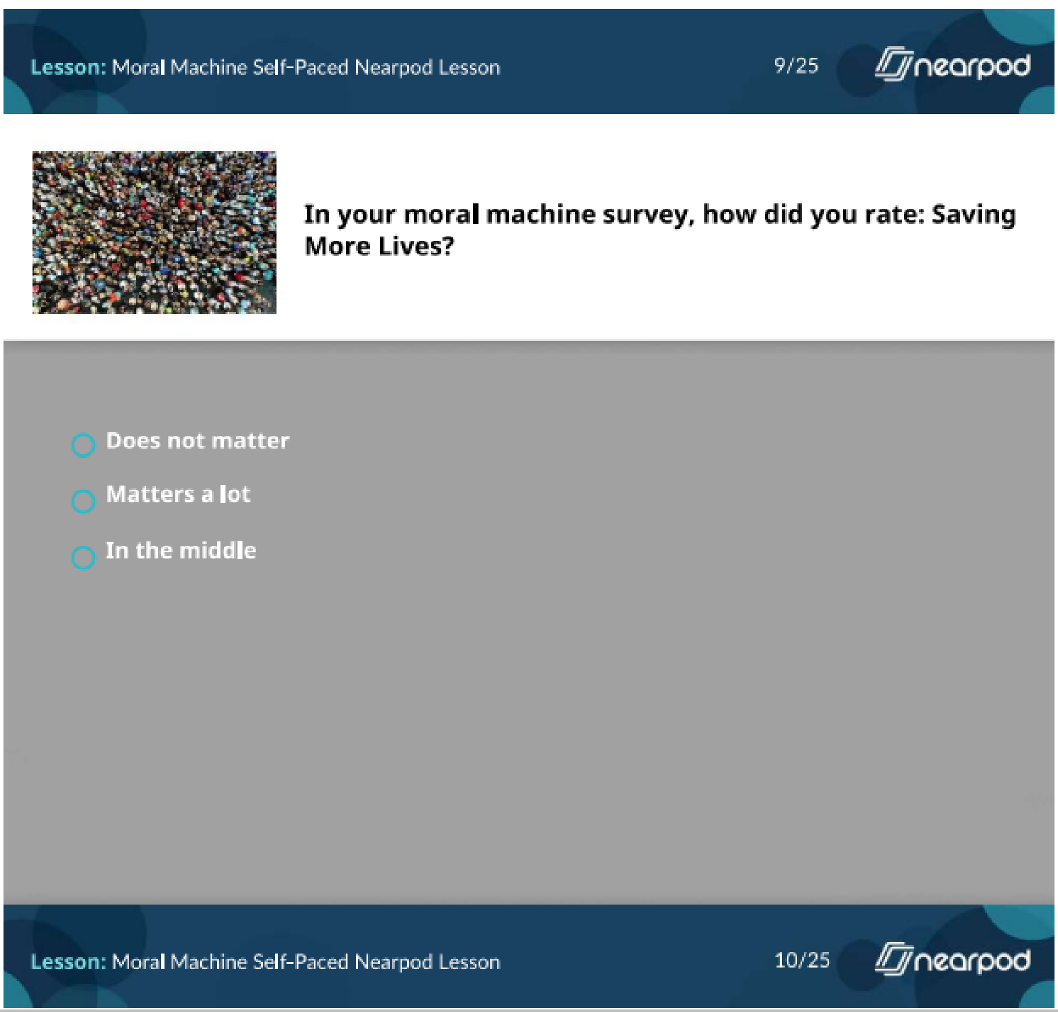

The MIT Moral Machine Experiment
You can browse the various scenarios, like the one seen here, by pressing the "Browse Scenarios" button.
Browse Scenarios
When you are ready to participate in the experiment, press the "Start Judging" Button.
Start judging
Ride or die
In this case, the self-driving car with sudden brake failure will continue ahead and drive through a pedestrian crossing ahead. This will result in ...
Dead:
1 male executive
1 elderly woman
1 criminal
Note that the affected pedestrians are abiding by the law by crossing on the green signal.
Hide Description
Show Description
Lesson: Moral Machine Self-Paced Nearpod Lesson
5/25
nearpod

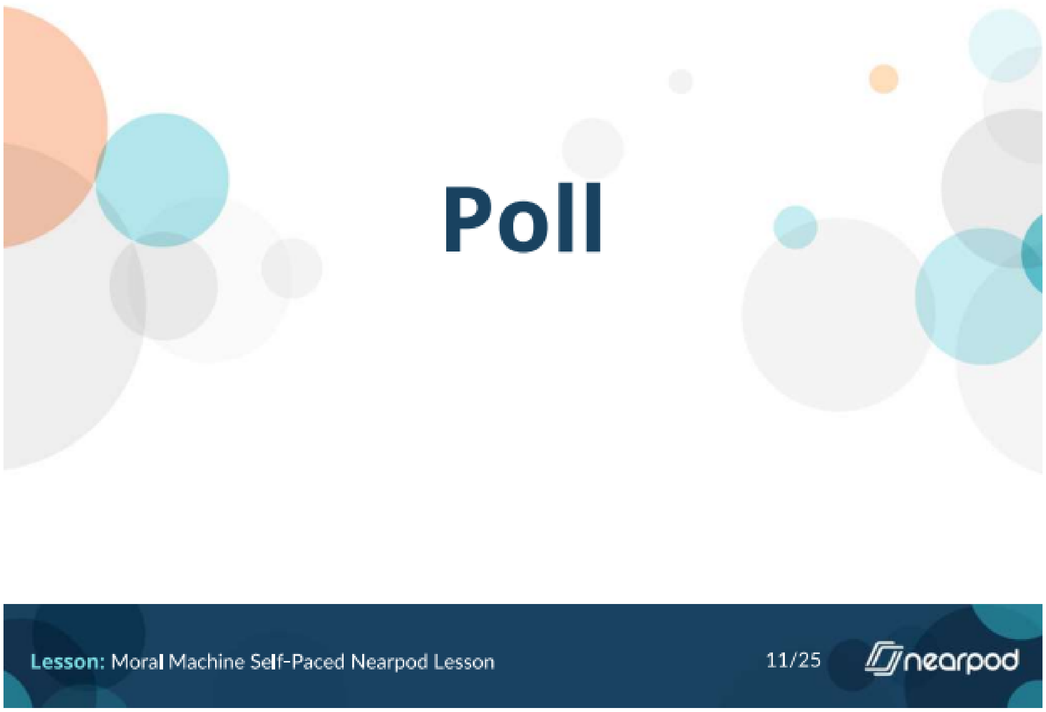

The MIT Moral Machine Experiment
After judging the scenarios, be sure to save your results. You can share your results and opinions through the polls and collaboration boards here in this self-paced Nearpod Lesson, or in class/online through another forum.
Results
Most Saved Character
Most Killed Character
Lesson: Moral Machine Self-Paced Nearpod Lesson
6/25
nearpod

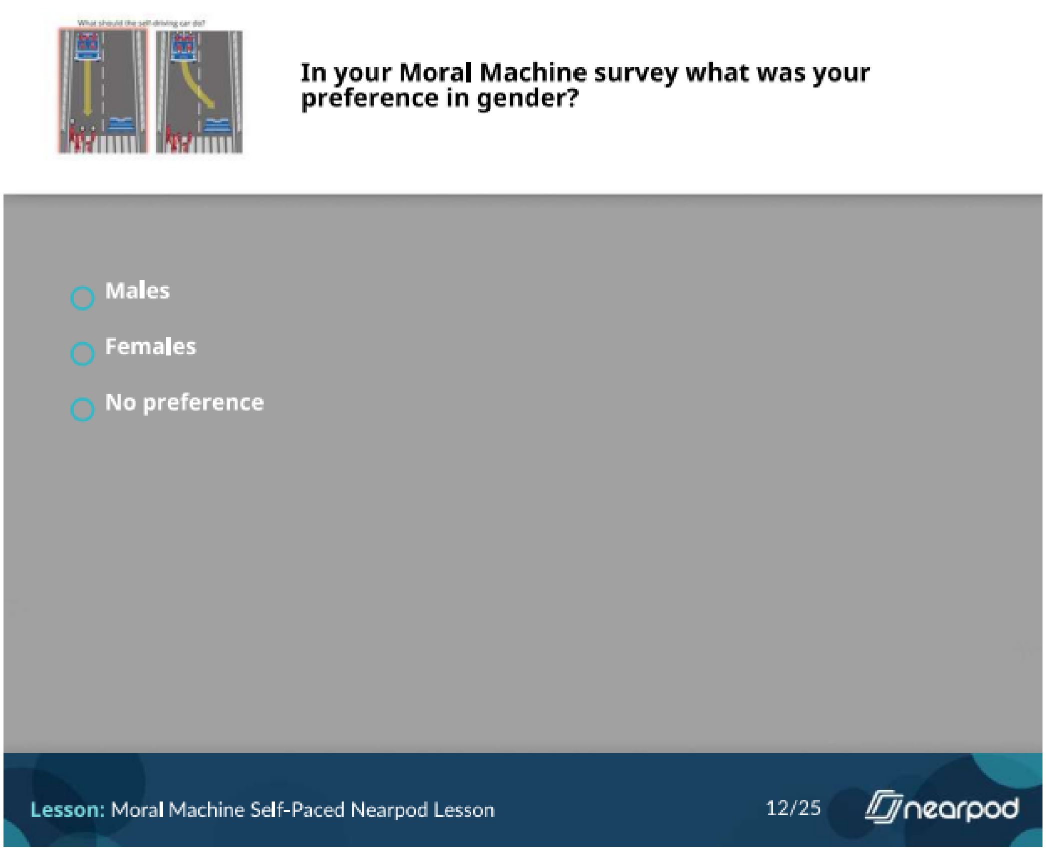

Moral Machine
Directions at MIT
Lesson: Moral Machine Self-Paced Nearpod Lesson
7/25

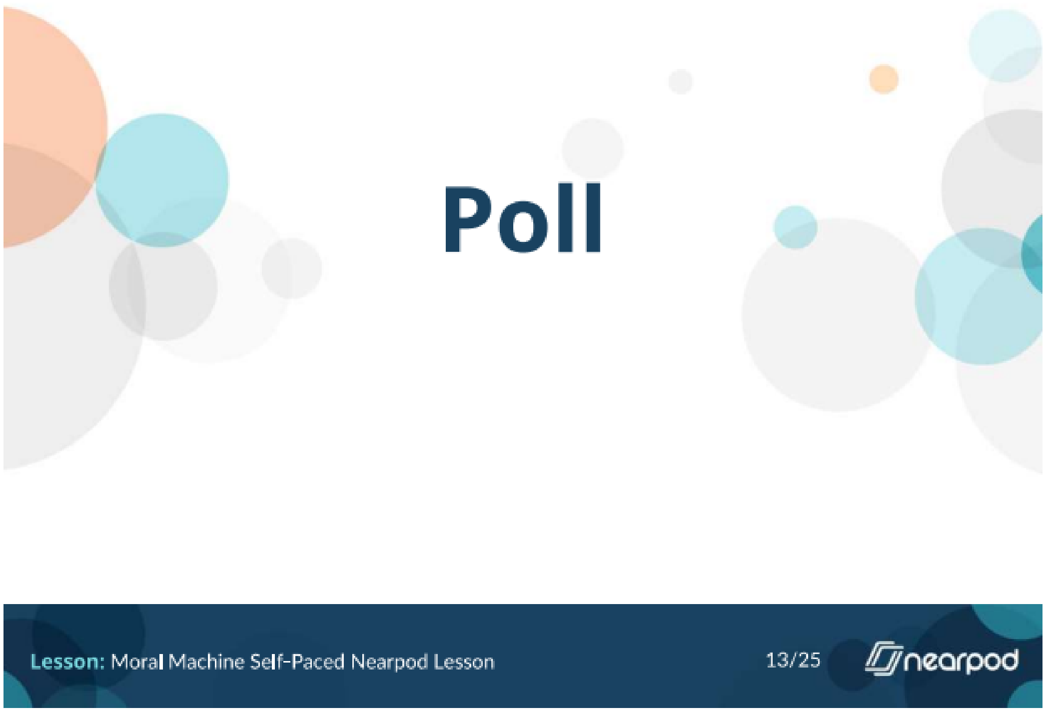

Ethical Issues?
What are some ethical Issues w/ the programming of self-driving cars?
Instructions
Collaborate Board
Ethical Issues?
Lesson: Moral Machine Self-Paced Nearpod Lesson
8/25

