

Developing Chatbots for Sustainability: Experiential Learning in an Undergraduate Business Course

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Abstract

This paper presents an experiential learning pedagogy that teaches undergraduate business management information systems students hands-on AI skills through the lens of sustainability. The learning modules aim to empower undergraduate business students to gain interest and confidence in AI knowledge, skills, and careers, to sharpen their higher order thinking abilities, and to help them gain a deeper understanding of sustainability issues. Students learn AI through developing chatbots that address pressing sustainability issues within their own communities. Results of the pilot study indicate that students have increased self-efficacy in AI, more positive attitudes towards AI learning and AI-related careers, enhanced sustainability awareness, and more confidence in their ability to innovate.

Introduction

The rapid development of artificial intelligence is changing almost every industry and impacting everyday life. While AI promises to enhance business efficiency and productivity, it also has potential implications for the future workforce including job replacement and job obsolescence. Thus, institutions of higher education must not only equip students with AI knowledge and skills, but also strengthen the human skills, such as empathy, collaboration, innovation, and critical thinking, that AI can't replicate. It is equally essential to teach students to be competent and responsible in making AI to support the sustainable development of society and the global economy. The United Nations Educational, Scientific and Cultural Organization has highlighted sustainability as a Human Right Approach to AI: "AI technologies should be assessed against their impacts on 'sustainability,' understood as a set of constantly evolving targets such as those set out in the UN's Sustainable Development Goals"

(UNESCO, 2024). In the past decade, a growing number of researchers in the information systems (IS) field have started to investigate AI education among a diverse range of learners. However, there is little research into effective pedagogical approaches to teaching AI among undergraduate business management information systems (MIS) students and even less on teaching the societal impacts of AI.

This paper presents an experiential learning pedagogy that teaches undergraduate business MIS students hands-on AI skills through the lens of AI for sustainability. The learning modules aim to improve undergraduates' interest and confidence in AI knowledge, skills, and careers, to sharpen their higher order thinking abilities, and to help them gain a deeper understanding of sustainability issues. Students learn AI through developing chatbots that address pressing sustainability issues within their own communities. This pilot project aims to explore the following questions.

- whether and in what way does the project facilitate student learning about AI?
- whether and in what way does the project facilitate student learning about sustainability?

Related Work

AI Education

Most common in highly technical majors, AI literacy education is increasingly needed in various disciplines (Touretzky & Gardner-McCune, 2022). AI education for non-technical majors is becoming more realistic and feasible with the emergence of no-code, low-code AI development tools that remove the need for programming knowledge (Kong et al., 2023). Further, most education programs and initiatives focus on AI's technical aspects with

only a few considering AI's potential societal impact (Michaeli et al., 2022) – Idea #5 of the “Five Big Ideas of AI” (Touretzky & Gardner-McCune, 2022). AI societal impact topics include: (1) the ethics of AI making decisions about people, (2) economic impacts of AI, (3) AI and culture, and (4) AI for social good (AI4SG) with the latter of these the most understudied. In the past five years, a growing number of institutions have started to offer AI4SG in higher education, such as the AI for Social Impact course for CS students at Harvard University and AI Methods for Social Good offered at Carnegie Mellon University. However, the courses are mainly offered for computer science or engineering students who learn about the societal impact of AI through existing AI4SG projects conducted by other researchers.

While there is a growing body of information systems (IS) research about leveraging AI to enhance the quality of education (Weber et al., 2023; Ellenrieder et al., 2023; Kishore et al., 2023), few projects in the IS field investigate teaching students about AI. One of the few examples is the AiLingo project by Pinski et al. (2023) which promoted AI literacy among non-expert adults in informal settings. Evaluating the AiLingo prototype shows that learners' AI literacy positively influenced their attitude towards AI and future AI usage intention. Among the very few IS studies that investigate societal impact in AI education, Grøder et al. (2022) explored how to teach responsible AI based on experiential learning in a graduate level course in Norway. In this novel pedagogical design, students learn and teach AI through presenting AI knowledge used in welfare services to citizens. In post-course student reflections, some students reported an increased excitement and interest in learning more about how AI could be used in a governmental context and for welfare, while other students felt more skeptical about AI after the course.

