GENERATIVE AI IN DESIGN EDUCATION: BUSINESS AS USUAL, A TROUBLEMAKER, OR A GAME CHANGER?

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ABSTRACT
Higher education institutions (HEI) are facing fundamental questions regarding students' use of artificial intelligence (AI) tools in the form of large language model (LLM) based chatbots. Students are already using AI tools to respond to written assignments and exams. Our research question is: What is educators' standpoint about students' use of generative AI in higher education? A mixed methods approach was applied for the present study. First, a qualitative investigation was conducted, centred around interviews that revolved around potential consequences (i.e., opportunities, threats, challenges, etc.) and factors related to the educators' views on AI. Based on the qualitative approach, three propositions were postulated for a narrower quantitative approach, including a larger sample of educators from industrial design (ID) educations at HEIs' in Europe. The quantitative data was collected through a questionnaire and analysed using a fuzzy-set qualitative comparative analysis (fsQCA). The findings from the questionnaire supported our proposition about (1) Knowledge about AI leads to seeing opportunities rather than challenges, but not our propositions of (2) Emphasizing skill-focused learning outcomes leads to seeing opportunities rather than challenges, and (3) Use of authentic cases leads to educators' not emphasizing challenges. This study emphasizes the importance of knowledge about AI for educators.

Keywords: Generative AI, artificial intelligence, higher education practices, assessment, AI knowledge

1 INTRODUCTION
Higher education institutions (HEI) are facing fundamental questions regarding students' use of artificial intelligence (AI) tools in the form of large language model (LLM) based chatbots, image generators [1]. Students are already using AI tools to respond to written assignments and exams. Support from generative AI solutions such as ChatGPT may mean that yesterday's well-established proxies for doing, reflecting, and learning must be rethought [2]. For instance, writing an essay must mean that the students learn the literature needed for the essay. Thus, continuing many of our current ways of giving students assignments may neglect that writing skills, literary knowledge, and reflective insight are not required to deliver a seemingly sound response to an assignment or an exam. Hence, students may use AI in a way that does not facilitate in-depth understanding and provide the desired and required learning outcomes. Furthermore, it is known that AI services may also generate incorrect information, and previous research found that students are less inclined to critical thinking when using AI tools [3], which could result in significant misconceptions. Students' use of AI is relatively new, and higher education institutions (HEI) do not have sufficient guidelines and knowledge on how to use AI in education and also lack experience in dealing with the challenges that might occur [4]. Though generative AI presents some challenges, there are also opportunities. Generative AI tools can be powerful to automate repetitive tasks and can aid students with the writing of text [2]. Nevertheless, the development and availability of generative AI has prompted a need for new learning outcomes, including knowledge about AI, more focus on critical thinking and reasoning, digital literacy, and generic skills [5]. Educators are now facing the challenges AI brings to assessment methods in HEI, but do not necessarily have solutions readily at

hand. In this paper, we wish to explore what influences educators' viewpoints on students' use of generative AI in higher education.

2 BACKGROUNDS

2.1 AI in higher education

Generative AI tools can provide opportunities in education, but also have some limitations. AI tools, such as ChatGPT, can increase access to information, facilitate personalized and complex learning, and decrease teaching workload [6]. Chatbots can be used for brainstorming, writing assistance, and individualized learning [2]. In a review from 2020 [7], researchers found that AI has been adopted in education and used to perform administrative functions to reduce time use. Furthermore, AI has been used to aid learning processes by helping customize content. AI tools such as writing assistants and revision assistants are made to aid students and can benefit learning. Adaption for students using AI tools can foster retention and uptake, ultimately improving the students' learning. On the other side, AI may encourage dishonesty by students using AI platforms and tools to write or do tasks for them [7]. AI tools such as ChatGPT also has a lack of understanding, difficulty in evaluating the quality of responses, risk of bias and discrimination, and lack of higher order thinking skills [6].

