

Research on the Application of Generative Artificial Intelligence in the Field of Design Teaching at a Taiwan University of Science and Technology

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Abstract

In the context of a declining birthrate, the reduction of human resources, and the rapid development of generative artificial intelligence, many jobs are facing potential replacement and time-labor compression. This has resulted in a mismatch between graduates' skills and industry demands, leading to issues with competitiveness. Therefore, this study explores the potential application of generative artificial intelligence in design education within the context of Taiwan's declining birthrate. Through literature review and qualitative interviews, data were collected and analyzed from the Department of Interior Design at a technology university in New Taipei City, Taiwan. The study found that, in the initial stages of traditional design courses, students communicate with instructors using hand-drawn or electronic sketches to advance their design concepts. Some students experience slow development of design concepts and struggle with maintaining the quality of design outcomes. Traditional design courses do not incorporate generative artificial intelligence to assist in design education. Consequently, the integration of generative artificial intelligence into the field of design education could bring about new transformations in teaching content, methods, and spaces.

Keywords: Generative Artificial Intelligence, Design Teaching, Image Generation, Flipped Classroom

1 Introduction

In Taiwan, declining birth rates have become a severe societal issue. However, in the field of technical and vocational education, declining birth rates also present numerous challenges. The impact of declining birth rates on technical and vocational education is primarily reflected in the reduction of student enrollment, teaching staff, and the number of schools, leading to a decrease in overall scale and subsequently diminishing educational resources and quality. The emergence of generative artificial intelligence has sparked extensive discussions in the field of design education: to what extent will generative artificial intelligence change design teaching? How will it reshape the design process and modes of design thinking? Some even question

whether generative artificial intelligence will replace certain design personnel's work. This study aims to explore potential transformations in the design education field within the context of declining birth rates and rapid advancements in artificial intelligence, thereby proposing future perspectives on teaching spaces, content, and methodologies, and posing the following four questions:

1. What crises and opportunities does declining birth rates bring to technical and vocational education?
2. What is the current situation and potential pitfalls of artificial intelligence in design education?
3. What transformations have occurred in the current stage of teacher-student relationships, teaching methods, and spaces in the field of design education?
4. What are the future directions for the development of teaching spaces, content, and methodologies in design education in the context of technical and vocational education?

Additionally, this study employs qualitative literature analysis and qualitative interviews. The former involves collecting relevant data on declining birth rates and generative artificial intelligence in the field of design education at technical universities from databases such as Web of Science and CNKI. After screening, selected literature is included in the study. The latter method utilizes non-structured interviews with teaching staff and students at a technical university in New Taipei City, aiming to explore the potentialities of teaching methodologies and spatial development in the field of design education at technical universities amidst declining birth rates and the rapid development of generative artificial intelligence.

2 Review of Literature

2.1 The Crises and Opportunities of Vocational Education in the Context of Declining Birth Rates

Due to the rapid development of the times and the diversification of societal values, the phenomenon of declining birth rates has become an unavoidable trend in future global social development. Taiwan's fertility rate has been below the replacement level of 2.1 since 1984, falling into the category of ultralow fertility rates at 1.3 since 2003. In recent years, exacerbated by the impact of the Covid-19 pandemic, the fertility rate has dropped below 1.0 (National Development Council, 2023).

In traditional school education, schools typically divide students into different educational stages based on their age, ranging from lower to higher levels of education. Education is generally divided into four stages: preschool education, compulsory education, high school education, and higher education. It is believed that the impact of declining birth rates on different stages of school education does not occur synchronously but persists over time (Liu, 2021). Some scholars categorize the impact of declining birth rates on the higher education field into two aspects: on one hand, declining birth rates result in a shortage of university students; on the other hand, there are issues related to industrial upgrading and imbalances in the supply and demand of industry-academia collaboration. The latter mainly manifests in the mismatch be-

tween graduates' skills and industry demands, leading to difficulties in job seeking and an increase in unemployment rates. Approximately 47% of current jobs are expected to be replaced by artificial intelligence in the next 10 to 20 years (Zhang & Lin, 2019).

In the context of declining birth rates, there is a reduction in human resources, coupled with the rapid development of generative artificial intelligence, leading to many jobs becoming replaceable and undergoing time and labor compression. Consequently, graduates face issues of inadequate competitiveness due to their skills not meeting industry demands. Such changes pose both crises and opportunities. The limitation on course offerings due to insufficient student enrollment forces schools to demand teachers to update their teaching content and methods. In turn, teachers engage in relearning and improving their knowledge of modern concepts, enabling teaching methods and content to progress towards greater alignment with societal needs and quality enhancement.