AI education consists of three dimensions: cognitive, affective, and sociocultural (Kong et al., 2023). The cognitive dimension refers to educating participants about basic concepts and developing their competencies - the main focus of AI education. Meanwhile, there is a growing awareness in the sociocultural aspects of AI literacy in terms of ethical issues. However, there is less discussion around the affective dimension – “empowering participants so they can participate with confidence in the digital world” such as perceiving the social impact of AI, believing in one's ability to produce novel AI ideas and solutions, and being confident in one's competence in engaging with AI (Kong et al., 2023). We aim to design AI learning modules that touch the cognitive, sociocultural and affective dimensions of AI education.

Using AI for Sustainability

In the IS field, research on sustainability, such as developing means to provide clean air, food security, and renewable energy, has enjoyed rapid growth. “Green IS,” as it is often called, considers how information systems might be leveraged to address sustainability issues and create a greener society (vom Broecker & Seidel, 2012). More recently, advances in AI open up promising opportunities to address some of the world's most pressing societal issues and provide solutions to these issues aligned with the United Nations' 17 Sustainable Development Goals (UN SDGs) (Tomašev et al., 2020). In response, Green IS has grown to include investigations into how AI can address sustainability issues, such as leveraging machine learning for sustainability decision making (Nishant et al., 2020). To address food waste, Nascimento and team (2022) developed and tested an AI model to help small grocery stores with their product planning. Monteiro and Barata (2022) situated their work in a UNESCO-protected region and explored how to design and create intelligent composting networks to address the issues of food waste and support sustainable food production. Following suit, the IS curriculum is increasingly including AI for Sustainability topics (Deng et al., 2017). In this paper we present a pedagogical innovation that teaches undergraduate students about AI and leads them through an exercise wherein they develop chatbot solutions for sustainability issues they identified in their own communities.

Learning Modules

Learning Module Design

We designed an experiential learning project that seeks to 1) teach IS undergraduate students hands-on AI skills and 2) empower students to leverage AI for social good. Among the many types of AI technologies and the multiple dimensions of social impact, our project focuses on chatbots and sustainability issues. We chose chatbots because their recent advancements provided a means of educating less technical students on the applications, benefits, and challenges of AI through low-code, no-code exercises (Schuetzler et al., 2021). To help students gain a better understanding of sustainability issues, we framed the course project around United Nation (UN) Sustainable Development Goals (SDGs) (2024). Among the 17 SDGs, we focused on three areas that are most relevant to sustainability: AI for environmental sustainability, smart cities, and climate action (Nishant et al., 2020), which map to the following SDGs.

- SDG 2: Zero Hunger
- SDG 6: Clean Water and Sanitation
- SDG 7: Affordable Clean Energy
- SDG 11: Sustainable Cities and Communities
- SDG 12: Responsible Consumption and Production

- SDG 13: Climate Action
- SDG 14: Life Below Water
- SDG 15: Life on Land

Part 1. Artificial Intelligence (AI) Labs

We designed the AI labs to achieve two goals: 1) to teach students AI fundamentals and applications that are appropriate to their technical backgrounds; and 2) to serve as toolkits and foundations to build their own projects that address sustainability issues. Among the AI chatbot services offered by many high-tech companies, we chose IBM Watson Assistant, an AI-driven intelligent conversational agent platform. Similar to other chatbot tools, Watson Assistant requires students to know some foundational chatbot concepts, such as dialog, intents and entities, which help students practice logical thinking. Watson Assistant offers a no-code/low-code platform, making it ideal for students without advanced technical backgrounds. We designed the five labs to guide students to learn to build chatbots step-by-step:

- Lab 1: create a simple chatbot that displays a welcome message (about 30 minutes);
- Lab 2: build a chatbot by importing and modifying an existing chatbot (about 30 minutes);
- Lab 3: learn about intents and dialog design by designing a chatbot that could ask users questions and offering branching features based on user input (about 45 minutes);
- Lab 4: create a chatbot that recognizes user intents and answer questions (about 45 minutes);
- Lab 5: build a comprehensive customer service chatbot for a small business. Lab 5 was adapted from a publicly available tutorial published by IBM (about 90 minutes).

Even though generative AI technologies, such as ChatGPT, offer features that easily generate responses based on user input, Watson Assistant supports building chatbots that can guide end users in accomplishing tasks and providing accurate information, both of which are currently unresolved issues faced by chatbots that are powered solely by generative AI.