Though the use of AI for students can be a tool for learning, some students may be tempted to take shortcuts. In a study by Farazouli et al. [8], educators assessed home examinations blindly, where some were written by students and some generated by ChatGPT at three levels of complexity. The teachers were not successful in identifying the texts written by ChatGPT, and only correctly suspected ChatGPT 14% to 23 % of the time. The teachers with more experience with ChatGPT were more successful in suspecting the AI-written texts. Thus, AI creates new challenges for educators regarding assessment. A literature review on using chatbots in education found that the research is still in an early stage, with little consensus and knowledge about effective learning design or learning strategies with chatbots [9].

2.2 AI in design education

AI can be a useful tool in design education both for the students and educators. In design education, AI has been used as product testers for design students [10]. The AI tools were shown to be useful in participating in student design activities. Two educators explored using ChatGPT as a virtual colleague [11]. ChatGPT helped save time, structure textual content and documentation, and was used as a brainstorming tool in creating design course content and materials. The chatbot had some limitations as it often generated generic and vague content, and human prompting and editing were required to produce the desired outcome. Assessment that requires product design are moderately affected by generative AI [12].

Technology and AI impact designers, for example, in industrial design where technology is an integrated part of the product [13]. Integrating the rapidly developing technology in design education is valuable. Developing technologies and AI can provide innovative opportunities for the design of new products, and by disseminating knowledge about AI and emerging technologies to the design students, they will become better at implementing and using the technology in their designs and products.

2.3 Adopting new technologies

The technology acceptance model (TAM) presents factors influencing teachers' adoption of technology, such as perceived usefulness, perceived ease of use, attitudes toward technology, and self-efficacy [14]. A study applying TAM found that perceived usefulness and perceived ease of use positively impacted students' attitudes toward behavioural intentions and actual use of AI-based systems [15]. As AI is a new technology, according to the TAM teachers' perceptions and attitudes towards AI will influence both their adoption of the tool, and possibly students' attitude and use.

A significant factor for teachers to change behaviour and adopt technologies is knowledge [16]. For teachers to use technology in a way to facilitate learning, they need knowledge of the technology itself, knowledge of pedagogical practices appropriate for the technology, pedagogical methods for student learning and how technology can support the learning.

3 METHOD

A mixed methods approach was applied for the present study. This gave us a more comprehensive view of AI in design education and yielded richer and multifaceted insights. First, a qualitative investigation was conducted, centred around eight semi-structured interviews with educators from industrial design

(n=3), architecture (n=1), entrepreneurship (n=2), electronic engineering (n=1), and industrial engineering (n=1) about potential consequences of AI in design education (that is, for instance, opportunities, threats, challenges, etc.) and factors related to the educators' views. A pilot of the interview was conducted. A thematic analysis [17] was done on the interview transcripts. After getting familiarized with the data, initial codes were identified and eventually sorted into clusters that emerged as different themes. The themes were then reviewed and named. The resulting themes were used to postulate propositions for a narrower quantitative approach in the form of a questionnaire that was distributed to 14 universities in Norway, Sweden, Denmark, Finland, Netherland, Germany, England, and Italy, which offers industrial design courses. Therefore, a limitation of the study is that it is only conducted within a (mainly northern) European context. The questionnaire consisted of 24 questions distributed across four themes: knowledge about AI, use of authentic cases in education, skills-focused courses, and perception of challenges and opportunities with AI. *Answers were rated using a seven-point Likert scale, where 1 = Strongly disagree and 7 = Strongly agree. The measures were: Knowledge of AI, Use of authentic cases, Skill-based course, AI is an opportunity, AI is a challenge, AI is more of an opportunity than a challenge.* Questions about knowledge about AI is inspired by TPACK-deep [18]. The questionnaire was piloted with four Norwegian educators completing the questionnaire and giving detailed feedback. A potential limitation in the questionnaire design is that the respondents must themselves evaluate how "case-based" and "skill-based" should be interpreted in their educational context.

The quantitative data was collected through a questionnaire and analysed using two approaches: Fuzzy-set qualitative comparative analysis (fsQCA) and multivariate linear regression. We received 47 complete responses to the questionnaire. FsQCA is a set-theoretical approach that, unlike more traditional statistical methods such as multivariate regression, allows for investigating how combinations of several factors may explain an outcome [19]. Thus, our analysis is strengthened by using two independent approaches to assess the propositions from the qualitative part of this study.