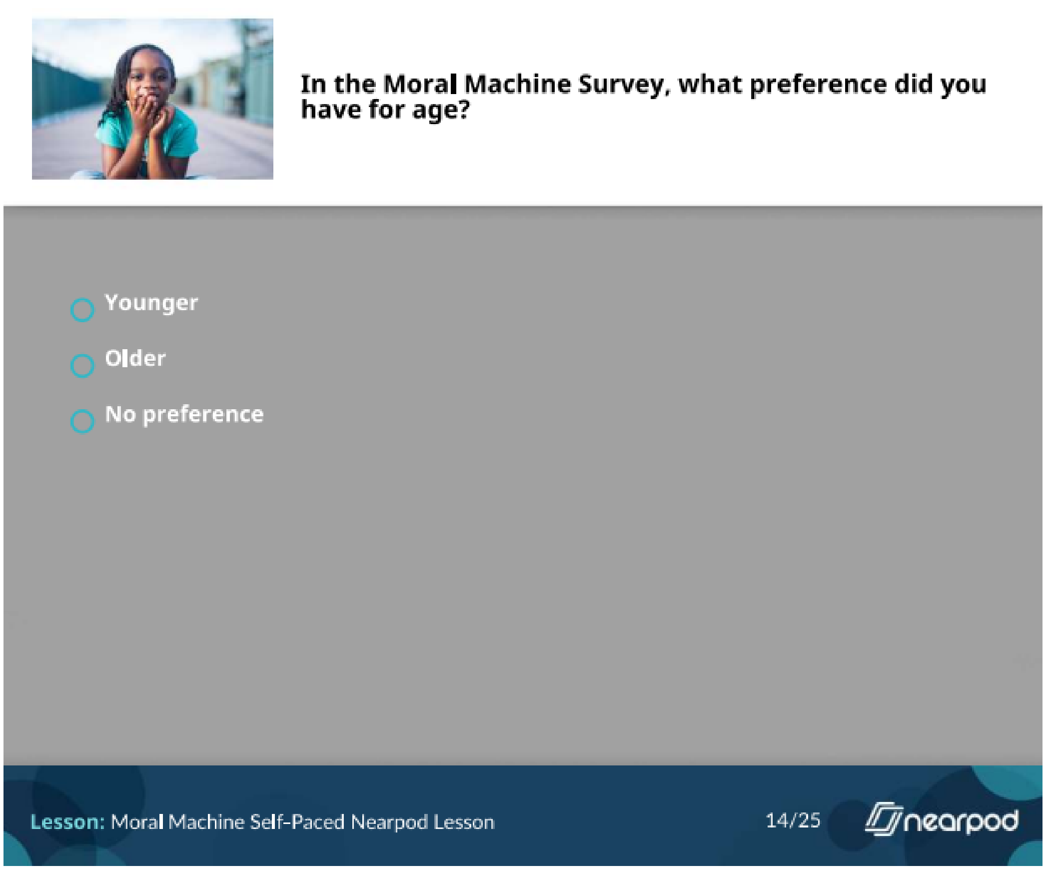

Poll

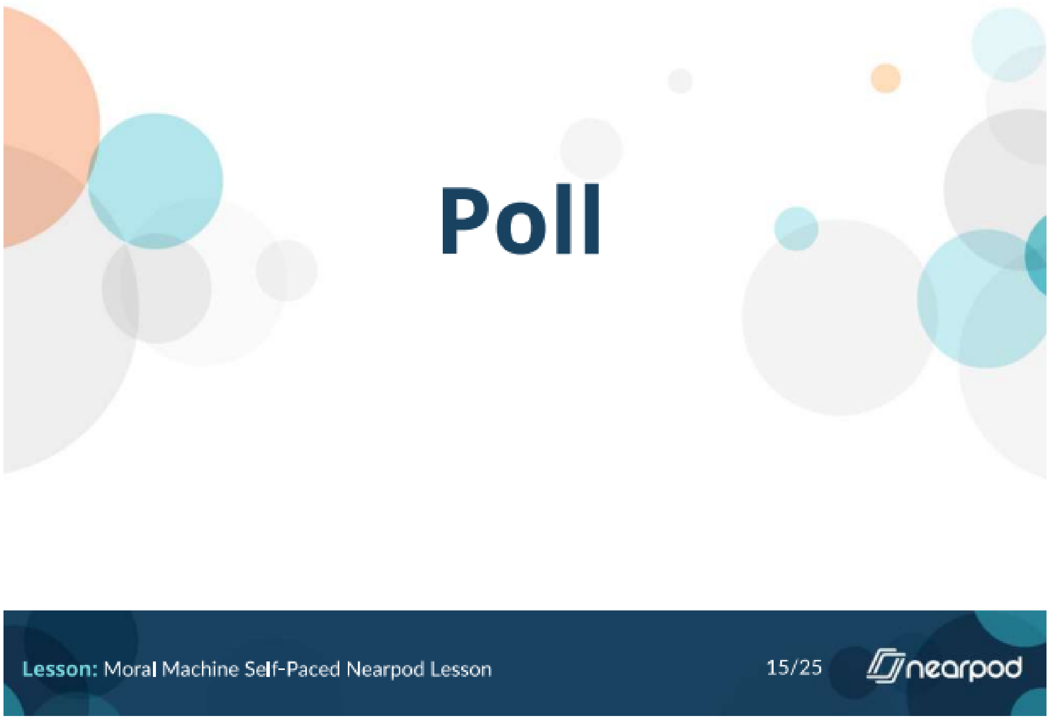

Lesson: Moral Machine Self-Paced Nearpod Lesson
9/25
In your moral machine survey, how did you rate: Saving More Lives?
Does not matter
Matters a lot
In the middle
Lesson: Moral Machine Self-Paced Nearpod Lesson
10/25

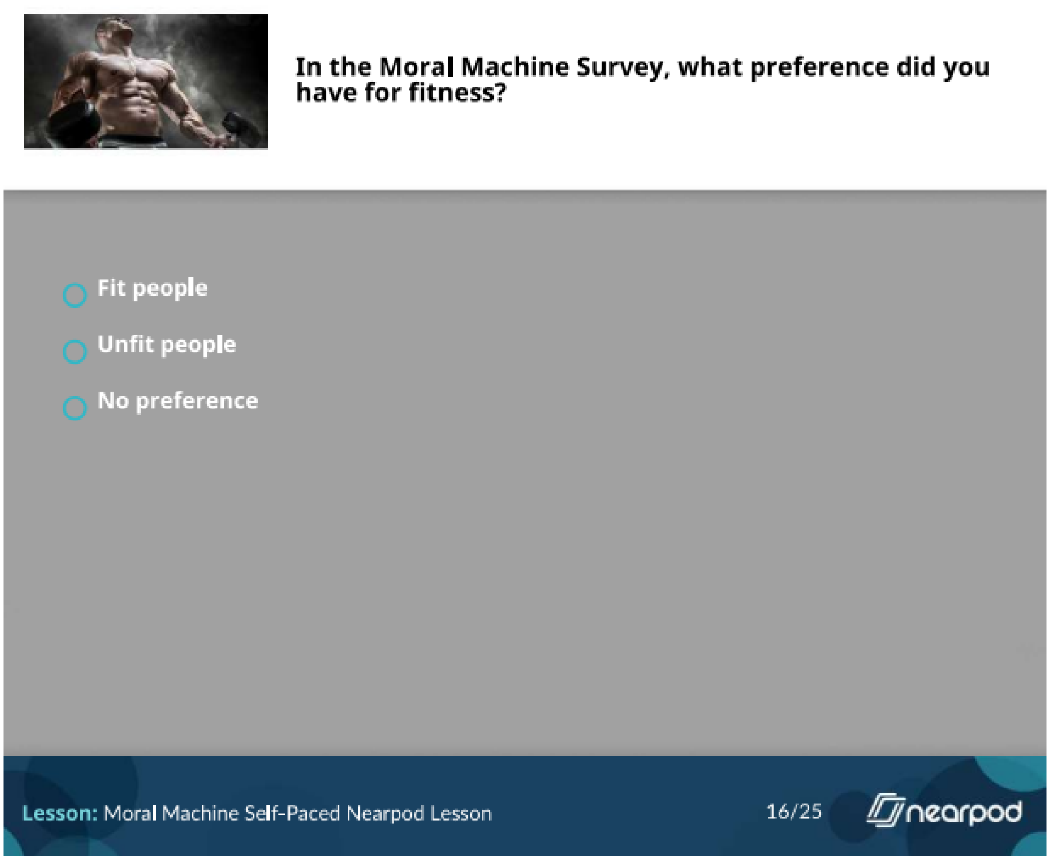

Poll
Lesson: Moral Machine Self-Paced Nearpod Lesson
11/25
nearpod

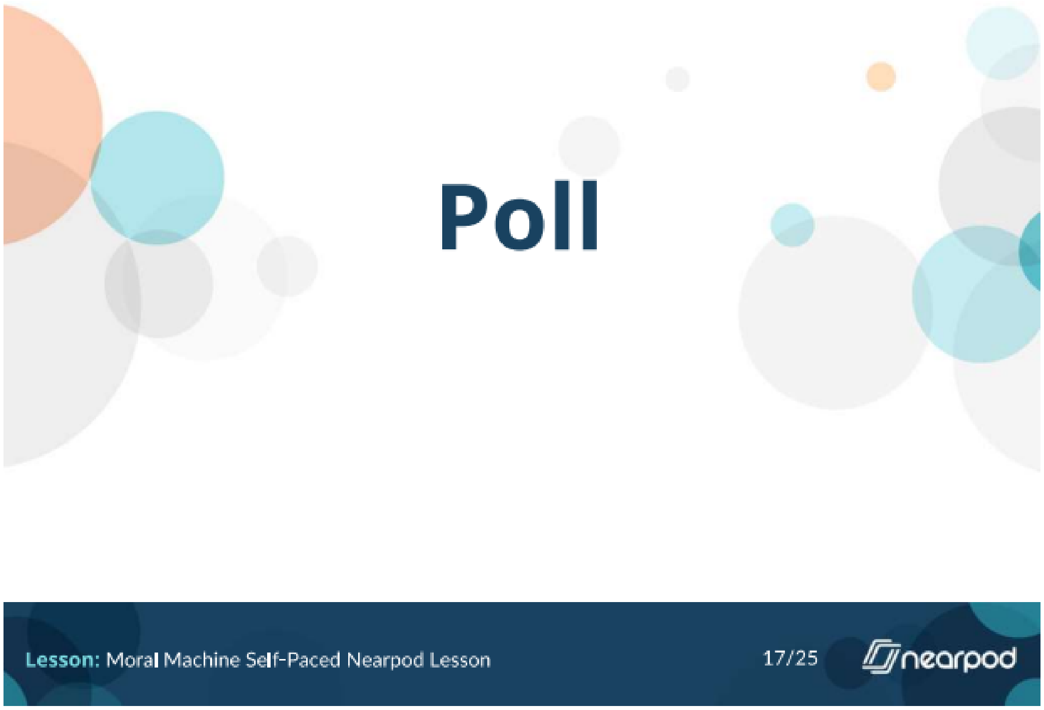

In your Moral Machine survey what was your preference in gender?
Males
Females
No preference
Lesson: Moral Machine Self-Paced Nearpod Lesson
12/25
nearpod