Part 2. AI for Sustainability Projects

After gaining the needed technical skills from the labs, students formed teams to create chatbots to address sustainability issues they identified in their communities following six weekly milestones.

- Milestone 1: Identify sustainability problems and brainstorm solutions. Students were prompted to choose a topic among the suggested UN SDGs and focus on a local problem in their communities. They then proposed possible solutions before developing their chatbots.

- Milestone 2: User scenario and conversational flow. Student groups then wrote user scenarios, analyzed user needs and system features, and designed the chatbot conversation flow.
- Milestones 3-5: Design. Teams iteratively designed a prototype chatbot based on instructor feedback and discussion on potential ethical issues in the chatbot design and development.
- Milestone 6: User feedback. Lastly, each team interviewed potential users for feedback.

Part 3. Gamified Social Entrepreneurship

Following milestone completion, student teams presented their projects in a final pitch and demonstration competition to a panel of invited industry judges as if they were co-founders of a social startup. Each team shared their project name, company logo, group profile picture, and their company's mission statement followed by a presentation of their issue and a demonstration of their chatbot solution. The gamification of social startup pitch competition aims to motivate students to situate the classroom presentations in professional settings (Chen et al., 2022). Winning teams received a gamified check as a trophy. The judges provided students with real-world experiences and feedback while also giving us the opportunity to showcase students' work to community partners. The presentations were evaluated according to five criteria: 1) effectiveness and efficiency, 2) design and usability, 3) creativity and innovation, 4) depth of insights from user interviews, 5) ethical concerns and proposed remedies. These evaluation criteria were adapted from the 2023 IBM Call for Code Global Challenge, a global hackathon for societal benefits.

Learning Module Deployment

We implemented the AI for Sustainability learning module in Fall 2023 in an upper division MIS elective course that teaches the role of emerging technology in organizations. The AI labs in Part 1 were used as five weekly individual assignments to help students build a solid understanding of creating a chatbot; the six milestones in Part 2 were as in-class group projects, followed by the final pitch competition in Part 3.

A total of 45 students created 9 chatbots. The topics included clean water conservation, renewable energy, responsible consumption, sustainable living, and marine biodiversity. Several student projects included chatbots that educate users on conservation practices to combat water waste and provide real-time decision support for solar and wind farms. Two other projects focused on supporting consumers to make informed decisions; one highlighting a company's products and mission and the other informing shoppers about the nutritional content of produce items. Sustainable living was a common theme across four projects. These included chatbots that connect users to resources and programs for

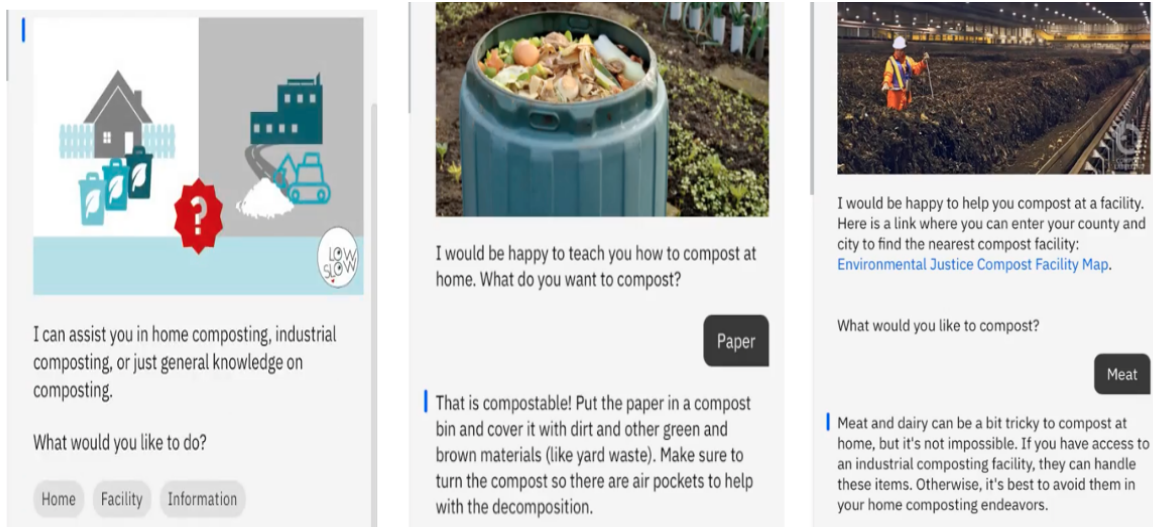


Figure 1: Screenshot of a sample chatbot project (Inarda et al., 2024)

sustainable living, serve a companion that informs users about the risks and benefits of composting, help users recycle and reduce wasteful packaging, and analyze users' sanitation status and hydration statistics. Lastly, one chatbot was designed to provide users with resources and guidelines for marine rescue situations around a local bay.