2.2 The Teacher-Student Relationship, Teaching Methods, and Teaching Space in the Field of Design Education

Under the traditional teaching paradigm, teachers wielded absolute authority in aspects such as social relations, knowledge authority, and teaching space (Shang, 2020). However, with the diversification of knowledge acquisition channels, there has been a gradual reversal in the current teacher-student relationship, teaching methods, and teaching space. Teachers have evolved from being mere disseminators of knowledge to becoming guides and facilitators, while students have shifted from passive recipients to active participants and explorers. The teacher-student relationship has transitioned from a unilateral top-down dynamic to one characterized by interaction and collaborative exploration. Teaching methods have also shifted from traditional rote learning to include blended learning, self-directed learning, and peer collaboration. Additionally, with the rapid development of technology, there has been a growing demand for technology equipment and internet access in teaching spaces, moving from spaces that required no equipment to those that necessitate technological devices and internet connectivity (Tsai, 2014).

However, in the field of design, designers often initially present their design concepts in the form of conceptual sketches. The generation of a design concept encompasses all elements of a thinking loop, including the generation of multiple ideas, various concepts, and creative, valuable thoughts (Chen et al., 2019). Hand-drawn sketches are an important part of designers' design and conceptualization process, with designers using sketches as a means to generate and communicate ideas. Despite the widespread use of computer-aided sketching software in design practice, the initial conception and conceptual design in design have long been dominated by manually drawn sketches (Mao et al., 2020).

In the early stages of conceptual design, communication and guidance between teachers and students are conducted through sketches to facilitate collaborative exploration in design courses. With the development of technology, there has been some degree of computer intervention in the field of design education, but it primarily in-

volves changes in drawing and presentation methods. With the emergence of generative artificial intelligence tools such as ChatGPT, Midjourney, and Runway, AI has begun to find new ways to quickly generate solutions, making it possible for generative AI to assist in design.

2.3 The Development and Hidden Dangers of Generative Artificial Intelligence

Artificial intelligence is an important branch of computer science, focusing on researching how to enable computers to perform tasks with intelligent characteristics that were previously exclusive to humans, such as understanding natural language, pattern recognition, decision-making, and learning from experience (Banh & Strobel, 2023). In the past, artificial intelligence was based on algorithms constructed from vast amounts of data and provided standardized response algorithms, known as Discriminative AI. With the rapid development of artificial intelligence and machine learning, the continuous evolution of deep neural network algorithms has accelerated machine intelligence. However, in 2022, OpenAI introduced ChatGPT, symbolizing a transition from discriminative to generative artificial intelligence. Now, generative artificial intelligence is capable of tasks such as generating images from text and performing intelligent tasks like 3D modeling (Li, 2023, Li et al., 2023, Huang, 2023).

However, both discriminative and generative artificial intelligence still have limitations in their application in the field of education. The pitfalls of artificial intelligence include: making learning shallow and potentially labeling learner differences; lack of transferability of knowledge, logical thinking ability, critical thinking ability, leadership, communication skills, innovation, and complex decision-making skills; and the tendency for algorithms and data standardization to lead to fragmented common sense knowledge among students, loss of tacit implicit knowledge, and an inability to develop independent thinking skills (Jiao & Zhu, 2022).

With the rapid development of deep neural network algorithms, generative artificial intelligence has made significant advancements in generating images, text, and models, making the use of generative AI in design assistance a trend. Therefore, this study believes that due to the pitfalls associated with it, when generative artificial intelligence intervenes in the field of design education at technical universities, it should bring about new changes in teaching content, methods, and spaces.

3 Research Design and Method

3.1 Research Process

The study employed semi-structured interviews to collect data on the teaching situation of computer-aided design and interior design at a university of science and technology. The collected data were then coded and analyzed to serve as the basis for subsequent research discussions. Subsequently, in-depth interviews were conducted with teachers and students from a university of science and technology in New Taipei City. Based on the literature analysis mentioned earlier, the study selected design conception and communication methods, design development and communication efficiency, as well as the current status of teaching space as the main topics of the

interviews(see **Table 1**). It aimed to explore the relationships and current situations among teaching content, methods, and space, and to propose recommendations based on this analysis.

Table 1. Issue classification.

Topics and Categories	Space	Teaching content and methods		Teaching
		Design conception and communication methods	Design development and communication efficiency	Space status
Student	How do students present design ideas	How does the teaching method affect students' design development speed		The current situation of teaching space for teachers and students
Teacher	How does the teacher guide students in designing	How effective are teaching methods in designing communication between teachers and students		

3.2 Interview Content Coding

Before delving into the relationship among teaching content, methods, and space, this study conducted in-depth interviews with both educators and learners to elucidate the inherent complexity of their relationship. Two lecturers, two second-year university students, and two third-year university students were selected for the in-depth interviews. Below are the basic details of the interviewees, along with the dates and locations of the interviews (see **Table 2**).

Table 2. Basic information of interviewees and interview date and location.