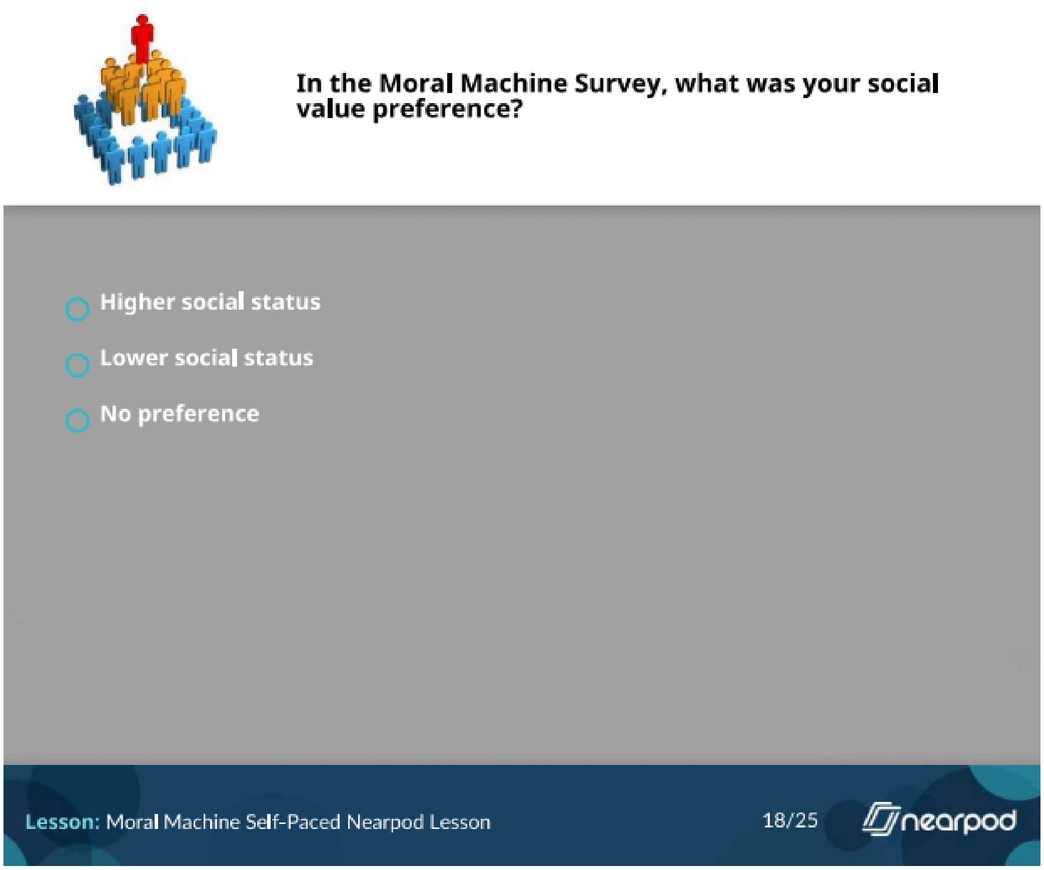

Poll
Lesson: Moral Machine Self-Paced Nearpod Lesson
13/25
nearpod

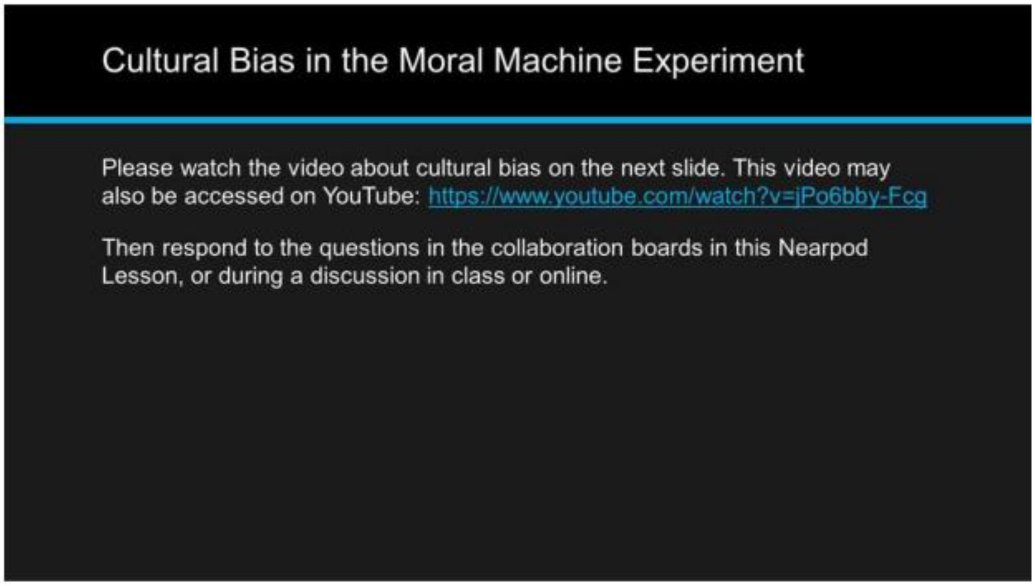

In the Moral Machine Survey, what preference did you have for age?
Younger
Older
No preference
Lesson: Moral Machine Self-Paced Nearpod Lesson
14/25
nearpod

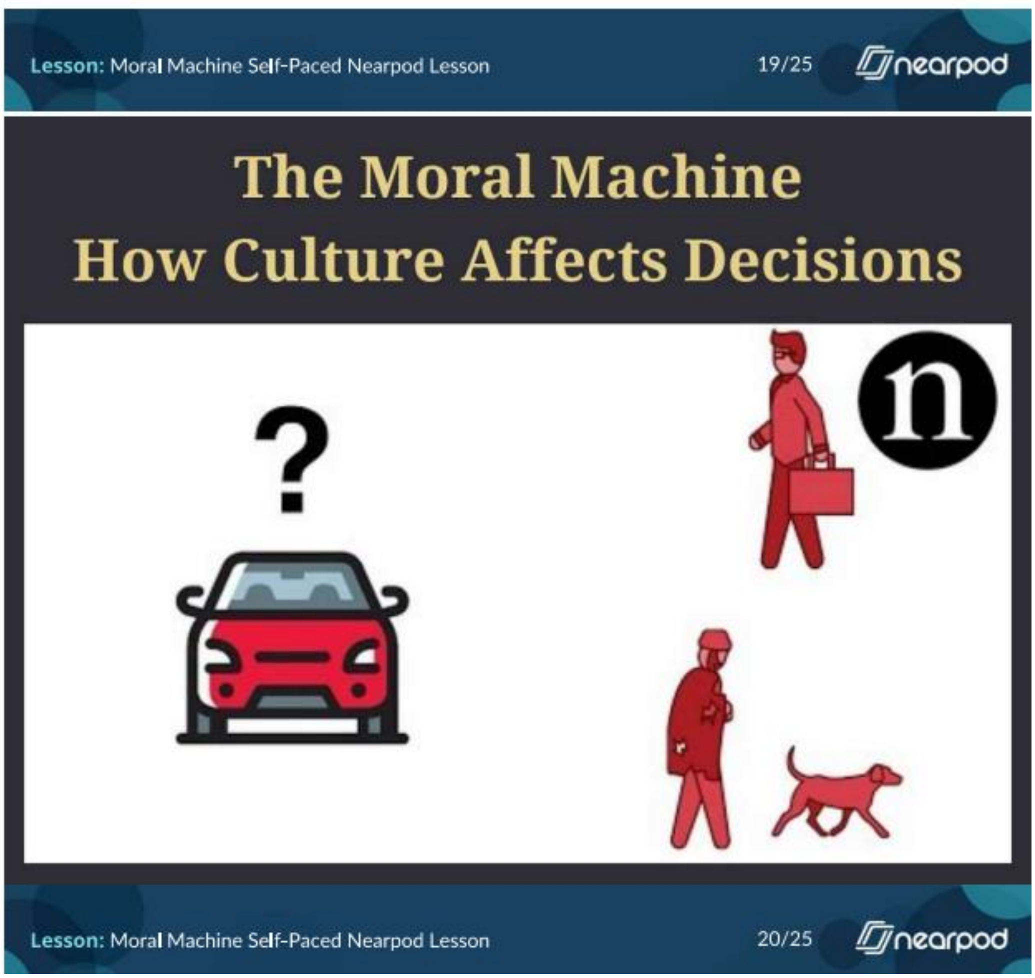

Poll
Lesson: Moral Machine Self-Paced Nearpod Lesson
15/25
nearpod

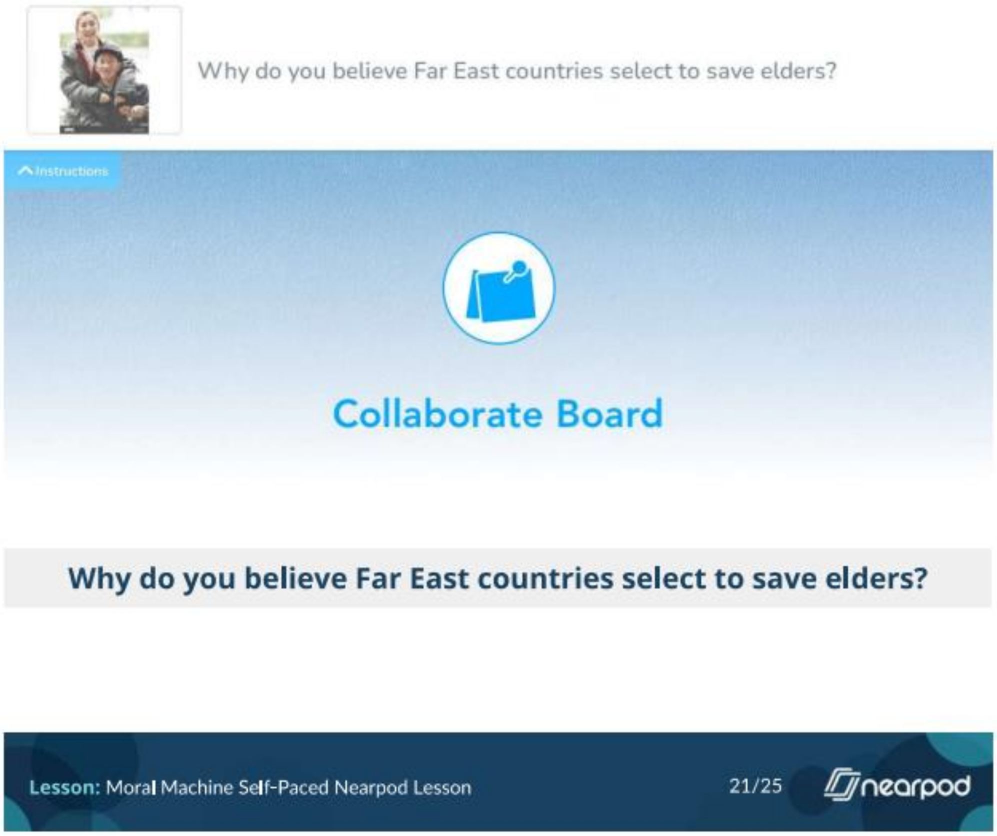

In the Moral Machine Survey, what preference did you have for fitness?
Fit people
Unfit people
No preference
Lesson: Moral Machine Self-Paced Nearpod Lesson
16/25
nearpod


Poll
Lesson: Moral Machine Self-Paced Nearpod Lesson
17/25
nearpod


In the Moral Machine Survey, what was your social value preference?
Higher social status
Lower social status
No preference
Lesson: Moral Machine Self-Paced Nearpod Lesson
18/25
nearpod


Cultural Bias in the Moral Machine Experiment
Please watch the video about cultural bias on the next slide. This video may also be accessed on YouTube: https://www.youtube.com/watch?v=jPo6bby-Fcg
Then respond to the questions in the collaboration boards in this Nearpod Lesson, or during a discussion in class or online.

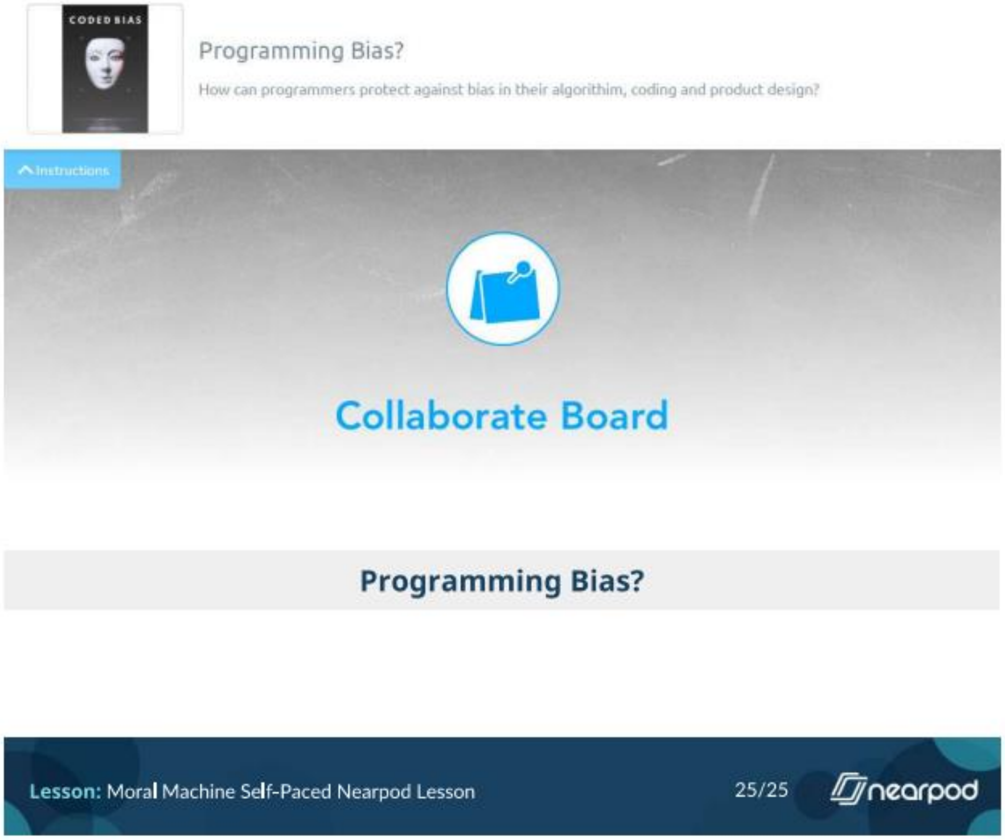

Lesson: Moral Machine Self-Paced Nearpod Lesson
19/25
The Moral Machine
How Culture Affects Decisions
?
Lesson: Moral Machine Self-Paced Nearpod Lesson
20/25