Figure 1 shows the screenshots of a sample chatbot created by a team that aims to educate citizens about food compost (Inarda et al., 2024).

Evaluation Methods and Data Analysis

To answer the questions, we assessed the project's effectiveness using a one-time post-and-then-pre survey that collected student perceptions of their post project knowledge as well as their recollections of their knowledge before the project began. This retrospective post-then-pre assessment method differs from traditional pre-test-post-test design in that both pre-test and post-test perceptions are collected at the same time using the same instrument (Drennan & Hyde, 2008).

Measurements

The project's effectiveness was measured with 30 five-point Likert scale items and one five-point sentimental differential scale adapted from existing items in literature. The 31 items fall into categories of student self-efficacy of AI, attitudes toward AI, intention to use AI, and sustainability awareness after studying the project. Table 1 describes the details of the survey items.

We chose questions to evaluate student self-efficacy of AI based on the work of Alvarez et al. (2022), Katuka et al.

(2023), and Vandenberg et al. (2023), focusing on their individual beliefs in their capability to use and interact with AI systems. We also assessed student attitudes towards AI, including their feelings, beliefs, and dispositions towards AI in the future and in schools, via questions from the work of Sindermann et al. (2021), Vandenberg et al. (2023), and Suh and Ahn (2022). Student intention to use AI systems was assessed using questions drawn from studies by Suh and Ahn (2022) and Vandenberg et al. (2023). Lastly, student awareness of sustainability issues was evaluated using three items we formulated for the purposes of this study. The survey ended with two open-ended questions asking students what they liked about the project and what they felt could be improved.

Data Collection and Analysis

The survey questions were administered via Qualtrics to students enrolled in the Fall 2023 course. Student survey participation was incentivized through extra credit. We also provided an alternative extra credit assignment for those who did not wish to participate in the survey. The survey was distributed by a coauthor who was not involved with the course. The survey was fully voluntary and the respondents were assured anonymity. Students were clearly informed that the instructor did not have access to the responses until their official course grades were posted.

Among 45 students enrolled in the course, 37 students filled out the survey. We removed a duplicated response from one student and three responses where the respondent selected the same answer for all questions suggesting an inattentive survey response. After data cleaning, the final study sample consisted of 33 responses. 67% of the students are male (N=22), 30% are female (N=10), and one student

preferred not to report gender. We conducted a paired-sample t-test with the bootstrapping resampling algorithm using 1,000 re-samples to estimate item mean differences and p-values using SPSS. We analyzed students' answers to the open-ended questions to examine any themes that might support the quantitative findings.

Findings

The empirical results (in Table 1) generally support that our project is effective in 1) teaching students hands-on AI skills and 2) empowering students to leverage AI for sustainability. Specifically, we found that our project added to students' AI knowledge, increased their confidence in both AI skills and their ability to learn AI, positively shifted their attitude towards AI, enhanced their perceptions regarding the importance of learning about AI and sustainability, and strengthened their interest and motivation to keep learning and working with AI.

Self-efficacy in Learning AI

Student ratings for questions 1-7 post-project are significantly higher than those pre-project with mean differences ranging from 1.184 to 1.868 ($p < 0.01$), which indicates that student self-efficacy with AI specifically, their knowledge of AI, their confidence in their ability to learn AI, and their confidence in their AI knowledge and skills, significantly improved after the project.

Student open-ended questions confirmed the above findings. Students also reported they gained increased knowledge and confidence in building a chatbot. For example, P22 (Participant 22) wrote: "I like how we get to use IBM Watson assistant because I learned so much from creating a chatbot" and for P9, "I liked how we got to explore different subjects and how we got to make prototypes of chatbots using Watson Assistant." In particular, students liked how the project pushed their boundaries in things they hadn't experienced previously (P14).