Both quantitative analyses were conducted using STATA/MP version 17.0 and fsQCA using the package 'fuzzy' by Longest and Vaisey [20]. Values for fsQCA should have a value between 0 and 1, where 0 represents "full non-membership" of a certain condition, such as the absence of knowledge about AI, and 1 represents "full membership" of a certain condition, such as the presence of knowledge about AI. Preparation of the dataset through data calibration is therefore necessary, and we used the direct approach proposed by Ragin [21]. The calibration should result in three values for each variable: (1) A crossover-point (CP), which is the point of maximum ambiguity whether it represents membership or non-membership, (2) a full non-membership threshold (FNT), where it is certain that a value represents the absence of a factor, and (3) a full membership threshold (FMT), where it is certain that a value represents the presence of a factor. We used a combination of theoretical anchors and empirical anchors (distribution of values of each variable) to define the three calibration values, which are presented in Table 1. Since we used a seven-point Likert scale, a value of 4 is the theoretical crossover-point. Empirically, a starting point for the crossover point could be the median value for the measured variable. We chose a 75% weighting on the theoretical perspective, except for the skill-based course variable, where the distribution of values was biased towards higher values, which is expected in industrial design courses.

Table 1. Descriptive statistics and calibration values

Variable	Mean	SD	Median	Min	Max	FNT	CP	FMT
Knowledge about AI	4.43	0.63	4.43	3.14	6.00	3.71	4.07	4.86
Case-based course	4.93	1.28	5.20	1.20	6.60	3.90	4.21	6.00
Skill-based course	6.11	0.73	6.00	3.25	7.00	5.50	6.00	6.75
AI opportunities	4.65	1.22	5.00	2.00	7.00	3.33	4.20	5.60
AI challenges	3.89	1.34	4.00	1.33	7.00	2.60	3.92	5.00

FNT and FMT were set empirically at 20 percentiles and 80 percentiles, respectively. A minimum significance level of $p<0.05$ and a consistency threshold of 0.8 was defined for the fsQCA, in line with recommendations by Ragin [22]. The results from fsQCA were reduced to a minimum reduction set using the Quine-McCluskey algorithm [20].

4 FINDINGS

4.1 Qualitative thematic analysis

The thematic analysis of the eight interviews identified the following themes:

1. **AI is an opportunity:** The educators viewed generative AI as an opportunity for the students to learn to use a new tool and to work more effectively.
2. **AI does not hinder learning:** The educators were not worried that generative AI would hinder students learning and argued that the courses was based on experiential learning and therefore the students would learn, no matter if they used generative AI or not. For example, the students still had to do their own considerations and choices based on the information they had.
3. **AI is not a challenge:** Specificity and practical work in the courses were emphasized, where the educators meant AI could not do this work for the students. For example, physical models must be built, and specific information and context must be included in their project. The educators therefore meant that AI was not a challenge in their courses.

The interviewed educators had not yet implemented specific AI tools in the courses but considered possibilities for it in the future. Based on the qualitative approach, the following three propositions were postulated for a narrower quantitative approach: (1) Knowledge about AI leads to seeing opportunities rather than challenges, (2) Emphasizing skill-focused learning outcomes leads to seeing opportunities rather than challenges, and (3) Use of authentic cases leads to educators' not emphasizing challenges.

4.2 Quantitative analysis

47 educators answered the questionnaire (15,7 % response rate). The results from fsQCA are presented in Table 2 below, and the results from multivariate linear regression are presented in Table 3 below. Two sets representing paths to seeing AI opportunities were found (sets 1 and 2 in Table 2). From sets 1 and 2, we see that knowledge about AI must be either combined with a skill-based but not case-based course (set 1) or with a case-based but not skill-based course (set 2). Set 3 represents the one path to seeing AI challenges, where a combination of absence of AI knowledge and absence of a case-based course is necessary. Thus, AI knowledge is necessary, but not sufficient, to explain AI opportunities. The absence of AI knowledge is necessary, but not sufficient, to explain AI challenges.