Why do you believe Far East countries select to save elders?
Instructions
Collaborate Board
Why do you believe Far East countries select to save elders?
Lesson: Moral Machine Self-Paced Nearpod Lesson
21/25
nearpod


Why do French-affiliated countries prefer to save females?
Instructions
Collaborate Board
Why do French-affiliated countries prefer to save females?
Lesson: Moral Machine Self-Paced Nearpod Lesson
22/25
nearpod


Why would affluent countries prefer to save higher status?
Instructions
Collaborate Board
Why would affluent countries prefer to save higher status?
Lesson: Moral Machine Self-Paced Nearpod Lesson
23/25
nearpod

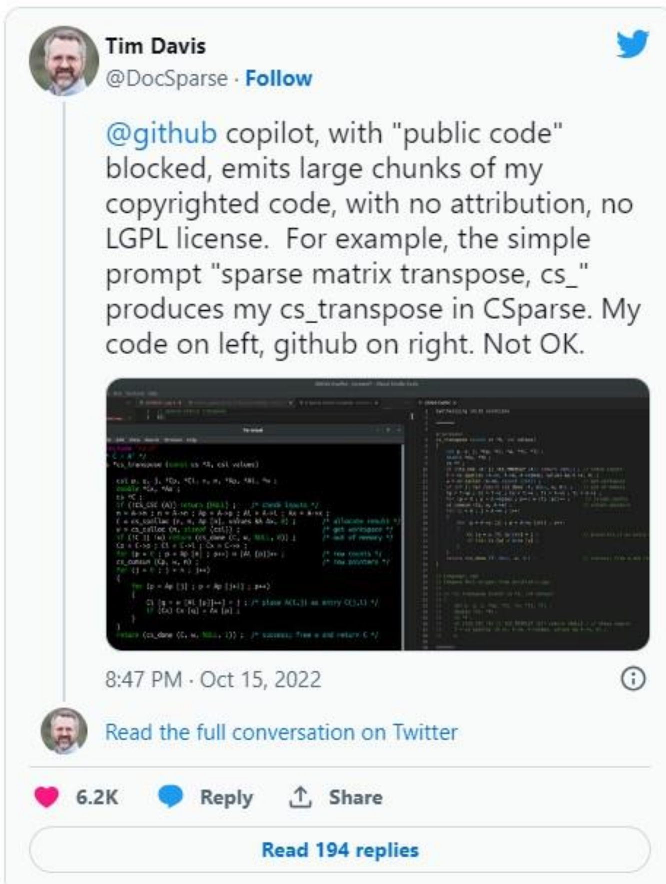

Programming Bias in the Moral Machine Experiment
Think about the following statement: "People like to assume that computers and machines are neutral in their results. In reality, machine-learning software that uses datasets to "train" software often amplifies existing social biases. Companies are currently relying heavily on software that learns by sorting piles of data. This has led to computers taking on unsavory biases from both the programmer and society in general."
Pun, I., Evrim, B. and Cheng, Y. (2019). «Are we programming computers to be biased?» Ethics in the Built Environment, https://sites.psu.edu/visionaryarchitecture/2019/06/17/are-we-programming-computers-to-be-biased/.
How can programmers protect against bias in their algorithim, coding and product design?
Lesson: Moral Machine Self-Paced Nearpod Lesson
24/25
nearpod


CODED BIAS
Programming Bias?
How can programmers protect against bias in their algorithim, coding and product design?
Instructions
Collaborate Board
Programming Bias?
Lesson: Moral Machine Self-Paced Nearpod Lesson
25/25
nearpod

Appendix C
Not OK: AI Copyright Infringement Exercise

In 2021, Microsoft and its computer code-sharing website GitHub, as well as artificial intelligence firm OpenAI, were sued in California in a class-action lawsuit. The complaint (J. DOE 1, et al., Plaintiffs, v. GITHUB, INC., et al., Defendants) claimed that the companies' AI-powered programming tool *Copilot* infringed copyright by using millions of lines of human-written code without proper attribution. According to *NewScientist*, this is the "first big copyright lawsuit over AI and potential damages could exceed $9 billion" (Wilkins, 2022).

Texas A&M University Computer scientist Tim Davis claimed on Twitter that the Microsoft-owned AI programming assistant "emits large chunks of my copyrighted code, with no attribution, no LGPL license." The "LGPL" Davis mentions is a type of Open-Source use permission — the Lesser General Public License — which makes the code available for use to anyone *if* they adhere to the license requirements, such as attribution (which identifies the copyright holder of the work being reused — in this case developer Davis).



The LGPL is considered to be a weak "copyleft" license, and it typically applies to a narrow set of code. If a user modifies and distributes code covered by a weak copyleft license — as GitHub may have done with Davis's code — they would need to release the modified version under the same license as the original. Davis contends that the AI generated code he's seeing does not include the license or the attribution required by the LGPL terms. Individuals who use an Open Source Software (OSS) component are legally responsible for complying with the terms of the license. When that "individual" is AI, the question becomes "who is responsible if the license terms are violated?"

Copilot works by translating natural language to suggestions for lines of code, and trains on Open Source Software material. With the OSS license clearly attached to Tim Davis's code, he alleges that the GitHub generated code is violating his copyright.

In his Twitter discussions, Davis correctly points out that while algorithms are not generally copyrightable, the expression of the code can be protected. Even though Davis has placed his copyrighted code more or less in the public domain through the use of OSS, he is still entitled as the copyright holder, to set the terms of use including: attribution to him as the original developer, notice of his copyright, and inclusion of a copy of the LGPL license.

The monetization of the work by Microsoft/GitHub/Copilot is one of the primary irritants to developers like Davis. GitHub users pay $10 per month or $100 per year for access to Copilot. "Copilot's goal is to replace a huge swath of open source by taking it and keeping it inside a GitHub-controlled paywall," the complaint against the companies said. "It violates the licenses that open-source programmers chose and monetizes their code despite GitHub's pledge never to do so." The complaint also cites unlawful competition by the defendants in the "passing-off" of licensed code as their own creation, and alleges GitHub has been unjustly enriched by their unlawful conduct.

The defendants responded to the copyright allegations in early 2023 by evoking the doctrine of fair use. The companies cited the 2021 Supreme Court of the United States (SCOTUS) decision in *Google LLC v. Oracle America, Inc.* where the court determined that the reuse of application programming interfaces (APIs), including representative source code, can be transformative and fall within fair use. Although the court has yet to address the fair use defense in the case, Judge Jon Tigar ruled in May 2023, on the defendants' motion to dismiss (throw out the case), and a number of claims were dismissed; the plaintiffs were given leave to amend most of these claims; however, and they did so on June 8, 2023. Featured predominantly in the amended complaint is the allegation that "Codex (powering Copilot) outputs copyrighted materials without following terms of the applicable licenses" as seen in the excerpt below:

"52. Below is an explanation of how Codex functions. When Codex is prompted with:

function isEven(n) {
it assumes this is the beginning of a function written in the JavaScript language that will test whether a number is even.

53. Based on this assumption, Codex will then provide Output meant to complete the rest of the function. Based on the given prompt, it produced the following response:

```
function isEven(n) {
  if (n == 0)
    return true;
  else if (n == 1)
    return false;
  else if (n < 0)
    return isEven(-n);
  else
    return isEven(n - 2);
}
console.log(isEven(50));
// → true
console.log(isEven(75));
// → false
console.log(isEven(-1));
// → ??
```

54. The function itself occupies the first ten lines. Six additional lines follow the function, beginning with "console.log(isEven(50))". One possible explanation for Codex's inclusion of these lines is to test the "isEven" function. Though not part of the function itself, the lines will confirm the function works for certain values. In this case, the code implies that "isEven(50)" should return the value "true", and "isEven(75)" should return "false". Those answers are correct.

55. The penultimate line indicates "isEven(-1)" should return "??". This is an error, as "isEven(-1)" should return "false".

56. Codex cannot and does not understand the meaning of software code or any other Licensed Materials. But in training, what became Codex was exposed to an enormous amount of existing software code (its "Training Data") and — with input from its trainers and its own internal processes — inferred certain statistical patterns governing the structure of code and other Licensed Materials. The finished version of Codex, once trained, is known as a "Model."

57. When given a prompt, such as the initial prompt discussed above — "functionisEven(n) {" — Codex identifies the most statistically likely completion, based on the examples it reviewed in training. Every instance of Output from Codex is derived from material in its Training Data. Most of its Training Data consisted of Licensed Materials.

58. Codex does not "write" code the way a human would, because it does not understand the meaning of code. Codex's lack of understanding of code is evidenced when it emits extra code that is not relevant under the circumstances. Here, Codex was only prompted to produce a function called "isEven". To produce its answer, Codex relied on Training Data that also appended the extra testing lines. Having encountered this function and the follow-up lines together frequently, Codex extrapolates they are all part of one function. A human with even a basic understanding of how JavaScript works would know the extra lines are not part of the function itself.

59. Beyond the superfluous and inaccurate extra lines, this "isEven" function also contains two major defects. First, it assumes the variable "n" holds an integer. It could contain some other kind of value, like a decimal number or text string, which would cause an error. Second, even if "n" does hold an integer, the function will trigger a memory error called a "stack overflow" for sufficiently large integers. For these reasons, experienced programmers would not use Codex's Output.

60. Codex does not identify the owner of the copyright to this Output, nor any other — it has not been trained to provide Attribution. Nor does it include a Copyright Notice nor any License Terms attached to the Output. This is by design — Codex was not coded or trained to track or reproduce such data. The Output in the example above is taken from Eloquent JavaScript by Marijn Haverbeke."

And then comparing Copilot's response to that of Codex:

72. When we give Copilot the same prompt discussed above in Paragraph 52, "function isEven(n) {", it interprets the prompt as the beginning of a function written in the JavaScript language that will test whether a number is even, same as Codex.

73. However, the Output of Copilot in response to the prompt is different than Codex, namely:

```
function isEven(n) {
   return n % 2 === 0;
}
```

74. This function is much closer to what a human programmer might use as compared to Codex's older, inaccurate offering. It handles all values and types of "n" correctly. It does not cause a stack overflow for larger values of "n" like the Codex Output.

75. Copilot's Output, like Codex's, is derived from existing code. Namely, sample code that appears in the online book Mastering JS, written by Valeri Karpov. Like Codex's Output, Copilot's is also based upon copyrighted educational material. Mastering JS is a set of educational exercises for programmers. Like Eloquent JavaScript, there are many copies of Karpov's exercise stored in public repositories on GitHub. Programmers working through Mastering JS store their answers there.

76. If Copilot is prompted with the name of a function that will test whether a number is prime (that is, a number that can only be evenly divided by 1 and itself), namely "function isPrime(n) {", it returns:

```
function isPrime(n) {
   if (n < 2) {
      return false;
   }
   for (let i = 2; i < n; i++) {
      if (n % i === 0) {
         return false;
      }
   }
   return true
```

77. Though this function will work, it contains an error often made by beginner programmers that makes it much slower than it could be. Namely, the loop in the middle, which checks possible divisors, does not need to check every divisor smaller than "n," only the divisors smaller than the square root of "n". As with Codex, Copilot has no understanding of how the code works. It knows that more functions called "isPrime" contain the portion that checks for all divisors smaller than "n", so that is what it offers. It does not return what it "thinks" is best, it returns what it has seen the most. It is not writing, it is reproducing (i.e., copying).

78. Like the other examples above — and most of Copilot's Output — this output is nearly a verbatim copy of copyrighted code. In this case, it is substantially similar to the "isPrime" function in the book Think JavaScript by Matthew X. Curinga et al, which is:

```
function isPrime(n) {
   if (n < 2) {
      return false;
   }
   for (let i = 2; i < n; i++) {
      if (n % i === 0) {
         return false;
      }
   }
   return true;
}
```

79. As with the other examples above, the source of Copilot's Output is a programming textbook. Also like the books the other examples were taken from, there are many copies of Curinga's code stored in public repositories on GitHub where programmers who are working through Curinga's book keep copies of their answers.

80. The material in Curinga's book is made available under the GNU Free Documentation License. Although this is not one of the Suggested Licenses, it contains similar attribution provisions, namely that "You may copy and distribute the Document in any medium, either commercially or noncommercially, provided that this License, the copyright notices, and the license notice saying this License applies to the Document are reproduced in all copies, and that you add no other conditions whatsoever to those of this License."

81. As with Codex, Copilot does not provide the end user any attribution of the original author of the code, nor anything about their license requirements. There is no way for the Copilot user to know that they must provide attribution, copyright notice, nor a copy of the license's text. And with regard to the GNU Free Documentation License, Copilot users would not be aware that they are limited in what conditions they can place on the use of derivative works they make using this copyrighted code. Had the Copilot user found this code in a public GitHub repository or a copy of the book it was originally published in, they would find the GNU Free Documentation License at the same time and be aware of its terms. Copilot finds that code for the user but excises the license terms, copyright notice, and attribution. This practice allows its users to assume that the code can be used without restriction. It cannot.