Respondent Code	Respondent Identity	Respondent Date	Interview Location
Jiang** A1	Teacher	2023.12	Tteacher's office
Li** A2	Teacher	2023.12	Tteacher's office
Chen** B1	Second year student	2023.12	Classroom
Lin** B2	Second year student	2023.12	Classroom
Guo** C1	Third year student	2023.12	Classroom
Huáng** C2	Third year student	2023.12	Classroom

3.3 Interviews Result and Findings

Through an interview with a science and technology university in New Taipei City, it was found that students in the early stages of conceptual design often utilize methods such as manual sketching, AutoCAD, or computer modeling to develop their design ideas. They communicate these ideas with teachers in the form of sketches. Teachers typically use whiteboards or projectors in classrooms and provide guidance

to students through verbal communication, hand-drawn sketches, and relevant real-life examples. This process facilitates the advancement of design concepts.

After conducting interviews, researchers made judgments based on the responses and content provided. They found that some students, while exploring the design process with teachers, faced challenges. Since teachers mainly used verbal communication, hand-drawn sketches, and relevant real-life examples to guide students, these responses sometimes did not provide timely and effective feedback to students' designs. As a result, students needed to spend additional time sketching again to respond, and if the feedback was inadequate, it required even more time for further communication. This slower pace in the development of design concepts led to difficulties in controlling the quality of design outcomes.

Through interviews conducted at the university of technology, it was found that the university is still in the stage of observation and experimentation regarding the use of generative artificial intelligence in design assistance. There are no formal courses or corresponding teaching content, methods, and spaces to support this approach. This study suggests that when facing challenges such as slow development of design concepts and difficulty controlling the quality of design outcomes among some students, the use of generative artificial intelligence in the design teaching process can facilitate more effective design communication and enhance the speed of design development for certain students.

4 Research Discussion and Result

4.1 Collecting Information for Instructional Content, Developing Teaching Materials, and Applying Software in Teaching

After the intervention of generative artificial intelligence in design teaching, the process of data collection and teaching material creation will become faster and more diverse. Generative artificial intelligence is a tool based on big data models for synthesizing outputs, serving as a convenient aid for both students and teachers in data collection. However, due to the inaccuracies in integrating and outputting content, there may be some errors in the output. For example, ChatGPT may produce uncertain outputs in terms of correctness, sometimes not aligning with objective facts. Similarly, software like Midjourney may generate interior images with proportional discrepancies or illogical elements. Therefore, while enhancing students' learning methods and understanding of generative artificial intelligence applications, it is also important to guide students in improving their ability to judge the outputs.

4.2 Multifaceted Thinking and Discussion on Communication in the Design and Development of Instructional Methods within Teaching Approaches

After the intervention of generative artificial intelligence in design teaching, the teaching approach will transition from the original one-to-one or one-to-many format to one-to-one-to-one or one-to-one-to-many. Generative artificial intelligence will begin to intervene in the development process of design concepts. Through interviews, it was found that in the current design courses at the university of technology, students initially communicate with teachers in the form of hand-drawn or electronic

sketches. However, some students encounter challenges in the design process because the feedback from teachers during the design communication process is sometimes not timely or effective, resulting in slow convergence of design concepts and difficulty in controlling the quality of design outcomes. After using generative artificial intelligence, students can engage in self-discussion and obtain practical design concept communication through interaction with ChatGPT via question and answer. Additionally, students can even input concepts in the form of prompts into generative artificial intelligence tools like Midjourney, thereby quickly generating creative and unique design concept images. Teachers can then advance the development of design concepts by communicating with students based on the prompts and the concept images generated by artificial intelligence.

4.3 The Intelligence and Resilience Adjustments that should be made within the Teaching Space to Facilitate Flipped Learning

Adjustments in teaching spaces are also needed to accommodate changes in teaching content and methods. Some scholars argue that the meaning of objects changes as human experiences change (Bi, 1993). Others suggest that space is a field of power construction, and the selection and use of objects in classroom spaces will change with the innovation of teacher-student relationships and teaching methods (Liu, 2004). In traditional teaching processes, where the teacher's role is that of a knowledge transmitter and the student's role is that of a passive recipient, the typical spatial arrangement involves the teacher positioned at the front podium and students sitting in rows behind. However, due to the flip in teaching methods, design teaching at present primarily adopts a group-based instructional space. Flipped teaching spaces can better facilitate one-to-one or one-to-many discussions between teachers and students at whiteboards, display areas, or seating arrangements.

5 Conclusion

Based on the above analysis and discussion, this study proposes the following three conclusions and recommendations:

1.Regarding teaching content:

From data collection to material production, it is advisable to use generative artificial intelligence reasonably to assist. Additionally, efforts should be made to enhance students' training in relevant learning methods, including improving their ability to apply generative artificial intelligence and judge its output content.

2.Regarding teaching methods:

Knowledge sharing among students, teachers, and generative artificial intelligence should be encouraged from multiple perspectives to consider and explore design solutions. This approach can enhance students' design convergence speed and the quality of design outcomes.

3.Regarding teaching spaces:

The resilience and intelligence of teaching spaces should be increased to meet the changing needs of knowledge authority during the learning process.

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