Attitudes Toward AI

Student ratings for questions 10, 12, and 14-16 post-project are significantly higher than pre-project with mean differences ranging from 0.579 to 0.737 ($p < 0.01$), which indicates that student attitudes toward AI and their perceptions of the importance of learning AI significantly improved.

Looking at student comments, we found that the project helped them see "how AI could positively affect social issues" (P5) and put them "in a situation to get creative with our solutions and what is possible with AI" (P26). Students' positive experiences addressing social issues with AI might be what influenced their attitudes towards AI and their perceptions of the importance of learning AI.

Intentions to Use AI

Student ratings for questions 17-28 post-project are also significantly higher than pre-project scores with mean differences ranging from 0.763 to 1.079 ($p < 0.01$), which suggests that students' intention to use AI, their interest in using and learning AI, and their perceived usefulness of learning AI significantly improved after the project.

Some students also started to see themselves working in an AI-related field after this course. As P11 reported, the project would be "very similar to a project I could see myself doing in the real world after college." P35 considered that "it's good to incentivize AI development among students to get them accustomed to the technologies that will be prevalent in their lives if they already aren't." Four participants mentioned they wished to go deeper into AI. For example, P14 wished to spend more time exploring Watson services and to develop skills on how to use it and P24 would like to explore more functionalities in IBM Watson services. P28 even wished to have done better research in AI technologies above and beyond Watson: "I had watched a video and other applications for Watson and wish I could have integrated it more."

Sustainability and AI

Student ratings for questions 29-31 post-project are significantly higher than those pre-project with mean differences ranging from 0.816 to 0.974 ($p < 0.01$), which indicates that students' sustainability awareness generally, their awareness of sustainability issues in their community specifically, their AI knowledge in solving sustainability issues, and their confidence in their ability to innovate significantly improved after the project.

Eight participants highlighted their appreciation for the experiential learning aspect through a sustainability and social lens. Overall, participants like P19 "liked the idea and message behind the project initiative. Helping the environment using our skills in AI was very fulfilling." As P18 said: "I like that the project made us delve deep into our imagination and come up with ideas that could potentially help the society." For P21, "We then get to see our vision come to life after a semester's worth of work." P25 "enjoyed how it related to real-world problems to really put into perspective how our generation can fix some of the issues in the world." Participants liked the innovation and collaboration aspects of the projects. "It's iterative and encourages you to constantly brainstorm and think outside the box" (P4). They also appreciated the freedom in choosing the topics of their own projects (P24). As P28 reported: "I enjoyed the real-life scenarios and the opportunities given to us to use AI and different options that we can use in our day-to-day lives." Multiple participants also reported it was "fun" and "interesting" to learn about everyone's different topics and chatbot solutions (P7 & P8).

Category	References	Survey Question	Mean Dif. (post-pre)	Std. Error
Self-efficacy	Alvarez et al., 2022	Q1. How much do you know about how to build AI applications?	1.87**	0.20
	Katuka et al., 2023	Q2. I can do well in AI.	1.42**	0.19
		Q3. I can figure out how to solve hard AI problems if I try.	1.4**	0.21
	Vandenberg et al. 2023	Q4. I can use AI to help solve problems around me.	1.45**	0.19
		Q5. I can be successful in learning AI.	1.18**	0.19
		Q6. I am confident I can understand the ideas behind how AI works.	1.26**	0.21
		Q7. I can explain what AI is to my friends.	1.45**	0.20
Attitudes towards AI	Sindermann et al., 2021	Q8. I fear artificial intelligence.	0	0.21
		Q9. Artificial intelligence will destroy humankind.	-0.05	0.20
		Q10. Artificial intelligence will benefit humankind.	0.71**	0.21
		Q11. Artificial intelligence will cause many job losses.	0.00	0.20
	Vandenberg et al., 2023	Q12. I think AI makes people's lives better.	0.58**	0.20
		Q13. I think AI is dangerous.	0.13	0.19
	Suh & Ahn 2022	Q14. I think that it is important to learn about AI in school.	0.68**	0.16
		Q15. I think that lessons about AI should be taught in school.	0.74**	0.18
		Q16. I think every student should learn about AI in school.	0.66**	0.18
Behavioral intention	Suh & Ahn 2022	Q17. I want to work in the field of AI.	1.03**	0.19
		Q18. It is fun to learn about AI.	1.08**	0.21
		Q19. I want to continue learning about AI.	0.92**	0.20
		Q20. I want to make something that makes human life more convenient through AI.	1.08**	0.22
		Q21. I am interested in the development of AI.	1**	0.20
		Q22. It is interesting to use AI.	0.76**	0.16
		Q23. I think that there should be more class time devoted to AI in school.	0.82**	0.20
	Vandenberg et al., 2023	Q24. It is important for me to learn about AI.	0.95**	0.20
		Q25. I am interested in AI.	1**	0.18
		Q26. I think I will be able to use what I learn about AI in the future.	1**	0.20
		Q27. Understanding AI is important to me.	0.92**	0.20
Sustainability awareness	Self-developed	Q28. AI is useful for me to learn.	0.92**	0.21
		Q29. I have a deep understanding about sustainability issues in our community.	0.82**	0.15
		Q30. I know how AI might help address some sustainability issues in my community.	0.97**	0.18
		Q31. I have confidence in my ability to innovate.	0.9**	0.20