The amended complaint also contains a significant number of examples similar to those of Tim Davis's comparisons of his code with Copilot's generated code. Although the litigation is still in early stages, the result will be an important step in clarifying federal protections for software and understanding the liability associated with AI programming infringement.

Discussion Questions
1. In a customer support message, GitHub stated the following:

> *Training machine learning models on publicly available data is considered fair use across the machine learning community . . . OpenAI's training of Codex is done in accordance with global copyright laws which permit the use of publicly accessible materials for computational analysis and training of machine learning models, and do not require consent of the owner of such materials. Such laws are intended to benefit society by enabling machines to learn and understand using copyrighted works, much as humans have done throughout history, and to ensure public benefit, these rights cannot generally be restricted by owners who have chosen to make their materials publicly accessible.*

Is this claim that *training machine learning models on publicly available code is widely accepted as fair use* accurate? Why or why not?

2. Review the following Twitter except from Tim Davis in response to a user query:

Why is the expression of code, but not an algorithm, copyrightable? What types of issues would be created if you could protect an algorithm as intellectual property?

3. Review the plaintiffs' arguments for demonstrating that Copilot (and Codex) has violated the terms of applicable licenses by generating copyrighted code. Do you agree with their evidence? Why or why not?

4. Almost immediately after Copilot began generating code, there were concerns about how the AI was trained. According to GitHub, it was trained on "billions of lines of code" in dozens of programming languages; this included code on GitHub itself, which is a common tool used for open-source developers.

a) How could you design Copilot's training regimen to avoid violating the copyright (and copyleft) licenses of other programmers and developers?

b) How could you ensure that any AI generated code you may use is not violating copyright?

5. According to Jonathan Bailey in the article "The Ethical and Legal Challenges of GitHub Copilot",

> *GitHub made much of its name and brand due to open-source developers. Before its purchase by Microsoft, it was the leading tool for such development. Now with Copilot, GitHub launched a product that many developers feel is against the ethos of open-source development by exploiting open-source code but omitting the attribution and licensing requirements that come with it. The response to Copilot's use of open-source code has been, overall, negative from the community.*

a) If you were the developer who created and trained Copilot, what would be your response to the software and programming community?
b) What would be a viable argument to support how Copilot operates?

6. Review the following excerpt from Tim Davis's Twitter thread on the issue of the alleged copyright violations:

a) What is your opinion of the use of blockchain (mentioned above) to provide renumeration to code developers for use of their copyrighted content?
b) Do you have other ideas about how copyright holders could be compensated for their holdings?

Commentator Kevin Fischer mentions above that we should rethink our fundamentals around IP ownership. There have been many arguments for a number of years that believe we should forego intellectual property rights and protections, because they are hindering research and development efforts.

a) What is your opinion of IP protections?
b) What are some advantages of legal protections such as copyright licenses? Disadvantages?

Bailey, J. (2022). The Ethical and Legal Challenges of GitHub Copilot, PlagiarismToday. Retrieved on June 18, 2023 at https://www.plagiarismtoday.com/2022/10/19/the-ethical-and-legal-challenges-of-github-copilot/.

Wilkins, A. (2022). Microsoft's Copilot code tool faces the first big AI copyright lawsuit. NewScientist. Retrieved on June 17, 2023 at https://www.newscientist.com/article/2346217-microsofts-copilot-code-tool-faces-the-first-big-ai-copyright-lawsuit/.

Redesigning CS 100 in the Context of a Changing University Curriculum

Mark Frydenberg
mfrydenberg@Bentley.edu

William ("Bill") VanderClock
wvanderclock@Bentley.edu

Computer Information Systems Department
Bentley University, Waltham, MA

Abstract

This paper reflects on the process of designing and implementing an update to the *Introduction to Information Technology* course at Bentley University, a business university in New England. Driven by a university-wide curriculum reform initiative and following best practices from digital literacy frameworks and IS model curricula, the new CS 100 course, entitled *Solving Business Problems with Information Technology*, shifted emphasis from a personal computing context to exploring small business applications of technology. Students networked with university alumni at "Topics in Tech" presentations, where they learned about career options as information technology professionals. The authors describe the pilot courses that led to proposing a new CS 100 course and reflect its challenges and successes. Challenges included meeting the university's goal of transfer friendliness, scaling from a few pilots to multiple sections, consistency of course delivery, and evaluating assessment. Successes include placing course topics in a business context, introducing current technologies, and providing opportunities for students to learn about career opportunities and experiences from university alumni. The paper also describes how CS 100 aligns with the university's student learning goals for the new curriculum. These include developing future-focused skills, encouraging curiosity and critical analysis, communicating and collaborating in different settings, and demonstrating understanding of issues related to ethical use of technology.

Keywords: business education, IS curriculum, introductory course, computing concepts, Excel.

Recommended Citation: Frydenberg, M., VanderClock, W., (2024). Redesigning CS 100 in the Context of a Changing University Curriculum*. Information Systems Education Journal,* 22(?), pp.89-107. https://doi.org/10.62273/WRVJ5409

Redesigning CS 100 in the Context of a Changing University Curriculum

1. INTRODUCTION

The Introduction to Information Technology course is intended to provide students with the technology skills necessary to succeed throughout their college career and beyond. As a foundational learning experience, the course builds a fundamental understanding of digital technology and the implications of hardware, software, cloud, and networking decisions.

Bentley University, a business-focused institution in New England, was undergoing its first major curriculum overhaul in more than a quarter-century. Major goals of the university's curriculum redesign were shrinking the set of required core courses, adding flexibility, promoting inclusion, and making the curriculum friendly to transfer students.

In addition to mastery of subject topics, student learning goals for the new university wide curriculum include:

- Demonstrating an understanding of the importance of sustainability, ethics, and social and organizational responsibilities
- Applying a set of future-focused skills
- Expanding cultural and diversity competencies
- Communicating and collaborating in different settings
- Exhibiting curiosity and critical analysis.

As enrollments in the IS discipline have declined in recent years(Firth et al., 2008), the new course had to be at a level appropriate for first-year students and designed to entice learners to pursue further studies in computing.

The university invited faculty to develop prototypes of new courses to be introduced to the curriculum. This opportunity served as a catalyst to re-examine IT 101, the university's Introduction to Information Technology course, to evolve to meet the university's goals for the new curriculum.

IT 101 covered 50% Excel topics, 40% computer concepts, and 10% coding with HTML to build simple web pages. Excel content included formulas, functions, charts, table look-ups and pivot tables, and basic macros, so students could gain intermediate level of proficiency. Technology concepts include hardware, software, the Internet, networking, operating systems, and databases. Teaching basic HTML gives students a taste of coding in a simple way. Excel examples and technology concepts were often based on more personal computing scenarios rather than solving business problems. (Leidig & Salmela, 2020, p. 32)

2. LITERATURE REVIEW: COMPETENCY BASED CURRICULUM DESIGN AND DIGITAL LITERACY FRAMEWORKS

Curriculum guidelines for introductory computing/information systems courses at business-focused universities typically include foundational concepts and skills necessary for students pursuing degrees in business and related fields.

Curriculum redesign is placing an emphasis on competency-based learning to promote critical and analytical thinking. "Competency-based requirements shift attention from course structures to required competencies. The main emphasis is on ensuring that the program curriculum engages students in tasks that promote achievement of required skill levels and competencies. The focus shifts from course structures to student learning" (Leidig & Salmela, 2020, p. 32).

In the Information Systems/Information Technology space, several digital competency frameworks have been developed (IEEE, 2021; Naji, 2018; Riel et al., 2012; *Technically Speaking*, 2002) which enumerate skills in information literacy, communication skills, and problem solving as key points necessary to prepare students for success as future IT professionals(IEEE, 2021; Naji, 2018; Riel et al., 2012; *Technically Speaking*, 2002). Noteworthy, the European Union describes 21 digital competencies related to information and data literacy, communication and collaboration, digital content creation, information security, and problem resolution (Carretero-Gomez et al., 2017; Naji, 2018).

The Information Systems Model Curriculum (IS 2010) proposes a Foundations of Information Systems course to provide a basic introduction to information systems for all students, regardless of major. (Janicki & Cummings, 2022). First-year introductory courses often provide an overview of topics related to information systems and the information technology discipline.

> Information Systems Foundations refer to the ability of students to understand the fundamental concepts of IS (including hardware, software, and information acquisition) and the support that IS provides for transactional, decisional, and collaborative business processes. They will also be able to understand the collection, processing, storage, distribution, and value of information and be able to make recommendations regarding IS that support and enable individuals in their daily lives as well as the management, customers, and suppliers of the enterprise. This competency includes conducting organizational business analysis and assessing processes and systems. (Leidig & Salmela, 2020, p. 51)

In addition to giving students the technology skills they need to succeed in college and as they begin thinking about their careers as future business professionals who need to function in a technology and data-driven world, the course also strives to present current topics and trends within computing/IT. While the new course should seek to educate students on the core ideas and principles as found in any introductory information technology class, as a required foundations course in the revamped university curriculum, the new introductory technology course also should strive to teach students how to harness their "creativity, empathy, judgement, intuition, interpersonal sensitivity, [and] problem solving" skills along with technology so that it "can be leveraged to allow employees to do their work more effectively (Levit, 2018)."

When determining requirements for the university core curriculum, AACU value rubrics for evaluating student performance across many categories provided guidance (American Association of Colleges and Universities, 2013). Especially relevant are applying future-focused skills, explaining the changing roles of technology when conducting business, locating, and evaluating data and using it ethically, assessing the impact of new technologies, and creating skills as self-directed learners to synthesize and transfer learning to new and complex situations.

These outcomes are aligned with competencies identified by the National Association of Colleges and Employers (NACE), which identified critical thinking and leveraging existing digital technologies ethically and efficiently to solve business problems, as two of eight competencies associated with career readiness. (National Association of Colleges and Employers, 2023).

Requirements and approaches from current models for undergraduate programs in information systems (Impagliazzo & Pears, 2018; Leidig & Salmela, 2020; Waguespack & Babb, 2019) also influenced the course design process.

After considering best practices from digital literacy frameworks and the IS model curricula, the authors set about to evolve the introductory technology course within the context of the university's curriculum reform process. These frameworks influenced the redesign of IT 101 to integrate technology topics and exercises that allow students to develop their digital skills. (Aylesworth et al., 2022)

3. REDESIGNING THE "INTRO TO COMPUTERS" COURSE WITHIN THE UNIVERSITY'S CURRICULUM REFORM

The University's curriculum reform provided the impetus to redesign its "Intro to Computers" course. The real innovation in redesigning the new course is its approach to using business examples rather than personal computing examples. A change in title from *IT 101: Introduction to Information Technology and Computer Systems* to CS *100: Solving Business Problems with Information Technology* captured the focus of the new course and its emphasis on problem solving and critical thinking, also a goal in the university's curriculum reform. Like other courses introduced in the new university curriculum, CS 100 would need to meet the university's curricular goals while enabling students to develop the skills and competencies required and to achieve learning objectives for the course.

Research conducted at the university surveying all incoming students from 2019-2022 about their digital literacy skills confirmed that digital literacy skills of incoming students were decreasing each year (McCarron & Frydenberg, 2023). As a result, an increased emphasis on developing digital skills was critical.

Three instructors proposed and taught experimental "pilot" courses with original assignments, activities, or hands-on labs to evaluate different approaches. See Appendix B for a sample outline from one of the pilot courses.

A committee examined lessons learned from the pilot courses and began to design a new introductory technology course to become part of the new core curriculum.

Many of the topics from IT 101 carried over into CS 100, primarily guided by the content included in learning resources provided by the publisher. In addition, the university requested that CS 100 include new related topics (teamwork and cloud-based collaboration tools, for example) to expose students to these tools prior to taking future courses.

CS 100 needed to incorporate problems with more of a business focus. To accomplish this, students would build business related websites for their HTML assignments rather than personal ones; they would examine company balance sheets and stock data rather than personal budgets in Excel and would evaluate hardware and cloud services required to operate a small business. Taking a business approach to these topics became a major part of the course redesign. See Appendix A for an example of a sample website assignment. The course allocates two or three sessions on HTML, so the websites that students create include only basic elements such as headings, paragraphs, links, images, embedded maps or videos, and simple CSS to add colors and fonts for visual appeal. Some students created websites for their families' businesses, while others designed sites representative of local businesses such as a diner or landscaping agency.

Appendix C shows a sample syllabus and schedule for CS 100 as well as the sample schedule for its predecessor, IT 101. While the topics in IT 101 and CS 100 are similar, the business approach brought to CS 100 is its major contribution

The pilot courses had many more experimental hands-on lab activities and incorporated Excel problems that were often related to the week's technology concept content.