Table 2. Results from fsQCA
(R.cov=raw coverage, U.cov=unique coverage, S.con=solution consistency)

Set	Knowl.	Case	Skill	AI opp.	AI chall.	R.cov	U.cov	S.con
1	1	0	1	1		0.235	0.154	0.865
2	1	1	0	1		0.293	0.212	0.857
3	0	0	–		1	0.275	0.275	0.881

The results from multivariate linear regression are in line with the fsQCA. From Table 3, we see a strong and significant positive impact from knowledge about AI and AI opportunities and a substantial and significant negative impact from knowledge about AI and AI challenges. Significant influences from the other variables were not found.

Table 3. Results from multiple linear regression analysis
*(standardized coefficients, standard deviations in parentheses, *** p<0.01, * p<0.1)*

	Model 1: AI opportunities	Model 2: AI challenges
Knowledge about AI	0.458*** (0.263)	-0.294* (0.308)
Case-based course	0.066 (0.131)	-0.102 (0.154)
Skill-based course	0.056 (0.234)	-0.102 (0.274)
Adjusted R^2	0.169	0.056
Sample size	N=47	N=47

Interestingly, there is no significant correlation between AI opportunities and AI challenges (b=-0.126, p=0.389). Hence, AI opportunities and AI challenges represent independent dimensions and are not opposites of each other. This interdependency was confirmed using factor analysis. Overall, the quantitative analysis supports the first proposition from the qualitative analysis, namely that "Knowledge about AI leads to seeing opportunities rather than challenges". The analysis was unfortunately not able to successfully assess the two other propositions. A few respondents also used

the opportunity to leave a comment at the end of the questionnaire. Thoughts about using AI in their courses in the future were mentioned, although not yet implemented.

5 DISCUSSIONS

First and foremost, our results show how knowledge about AI is essential. Hwang & Chang [9] state that there is little research on the knowledge about how chatbots can be used to facilitate learning. Our results show a need for knowledge about AI to be able, as educators, to see opportunities for AI use in higher education. According to the study by Farazouli et al. [8], educators struggle with detecting assignments where students have used ChatGPT, though educators with more experience with ChatGPT were more successful. Atlas [2] argues that we must re-think current practices. The result of our study shows that if educators have more knowledge about AI in education, they also have a more optimistic and opportunity-seeking approach. This could be solved with more research on how AI influences assessment methods in HEI, but also that HEIs' create courses for educators to enlighten and increase competence on the topic. Opportunities from chatbots, image generators, and other tools available to students are powerful tools to automate repetitive tasks, can help with writing, save time, structure text content and documentation, as well as aid brainstorming [11].

According to TAM [14][15] perceived usefulness is important for the adoption of new technologies, which means that by increasing educators' knowledge about AI, they have a higher chance of perceiving the opportunities that lies withing the tools and therefore also be more inclined to use the tools. Having educators who understand the usage of AI tools might be essential to educating future designers who are capable of appropriate use and implementing these tools into their work and products [13]. Knowledge about the specific technology and how to use the technology in specific ways is important to increase students learning [16]. Our results also show that not having knowledge about AI leads to seeing challenges, which might lead to avoidance of the AI tools. Increasing knowledge about AI is therefore important for educating the designers of the future. The results also show that knowledge about AI together with either case-based but not skill-based course, or not case-based but skills-based course, lead to seeing opportunities for AI. These findings point towards some characteristics of courses that also need to be present, in addition to knowledge about AI, for educators to see opportunities. These findings somewhat align with the propositions postulated, though the relationships are more complicated. Though these findings are difficult to make sense of, the main takeaway is the importance of knowledge about AI in seeing opportunities, both for courses with a high degree of skill focus and courses with a high use of authentic cases.

6 CONCLUSIONS

Knowledge about AI is essential to see opportunities and a lack of this knowledge can lead to seeing challenges. To strengthen industrial design education, increasing educators' knowledge about AI is crucial, both for educators to be able to use AI in an appropriate and constructive way and to educate the designers of the future who can use AI, understand its limitations, and implement the technology into their designs in a suitable manner. Students' use of AI is already common practice. Therefore, educators must be able to guide students towards the appropriate and ethical use of these new and powerful tools.

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