Note: Mean Dif. (post-pre): Mean_post - Mean_pre; SE: standard error; **p-value (2-tailed) <0.01.

Table 1. survey questions and results

The differences between student ratings post-project and pre-project are insignificant on questions 8, 9, 11, 13 ($p > 0.05$). These questions are about students' perceived danger of AI. One explanation might be that students researched AI ethics, including how AI could be misused and how to design responsible solutions, which could lead to mixed opinions about the danger of AI. The incongruent views on the potential risk of AI among students suggest that this project inspired students' critical thinking through experiential learning.

Discussion and Lessons Learned

Our pilot study on AI for sustainability presents promising results on the cognitive, sociocultural and affective dimensions of AI education. In it, students were empowered to be co-creators of knowledge who enriched the class with valuable and diverse lived experience and collaborators / future leaders who will play important roles in both AI development and the creation of a sustainable society. The project allows faculty to serve both as educators and as mentors as students navigate the learning and innovating experiences needed to bridge the gap between the classroom and real-world problem solving and prepare themselves for a fast-changing future career. We would like to share three lessons we learned from this experience.

First, encourage students to learn AI relevant to their own experiences. Traditional AI education tends to prioritize classroom-based learning. However, our study suggests students may be highly motivated to learn AI by working on by practical and relatable problems. They may also feel inspired by exchanging ideas with their team members. By focusing on real-world issues, instructors may also benefit as much as, if not more than, students, learning from student problem identification and ideation, prototyping, and project development.

Second, empower students to leverage their sociocultural assets to create solutions relevant to their communities. AI's interdisciplinary nature offers tremendous business potential, but its benefits often bypass underserved communities and public sectors. By inviting students to learn about the problems facing their own communities and actively provide solutions, we create a classroom environment that fosters diverse perspectives and applications of AI technologies.

Third, enable students to explore differences and ethics of their communities and AI. As students identify community problems, they often observe disparities, such as those between high-income and low-income neighborhoods. These observations help students recognize potential biases that might be embedded in AI systems and models. By situating their learning in a community context, the learning modules invite students critically evaluate the differences and ethics in their community and in AI technologies.

Conclusion and Future Work

This paper presents a pilot study of a pedagogical innovation that aims to teach students to learn AI and innovation through the lens of community sustainability. It reports the implementation of the project among 45 undergraduate business MIS students. Preliminary findings suggest the module significantly heightened student confidence and interest in AI learning and AI careers and enhanced sustainability awareness. We then discuss the benefits of empowering students to be co-creators of knowledge, to assume full agency of their AI learning, and to investigate AI's impact on sustainability and humanity.

This pilot study only discussed one part of AI for sustainability – designing AI prototypes to address sustainability issues. An equally important aspect of AI sustainability is the environmental impact caused by computational resources, such as CO2 emission. We plan to include modules to educate students about making more sustainable AI systems to minimize environmental impacts. Though this paper only reports the results among 45 students, at the time of this paper's submission, the module had been implemented among over 130 undergraduate MIS students. We will continue to investigate the impact of this pedagogical approach on student learning and deepen our understanding of how students' self-efficacy with AI and their sustainability awareness impacts their attitudes toward AI and their intention to work with AI in the future.

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