4. INNOVATIONS

Course innovations include presenting topics in a business context, introducing current technologies, and requiring attendance at a "Topics in Tech" speaker series featuring university alumni. These innovations represent the successes and accomplishments in implementing CS 100 in line with curriculum goals.

Business Context

Students appreciated learning the material from a business perspective. They often could relate concepts from other introductory business courses that they were taking with what they were learning about in CS 100. Although some instructors were slow to adopt this approach during the inaugural offerings, as the course matures, and as more new full-time instructors are scheduled to teach CS 100 in coming semesters, issues of consistency in course delivery and buy-in to the business-oriented approach should resolve themselves.

Current Technologies

The course aimed to introduce, at an introductory level, several current developments in technology with which students should have some familiarity: artificial intelligence, machine learning, augmented and virtual reality, Internet of Things, data visualization, financial software services, cryptocurrency/blockchain, and cybersecurity.

Many instructors chose one or more of these topics to introduce to their classes at a very basic level, bringing publisher-provided materials, YouTube videos, or their own real-world experiences to the class discussion. This section presents ideas for instructors to implement experiential learning activities introducing these current technology concepts in their classrooms. Some instructors have implemented these and other hands-on activities in their classrooms, but they are not required or consistently offered in all sections.

Artificial Intelligence/Machine Learning. CS 100 launched officially in Fall 2023, just half-a year after the meteoric rise in popularity of widely available generative AI tools. Some instructors incorporated the use of generative AI tools in their classes, from showing how to generate images to creating effective prompts to assist in creating Excel formulas.

To convey the basic concepts of Machine Learning, the Quick, Draw! web app from Google provides the basis of a simple lesson. Participants draw the image (a dog, a banjo, a surfboard) presented to them on their computer or mobile device, and the application tries to identify their drawing. The application stores each drawing as training data for the guessing module. Learners can see all of the collected drawings from all users around the world for each image and describe, at an elementary level, how their drawings help train the model that Quick Draw! uses to recognize the different images.

Augmented and Virtual Reality. Students can experience augmented reality using their smartphones with Google Maps walking directions, which overlay direction arrows and landmarks on top of the live view of the user's location, or by visiting retail websites which allow users to see how an item might appear in their home, by superimposing a photo of a lamp, for example, in their living room. If virtual reality headsets are available, students can use those, or they can create VR scenes using available tools (Andone & Frydenberg, 2019; Doty & Gunderson, 2019).

Internet of Things. Hands-on lab activities using Raspberry Pi and Amazon Echo devices introduced students to Internet of Things concepts and technologies (Frydenberg, 2017, 2023).

Data Visualization. Open data websites with US government data (data.gov) and Analyze Boston (data.boston.gov) provide access to datasets and built-in tools to filter, sort, and analyze data, and visualize data with charts and maps. Specialized visualization tools such as Datawrapper (datawrapper.de) offer free or trial versions that allow users to create charts, maps, and tables to visualize data with no coding and little setup. Advanced learners can try to recreate some of these visualizations themselves using a spreadsheet app such as Excel or Google Sheets.

Financial Services Software. Introducing Bloomberg Terminal in an introductory information technology course exposes students to financial services software used in business and reinforces many concepts, such as client/server applications, interacting with a command line, and application programming interfaces (Frydenberg et al., 2021).

Cryptocurrency/Blockchain. Watch videos on blockchain; show students a cryptocurrency wallet if anyone has purchased Bitcoin or other cryptocurrencies; visit Paypal, Venmo, or other payment apps to see how they support payment in cryptocurrencies; view OpenSea (opensea.io) or other NFT (non-fungible token) online marketplaces to learn that they can be purchased with cryptocurrencies.

Cybersecurity. Show students how to check their own email addresses or passwords to see if they have been breached using Have I Been Pwned (haveIbeenpwned.com) or demonstrate open source intelligence tools that students can apply their knowledge to solve cybersecurity puzzles (Frydenberg & Lorenz, 2020),.

Topics in Tech

Students in all sections participated in the "Topics in Tech" program, a series of guest speakers, organized by the university's technology learning center. Most speakers are CIS alumni and industry leaders who talk about their careers as information technology professionals. (See http://cissandbox.com for information about prior speakers and recordings of their presentations.) Speakers often share experiences about life after graduation, college courses they found incredibly valuable as they started their careers, and examples of projects they are working on now. Ten to twelve speakers are invited each semester; students sign up for the topics that interest them; many are in person; some are online only when the speaker is geographically distant or cannot attend in person, and some are offered both in person and online simultaneously.

Topics in Tech introduces current students to university alumni, teaches them the importance of professionally networking (most attendees end up following their speaker on LinkedIn), and shows the wide range of career possibilities available to CIS majors and minors. Current students meet alumni working at both big name and local tech companies, and by hearing their experiences, can begin to see the possibilities that may be available for themselves upon their graduation.

Participation in Topics in Tech also encourages students to develop skills in educational awareness, identity awareness, resilience, critical thinking, leadership, and dialogue. After attending, students write a short report reflecting on these aspects of what they learned from the session they attended:

- Who is the speaker? What do/did they do?
- Could you see yourself doing the kind of work that they will do in the future? Why or why not?
- How did this presentation help you think about analyzing information before making decisions?
- In what way could you identify with the speaker's experiences or challenges?
- What one thing from the speaker's presentation that you remember the most, or that made impact on you?

Rather than ask for a summary of "what did you learn", these focused questions require the students to reflect on the experience in a way that is more personal and goes beyond stating facts. In many sections, instructors invite students who attended a Topics in Tech talk during the previous week to share what they learned with their classmates. Many students share thoughtful comments that generate engaging class discussions.

5. IMPLEMENTATION CHALLENGES

Building a new course from an existing one for an entirely new curriculum is no easy task. Challenges included meeting the university's curricular goal of transfer friendliness, scaling from a few pilot sections to multiple sections, consistency of course delivery, and assessment. As the course evolves, additional work will be necessary to ameliorate these challenges.

Transfer Friendliness

One goal of the university's curriculum reform was to enable students who take similar courses at other institutions to receive transfer credit for them. Creating a transfer-friendly environment for students is critically important to the university as an increasing number of college students complete one or two years at a community college before transferring to a specialty institution to complete their degrees. (Mangan, 2020). While transferability is an important goal to strive for, achieving it is exceptionally difficult for CS 100. Bentley University is unusual in requiring an IT course which combines both intermediate proficiency in Excel with strong digital literacy skills in the core curriculum. The combination of topics in CS 100 are not often found in one course at many other institutions, making it difficult to find equivalent courses offered at other institutions. Giving transfer credit to students whose prior courses omit one or more major components of CS 100 puts those students at a real disadvantage in their future business courses for which CS 100 is a prerequisite. As a result, very few transfer students received transfer credit.

To receive transfer credit for CS 100, students may need to show that they have taken multiple computer courses at other institutions that cover these topics. One recommendation to improve transfer friendliness may be to clarify the topic knowledge and competencies that incoming transfer students need to have to receive transfer credit.

Scalability

Creating a course that was scalable to multiple sections taught by several instructors was an administrative (not pedagogical) goal of this redesign. While the pilot courses relied on instructors building original Excel problems and locating articles, or websites from the Internet rather than standardized publisher-provided books and support materials may work fine for a small number of sections, this does not scale to more than 20 sections taught by several, mostly part-time, instructors.

Grading and preparation had to be manageable. Some instructors teach three or four sections each semester, which can be very grading intensive. The choice of publisher-provided learning materials impacts scalability. Selecting publisher-provided materials that cover the desired content and offer automatic grading of homework and exams, several versions of practice problems and quizzes, test banks, the ability to create multiple equivalent versions of the same exam to minimize academic integrity concerns, and a rich collection of instructor resources is crucial. This requirement can significantly narrow the choices for course materials.

The pilot program tried offerings from a different publisher and exposed these weaknesses. When launched, the new course used the same publisher-provided materials as the old course. This promoted the misperception that the former IT 101 and the new CS 100 were the same course because they used the same publisher learning materials, despite the new business focus and innovations brought to CS 100.

The course relies on CIS undergraduate tutors to provide consistent training for students to set up their laptops and mobile devices with the electronic resources and software necessary for the course. CS 100 students sign up for one of several 80-minute Jumpstart sessions offered outside of class time, during the first week of the semester. They gather in a learning lab where tutors guide them through the steps of configuring their email, cloud storage, malware detection, alternative browsers, e-books, and other resources. Students using Apple computers running MacOS have additional steps to configure a virtual applications server so that they can access Windows versions of Excel and other productivity applications whose Mac versions are not compatible with publisher-provided exercises or self-grading tools. This approach removes the burden from instructors on supporting computing configuration issues during class time. From a scalability perspective, providing this training to the nearly 700 students enrolled in CS 100 each semester requires offering 5 Jumpstart sessions with 25 students each, facilitated by two tutors, each day for seven days. This significant investment in tutoring resources allows offering this training at scale and helps ensure that students' devices will be set up correctly and minimize configuration issues later in the course.

Consistency of Course Delivery

Providing ample instructor training is critical to increase the likelihood of consistency in course delivery across sections. Training needs to focus on pedagogical choices and approaches to teaching the course in addition to reviewing the mechanics of configuring the publisher's provided learning materials and course management tools. Even with publisher-provided learning resources, common assignments and exams, some seasoned instructors found it difficult to adapt their teaching style to emphasize the new business-focus of CS 100. Most had not been involved in the pilot course development, so offering a greater background on the new approach would have been beneficial. Additional training would be required to ensure instructors are able to incorporate some of the hands-on technology labs introducing current technologies, as described in Section 4.

CS 100 had an increased emphasis on teamwork, primarily because using web-based collaboration tools was integrated into a lab activity that all sections completed. Several instructors reported that in-class examples were much more likely to be business oriented but overall, the experience in many CS 100 sections was a minor upgrade from IT 101, but not entirely the new course that was envisioned originally. Asking adjunct faculty to change or adapt their teaching styles and materials to support a new course can be difficult, but when supplied with the correct tools and support, they can change.

Assessment

The course relied on publisher-provided multiple-choice questions for standardized midterms and finals, as well as Excel skill tests completed in a virtual online environment to assess student learning. Exams are given within the publisher's online learning environment. Although exams are timed, because the publisher's online learning environment did not support the use of a lockdown browser, students were able to access AI tools and search engines, and therefore tests may not accurately measure what students are learning.

Surveying students before and after the course would have provided another metric to assess students' learning and experiences in the course.

6. DISCUSSION AND CONCLUSION

Updating an introductory computing concepts course to meet changing business needs and the requirements of the new curriculum was a long process. Students are coming in with fewer technology skills than in previous years, so the need for an introductory computing course remains strong. The university curriculum reform process evolved, requiring agile decision making to meet goals.

Information systems professionals rely on Excel, so emphasizing business-problem solving with Excel is an appropriate choice for meeting both department and university curriculum objectives related to critical thinking.

It is too early to assess the impact of the course on a student's future college experiences. The course would benefit from creating an earlier exercise focusing on teamwork that will introduce students to the tools, issues, and processes involved when working in teams before they need to complete a larger group assignment. Similarly, creating standard content for the current technologies identified earlier will facilitate instructors in including this material in their sections.

Teaching methods also need to evolve, as interactive, hands-on learning has resulted in increased student satisfaction. In many cases, this shift requires retraining longtime instructors to approach their courses in new ways. This is the direction that to must move with this course and the more instructors who effectively teach this way, the better today's students will learn. Incorporating a more project-based approach with automatically graded activities or assignments that are easy for instructors to grade manually will give students a richer experience and enhance their learning. Such a project-based learning approach would be a better way to ensure that students are learning and able to apply the course concepts, rather than memorizing terms often found as the subject of multiple-choice questions.

An innovative strategy may be to evolve CS 100 into an elective project-based approach where students choose labs to complete based on their own interests. Activities could include hands-on experiences with internet of things, data visualization, artificial intelligence, virtual reality, and other current topics. These activities, which faculty would need to develop and department tutors would need to support, would enable students to explore their own IT interests without requiring each instructor to become an expert on each activity. A few selected sections piloted this strategy during the first three semesters that the new course was offered and found it to be very successful. Additional work needs to be done to determine the extent to which this approach can scale to more sections.

Discussions related to redistributing digital media and the use of AI tools are natural for understanding the ethical issues when using technology. By participating in Topics in Tech events students learn not only about the cultures of business, but also the diversity of the workforce as they network with alumni who share their professional experiences.

The course redesign met several of the university's student learning objectives for the new curriculum, as learning new technologies and developing Excel skills encourages curiosity and critical analysis while applying a set of future focused skills. The increased focus on teamwork provides opportunities to communicate and collaborate in different settings and introduces the importance of one's responsibilities within an organization.

The redesign of CS 100 proved to be an exercise in creating a new course that presents information technology concepts from a business perspective, focuses on problem solving, and prepares students for future success.

6. ACKNOWLEDGMENTS

The authors acknowledge Joel Thomas, graduate student at Bentley University, for his assistance.

7. REFERENCES

American Association of Colleges and Universities. (2013, July). *VALUE Rubrics*. AAC&U. https://www.aacu.org/initiatives/value-initiative/value-rubrics/value-rubrics-information-literacy

Andone, D., & Frydenberg, M. (2019). Creating Virtual Reality in a Business and Technology Educational Context. In M. C. tom Dieck & T. Jung (Eds.), *Augmented Reality and Virtual Reality: The Power of AR and VR for Business* (pp. 147–159). Springer International Publishing. https://doi.org/10.1007/978-3-030-06246-0_11

Aylesworth, A., Beneke, C., Betts, R., Carter, N., Dove, S., & Moriarty. (2022, September 6). *Advice | 7 Hard-Earned Lessons From a Curriculum Makeover*. The Chronicle of Higher Education. https://www.chronicle.com/article/7-hard-earned-lessons-from-a-curriculum-makeover

Carretero-Gomez, S., Vuorikari, R., & Punie, Y. (2017, April 28). *DigComp 2.1: The Digital Competence Framework for Citizens with eight proficiency levels and examples of use* [Text]. EU Science Hub - European Commission. http://dx.doi.org/10.2760/38842

Doty, C., & Gunderson, A. (2019, January 23). *New Tech: Augmented Reality, Virtual Reality, And Mixed Reality, Q1 2019*. https://www.forrester.com/report/New+Tech+Augmented+Reality+Virtual+Reality+And+Mixed+Reality+Q1+2019/-/E-RES144477

Firth, D., Lawrence, C., & Looney, C. A. (2008). Addressing the IS Enrollment Crisis: A 12-step Program to Bring about Change through the Introductory IS Course. *Communications of the Association for Information Systems*, *23*(1). https://doi.org/10.17705/1CAIS.02302

Frydenberg, M. (2017). Ding Dong, You've Got Mail! A Lab Activity for Teaching the Internet of Things. *Information Systems Education Journal*, *15*(2), 20.

Frydenberg, M. (2023). Alexa, Help Me Learn About the Internet of Things! *ISEDJ*, *21*(2), 69.

Frydenberg, M., & Lorenz, B. (2020). Lizards in the Street! Introducing Cybersecurity Awareness in a Digital Literacy Context. *ISEDJ*, *18*(4), 33.

Frydenberg, M., Sultan, Jahangir, & VanderClock, William. (2021). Interacting with Bloomberg Terminal from an Information Technology Perspective. *Proceedings of the 2021 Edsig Conference*, *7*, 9. https://proc.iscap.info/2021/cases/5608.pdf

IEEE. (2021). IEEE Standard for Digital Intelligence (DQ)–Framework for Digital Literacy, Skills, and Readiness. *IEEE Std 3527.1-2020*, 1–47. https://doi.org/10.1109/IEEESTD.2021.9321783

Impagliazzo, J., & Pears, A. N. (2018). The CC2020 project—Computing curricula guidelines for the 2020s. *2018 IEEE Global Engineering Education Conference*

(EDUCON), 2021–2024. https://doi.org/10.1109/EDUCON.2018.8363484

Janicki, T., & Cummings, J. (2022). IS Model Curriculum: Adoption Rate of IS 2010 Model Curriculum in AACSB Schools and Impacts of the Proposed 2020 Model Curriculum. *Information Systems Education Journal*, *20*(1), 47–56.

Leidig, P., & Salmela, H. (2020). IS2020 A Competency Model for Undergraduate Programs in Information Systems: The Joint ACM/AIS IS2020 Task Force. *Peer-Reviewed Publications*. https://doi.org/10.1145/3460863

Levit, A. (2018). *Humanity works: Merging technologies and people for the workforce of the future*. Kogan Page Publishers.

Mangan, K. (2020, April). *Improving the Transfer Handoff*. Chronicle Store. https://store.chronicle.com/products/improving-the-transfer-handoff

McCarron, E., & Frydenberg, M. (2023). *Digitally Prepared for Success? Technology Skills of Incoming First-Year College Students*. *21*(3), 70–90.

Naji, M. J. (2018). Industria 4.0, competencia digital y el nuevo Sistema de Formación Profesional para el empleo. *Relaciones Laborales y Derecho del Empleo*. https://ejcls.adapt.it/index.php/rlde_adapt/article/view/555

National Association of Colleges and Employers. (2023). *WHAT IS CAREER READINESS?* https://www.naceweb.org/career-readiness/competencies/career-readiness-defined/

Riel, J., Christian, S., & Hinson, B. (2012). *Charting Digital Literacy: A Framework for Information Technology and Digital Skills Education in the Community College* (SSRN Scholarly Paper 2781161). https://doi.org/10.2139/ssrn.2781161

Technically Speaking: Why All Americans Need to Know More About Technology. (2002). National Academies Press. https://doi.org/10.17226/10250

Waguespack, L., & Babb, J. (2019). Toward Visualizing Computing Curricula: The Challenge of Competency. *Information Systems Education Journal*, *17*(4), 51.

APPENDIX A

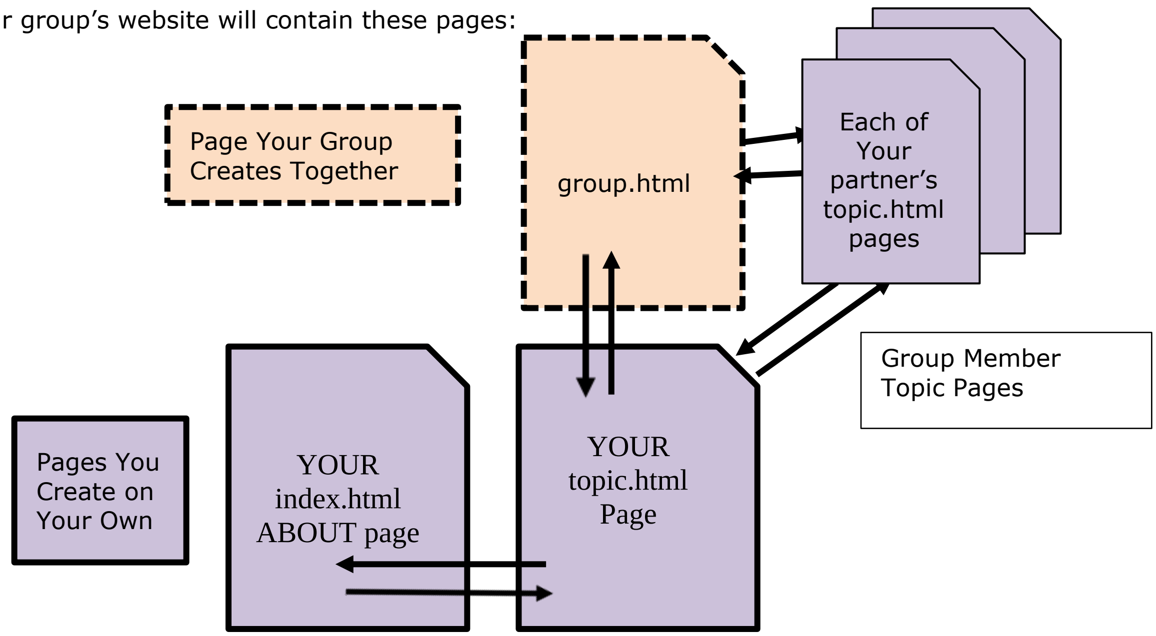
Business-Focused Web Assignment

CS 100 Fall 2022 Web Assignment Create a Company Profile

Instructor Notes: This assignment assumes students did previous research about a company in which they downloaded stock prices or other financial data to Excel and made charts of the data.

In this assignment you will work in a group of three to create a website sharing the results of your prior research about a publicly traded company. Each student will create one topic page as described below, and an "About" page. The group will create a group page that links to each member's topic page.

The Website
Your group's website will contain these pages:



Group Page: Company Information (Each person in the group should work on at least two or three of these features, ok to work together)

- Page must be named group.html
- A banner image (created using canva.com or some other app) placed at the top of the page
- Three facts about the company
- Links to the company's page(s) on social media (Facebook, Twitter (X), LinkedIn, Instagram)
- An embedded video from YouTube with information about the company
- An embedded Google Map showing the company's primary headquarters
- Format the sections of your group page using various heading tags (<h1>, <h2>) and styles
- Use an unordered list to include the names of the members of your group
- Navigation Links to each of the three topics pages using images from cooltext.com as links
- Upload the page to your web.Bentley.edu account and give the link to your group members

Topic Page 1: Financial Report

- Page must be named topic.html
- A banner image (created using canva.com or some other app) placed at the top of the page
- Screenshots of the company's income statement from an online finance site
- Two paragraphs (at least two sentences each) describing key take-aways from the income

statement (profit, sales trends, debt, cash on hand, assets, etc.)
- A link to the company's home page
- Navigation Links to your index page, the other topics pages, and the group page

Topic Page 2: Company News

- Page must be named topic.html
- A banner image (created using canva.com or some other app) placed at the top of the page
- Link to any online news story about the company
- Two paragraphs (at least two sentences each) summarizing recent company news
- An image containing the company logo that you find online
- Navigation Links to your index page, the other topics pages, and the group page

Topic Page 3: Recent Stock Prices

- Page must be named topic.html
- A banner image (created using canva.com or some other app) placed at the top of the page
- A link to your Excel workbook on Microsoft One Drive (anyone with the link should be able to view) showing stock prices for the past 3 years
- Screenshot of an Excel chart you made showing stock prices
- Two paragraphs (at least two sentences each) describing information you can learn from the stock prices chart
- Navigation Links to your index page, the other topics pages, and the group page

Your About Page

- Page must be named index.html
- Your Name
- List of contributions you made to the group page (as a bulleted list)
- A link to YOUR topic.html page

HTML and Style Requirements

On your topics or index page, use each of these tags, styles, or features appropriately at least once:
- All images placed in an images/ folder
- Different page backgrounds (colors, images, or gradients)
- <h1> and <h2> tags styled in any font other than Times New Roman, and not black
- <p> styled with a sans-serif font in a color other than black
- <span> tag to highlight a section of text in a different color, weight (bold), style, or font
- <img> tag with alt attribute
- Unordered <ul> or ordered <ol> list
- <a> tag to a page within your website that displays in the same browser tab
- <a> tag to an external page that displays in a new browser tab

Notes

- Each student uploads their index.html page and their topic.html page to the class web server
- One person uploads the group's group.html page to their account on the class web server and

provides the link to the entire group so each topic page can link to it.
- Navigation links to other pages from your topics or index page can be either text or graphics
- Navigation links from the group page to other page should be clickable images as links.

To center a banner image across the page, add the <div> tag code shown here around your image tag.

<div style="text-align:center;"><img src= "images/banner.png">**</div>**

What's Due and When
Part 1. Due Tues Nov 8

Create your own index page and topic page with only your name and the name of the pages. For example, your index.html page would have your name on it followed by the word *About*, and your topic.html page would have your name and a descriptive title. Be sure to customize the <title> tags. You will change the content of these pages when you work on Part 2.

HTML Features for Part 1:
- Format the backgrounds of these pages so that one uses a solid color other than white and the other uses a background image, gradient, or color of your choice.
- Set the <title> of each page to include your name followed by the word About for your index page, or Topic for your topic page.
- Add the links between your two pages.

Upload the index.html, topic.html to the class web server and visit the page in a browser to see that it works. Click on the links to verify they are correct. If you can't see the page, neither can I.

Part 2. Due Tues Nov 15

Add the content and links to your index page and topics pages as described above.
Work with your group to create the group page and add the content and links.

Please use the VS Code IDE to create a website and post it to your account at web.Bentley.edu.
Your website HTML code should follow current HTML5 standards. Do not use outdated (deprecated) tags.
Create a website folder on your computer where you will keep the files for your website

Fancy Stuff Using Images as Navigation Links

Go to http://cooltext.com and create graphics for each person's topics page, and the group' home page. Use these graphics as navigation links on the group page, and on each person's topics page. Place all images as navigation links just below the banner and just above the content of each page, on a new line, aligned center. You may share these files with your group members so they can use them on their sites as well.

To use an image as a navigation link, place the code for the image around the ** ** to make the image clickable. If you add border = 0 attribute, then the image will have no border.

```
<a href="topics.html">
   <img src="images/cyber.png" alt="cyber" border= "0">
</a>
```

Publish Your Website

Publish your pages to the class web server using Filezilla. You do not need to submit any files for this assignment. Please upload your website files to your account and check to make sure your website displays correctly! The best way to do this is to open a browser in private browsing mode (Shift + Control + N in Chrome) and view the website there. If you can't see it, neither can I, and I can't give you credit for a website I can't see!

Rubric

Part 1

Index page with link to Topics page	**3**
Topics page with link to Index page	**3**
Page Titles with customized <title> tags	**2**
Site loads in a browser (pages uploaded correctly)	**2**
Total:	**10**

Part 2

HTML Tags and Style Requirements	**18**
Original Banner Image on Your Topic Page	**2**
Navigation Links on Topic and Index Page to Group and other Topics Pages	**4**
Topic Page Image or Screenshots	**2**
Topic Page Link to specified content	**2**
Topic Page Text Description	**4**
Topic Page Content	**3**
Index Page Content	**3**
Your Contribution to the Group Page	**12**
Total:	**50**

APPENDIX B - CS 100 Experimental Pilot Course Outline

Topic	Software Skills/Active Learning	Sessions
Introduction to the course Starting a Business: Product vs. Service? Research competitors Differentiate – what can you bring to the table?	University Computing Services, LMS Setting up Online Textbooks Search engines: Research competitors, Create specialized search queries	2
Choose computer hardware PC vs. Mac vs. Chromebook Printers, Storage Devices Rent or buy? Cloud or on premises?	Getting Started with Excel	2
Operating your personal computing devices Folders, paths, etc. Zipping/unzipping Backup/restore Troubleshooting Security: Safe computing	Formatting workbook text and data Scan / back up your computer	2
Choose computer software Licenses vs. Cloud vs. 360 Docs, spreadsheets, presentations, database Set up a wireless network	Perform calculations with formulas & functions in Excel Compare Office Suites (Google, Office 365) on desktop and mobile platforms Synch data across devices and platforms	4
Data breach! (Ethics case) Keep machines clean Virus/malware issues Ransomware Phishing	Scan your system using antivirus, Malwarebytes, and similar software	1
Brand the company Name, logo, tagline Colors, fonts Mission/vision	Design a logo and graphics with graphics software Register a domain name	1
Create a Website Select a domain name Content Management System or Hand-coded? Buy hosting	Content Management Tools (Wix, Weebly, Google Sites, etc.) HTML, CSS, multimedia	3
Advertise the company Social media Google Analytics Direct? What makes sense for type of company	Twitter, Facebook, Instagram; Spreadsheets: Analyze or chart website usage data	1
Hire people What jobs do we need? How much can we afford? Advertise – where? Compare resumes	LinkedIn, monster.com	1
Start selling Add/delete people or products? Add new stores/features?	Analyzing and charting financial data	1
Get Capital Small business loan? Find investors? Go fund me, etc.?	Analyzing and charting financial data	1

Review session and Midterm	2	
Organize and Analyze Data Check daily, weekly, monthly sales Top employees/top customers	Pivot Table module Databases	4
Cloud Computing Services	Generating Reports	1
Staying Ahead of the Competition New and emerging technologies: - virtual and augmented reality - mobile apps - smart technologies (IoT) - machine learning/AI - Blockchain	Working with Multiple Data Sources	2
Final Projects		

APPENDIX C – CS 100 Course Syllabus and Schedule

CS 100 Solving Business Problems with Information Technology

Instructor		Office Hours	Please contact me to make an appointment via email, in class, or on Microsoft Teams. Tuesday 3:30 pm or by appointment.
Office			
Phone			
Email			

Texts

New Perspectives on Computer Concepts 2022: Comprehensive, by June Jamrich Parsons, 21st Edition, Copyright 2023

New Perspectives Collection, Microsoft® 365® & Excel® 2021 Comprehensive, by Patrick Carey,1st Edition | Copyright 2023

What is CS 100?

You will learn about the process of starting and running a small business from an information technology perspective. By the end of the course, you will be able to identify and use information technology resources for problem solving of all types and in all class work, with a specific focus on understanding how information technology enables modern businesses to operate. You will also be able to demonstrate your proficiency with information technology tools and concepts by accomplishing these tasks:

- Excel:
    - Write formulas, use built-in functions, and format data
    - Present data visually using charts and graphs
    - Analyze data with pivot tables and lookup functions
    - Record macros to improve productivity
    - Protect worksheets, validate data
- Web Development:
    - Recognize appropriate uses of HTML, JavaScript, and CSS
    - Code a website containing formatted text, links, and media
    - Interact with a browser and web server, and describe the role of each when viewing and publishing
    - Describe the process of selecting and registering a domain name
- Information Technology in a business setting:
    - Learn to work on technology projects as a member of a team
    - Describe strategies for selecting hardware, software, cloud, and networking
    - Use social media, search engines, and the web effectively
    - Use software to create, modify, and present business documents and multimedia
    - Use the web, web databases, and search engines as a research tool
    - Identify software and strategies to keep computers, mobile devices and data safe and protect individual privacy
    - Explain the role information technology plays in today's society by discussing the various legal, societal, ethical, and economic dilemmas and trends driven by information technology
    - Explore emerging technology trends such as artificial intelligence, machine learning, virtual/augmented reality and the Internet of Things and their impact on conducting business

What Happens in Class?
Our class meetings will combine a variety of learning formats, including hands-on activities, presentations by both students and the instructor, demonstrations, class discussions, readings and videos. By completing both individual and group homework assignments and projects, you will demonstrate that you have learned the course concepts. All assignment requirements and associated handouts will be available from the class Blackboard site.

Preparing for Class and Homework
Although you will only spend approximately three hours each week in class, please plan to spend four to six hours per week outside of the classroom working on readings or assignments for this class. This class will probably require more of your time than any other class you are taking (but it's also likely to be the most fun and offer the largest personal rewards).

Outside of class you will:

- Read the concept book content, complete quizzes, and prepare for class discussions
- Work on Excel problems and complete any activities that you do not finish during class.
- Attend at least one Topics in Tech event to learn about careers and/or current trends in technology.
- Check your email and the course Blackboard site every day. I try to respond to messages within 24 hours and expect that you will do the same whenever possible.

Getting Help

- Please feel free to contact me on Microsoft Teams for quick questions or to make an appointment to meet to go over topics or assignments, or just to say hi. I'm often online late in the evening, and when I can, I'll post a Zoom link so you can join me. Feel free to email me during the day and if I can I'll meet you in the evening.
- When sending me email, PLEASE include your section and a brief description in the subject line (i.e. “CS100-18 Assignment 1”). Your emails are important, and I don’t want to miss them!
- Tutors are available to help you online or in person. Please visit the lab for drop-in hours. Almost all of them have all taken this course so there's usually someone available to help you.
- Please do not ask the tutors how to do your homework (or to do it for you). It's ok to show them what you've done and explain what you think needs work.

Assignments and Grading
Each assignment is worth a percentage of your final grade. Together, all the assignments add up to 100%. Please note that the total number of points shown on Blackboard is not your final grade in the class. 100 points on an exam are weighted more than 100 points on one of your Excel assignments.

Concepts Modules	10%
Excel Tutorials (8)	8%
Excel Projects (8)	17%
Website	10%
Topics in Tech	2%
Attendance, Attitude, Attention	3%
Router Lab	5%
Other Hands-on Labs	5%
Research Project	5%
Midterm	15%
Final Exam	20%

- Exams primarily will cover Excel topics.

- Excel Labs are business problems designed to develop your proficiency and skills using Excel. They are completed in Excel and graded automatically.
- Hands-On activities give you the opportunity to build technology solutions.
- In the Group Project you will work with a team of four students to research and present the use of an emerging technology in a business context. You will collaborate as members of an international team with students at another university. For this project's deliverable, your group will create some form of collaborative digital media to convey what you learned. You will present it in class.

Due Dates, Extensions, and Make-Ups

Please hand in every assignment on time. Due dates will be posted on Blackboard. I may take off points if an assignment is handed in late, and generally will not accept an assignment submitted more than seven days after its due date. To encourage you to complete your work on time, I may apply a penalty of 20% on any assignment submitted up to seven days after the announced due date.

That said, if you need extra time on an occasional assignment because you have a busier-than-usual week, or because of other unforeseen circumstances, please ask beforehand and if possible, I will try to accommodate your request.

Adjusting to a new routine in college is not always easy. If circumstances at home or on campus are affecting your ability to do course work or you are feeling overwhelmed, please contact me so I can work with you, direct you to appropriate campus resources, and accommodate as necessary. You do not need to disclose any more information than you are comfortable.

Make-up exams will not be allowed except for the most extreme circumstances and only with prior arrangement. It is your responsibility to schedule a makeup exam with me. Please keep track of your class standing throughout the term. It's important that you discuss any significant issues with me before the end of the course. Incomplete grades (I) are never automatic and, in fact, are highly undesirable. Please complete the course work to the best of your ability during the semester. If you fall behind, please reach out as soon as possible so we can get you back on track.

Use of Computers and Phones in Class

You will need to use Microsoft Office productivity applications, MS Teams for group work, VS Code for web development, Filezilla for uploading files to a server, Edge, and Chrome browsers, and other applications as part of the coursework in this class. You will learn to install these at a Jumpstart session early in the semester.

This is a technology class, so of course you can use your mobile device for class-related purposes. (Texting, sending messages on Messenger, watching the latest World Cup soccer match, and checking Facebook are not usually class related purposes.) Keep your phone silent so ringtones and notifications do not disturb the course. Follow instructions regarding the use of computers and mobile devices during exams.

Broken computers are not an excuse for late work. You must find an alternative means for getting work done on time. Computers and printers are available in the library, and most computers on campus in have the software you need already installed. If you cannot complete any exam or assignment due to a broken or damaged computer, you will not get credit for it.

Please be sure your laptop is charged or plugged in so that you can follow along with any handouts or software demonstrations. You may also use your computer to take notes during class.

Back up all work onto your OneDrive, e-mail, a cloud storage account, or portable storage device so it is readily available from multiple locations.

[Information on university standard course policies (attendance, academic integrity, religious observances) and information about university resources (disability services, academic services, library, tutoring centers, diversity and inclusion, Title IX, etc.) are omitted.]

Sample CS 100 Topics and Schedule

		Tuesday		Friday
Jan	**24**	Welcome to CS 100! Set Up Ebook Accounts	**27**	Course Introduction
	31	MS Teams, OneDrive, Collaboration and Teamwork	**3**	Excel 1 – Getting Started
Feb	**7**	Concepts 1 – Digital Content	**10**	Excel 2 – Formatting
	14	Concepts 2 – Digital Devices	**17**	Excel 3 - Formulas and Functions (1)
	21	Concepts 3 – Networks	**24**	Excel 3 - Formulas and Functions (2)
	28	Concepts 4 – The Web	**3**	Excel 4 – Analyzing and Charting
Mar	**7**	Router Lab	**10**	Midterm Exam
	14	Spring Break	**17**	Spring Break
	21	Web 1 – HTML Structure, Links, FTP Mobile Apps Lab (ungraded)	**24**	Excel 5 – Generating Reports
	28	Web 2 – Styles and Images	**31**	Excel 6 – Managing Data
Apr	**4**	Web 3 – Embedded Content	**7**	Business Applications of IT
	11	Concepts 5 – Social Media Concepts 6 – Software	**14**	Excel 7 – Pivot Tables
	18	Special Topics (Internet of Things, Artificial Intelligence)	**21**	Excel 12 – Developing an Excel Application
	25	Concepts 7- Digital Security	**28**	Review
		Concepts 10 – Databases (on your own)		
May	**2**	Reading Day (No Classes Held)	**5**	Final Exam

Each concepts chapter test is a ten-question multiple choice quiz: that is due at the start of class on the day the topic is listed. The chapter test will open seven days before discussing the chapter in class.

Each Excel module has a tutorial and a project. The tutorial is due the day after we cover the topic in class, and the project is due one week after learning the topic in class.

Sample IT 101 Topics and Schedule

		Monday		Wednesday
Aug	**27**	Course Introduction	**29**	Using Your PC in IT 101
Sep	**3**	Labor Day, No Class	**5**	Concepts 1 - Digital Literacy
	10	Excel 1 – Getting Started	**12**	Concepts 2 – The Internet
	17	Focus on HTML – 1st class	**19**	Excel 2- Formattng
	24	Focis on HTML 2nd class	**26**	Excel 3 - Formulas and Functions
Oct	1	Focus on HTML 3rd Class	3	Excel 4 – Charts and Financial Data
	8	Fall Break / No class	11	Excel 4 – Charts and Financial Data
	15	Concepts- Computers and Mobile Devices	18	Midterm Exam
	22	Excel 5 - Tables, Filters, Sorting	25	App Development
	29	Concepts – Communications Networks	31	Excel 6– Multiple Worksheets
Nov	**5**	Excel 7 – Macros and Data Validation	**7**	Router Lab
	12	Input/Output/Storage	**14**	Thanksgiving Break
	19	Operating Systems	**21**	Advanced Functions in Excel
	26	Concepts 7- Digital Security	**28**	Hands On Lab
Dec	**3**	Concepts 10 – Databases	**5**	Review
	9	Final Exam		