## A Pilot Study

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# A Pilot Study: Engineering Students use Generative AI to Support the Development of Playful Educational Technology

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**Abstract**: This qualitative pilot study provides an example of how generative Artificial Intelligences (GenAI) can be applied in an engineering course focused on the development of playful educational technology. In this context, playful educational technology refers to games or game-like applications designed for educational purposes. We explore various applications of GenAI in creative design processes such as brainstorming, acting as a collaborative partner in design, facilitating image and sound creation, and aiding in the resolution of coding challenges. By examining examples from 36 engineering students' semester-long projects, we highlight the potential and drawbacks of GenAI as an extra teammate in enhancing the design process for developing educational game-based learning experiences. Key findings from the study include: The students opted to use a GenAI as a teammate, whose input required validation. They employed GenAI in areas where they found it effective and where no major ethical issues were involved. It was also surprising to observe the wide variety of AI tools the students incorporated.

**Keywords:** AI, Design Processes, Educational Technology, GBL, Higher Education, Generative Artificial Intelligence.

## 1. Introduction

The paper explores the innovative use of generative AI (GenAI) in an engineering course focused on students' development of playful educational technology. In this context, it refers to game-like software applications designed for educational use. It highlights GenAI's role in enhancing creativity and learning outcomes in development processes. The paper offers interdisciplinary insights and suggest future research directions, appealing to a broad audience of educators, developers, students, and researchers in the fields of technology and education.

Since the end of 2022, GenAI has been at the forefront of educational discussions at all academic levels (MYRE, 2024). Initially, there was concern among educators about how GenAI might negatively affect students' competencies. In response, my research group decided to approach GenAI as a powerful tool, analogous to the introduction of calculators to the market in the late 1970s. Recognizing that GenAI will be a part of our students' future work life, we believe it is essential for them to understand and effectively use this tool. They should become knowledgeable about its pros and cons and be adept at leveraging its potential. This means that efforts should be focused on enhancing students' AI literacy (Hammerscmith et al., 2024).

In practice, it will be impossible to ban GenAI in written exam papers, such as semester projects, bachelor's projects, and master's theses, which are prepared over several months. Currently, it is not possible to detect with certainty whether GenAI has been used (Else, 2023). To sum up the reaction to GenAI: (1) banning it, (2) setting rules for something we don't yet fully understand, or (3) promoting student reflexivity and AI literacy. This study explores the third strategy.

Research questions of the paper: How can GenAI be used in the development of game-like applications for educational use? Including, how can we promote students' reflections on GenAI?

We want the students to reflect on the use of GenAI in relation to development of software applications and the usefulness of the tool in the future. Reflection is a central part of learning processes (Kolb, 1984; Kolb & Kolb, 2011). In experiential learning, the alternation between concrete experiments and reflection is a key parameter (Kolb and Kolb, 2011). In this context, the iterative software development process is concrete experiments that students must complete. Experiential learning as a teaching method can advance the understanding of GenAI (Sun et al., 2024).

In the autumn of 2023, 36 third-semester students in the Game Development and Learning Technology engineering program completed a semester project in the subject 'Learning Technology 1'. The theme of the project was the green transition, and the students were required to use generative AI in the design process.

The learning objectives included the ability to plan and implement both physical and digital prototypes for a learning application, spanning from the pre-analysis phase to the digital implementation. Furthermore, students had to prepare a written report that explained the key features of the digital prototype and the design process,

as well as make an oral presentation of key parts of the development process. Additionally, students needed to be capable of explaining central theoretical learning paradigms pertinent to the project, reflecting on didactic and learning theory issues related to the use of technology in teaching contexts. Reflecting on the use of GenAI within design processes was included as an additional learning objective for the course.

The course was conducted with a block of four hours per week for 12 weeks, followed by an additional eight weeks dedicated to completing the project work. All 20 weeks constituted the project work period. Concurrently, students were introduced to the subject area of learning technology. They were required to document the iterative design process, the learning-oriented didactic design, and the technical design of the learning technology equitably. Moreover, students were expected to incorporate GenAI wherever they deemed it useful and to reflect on its use in the project report. The project work were to be carried out in groups of four to six students. The digital prototypes were developed using either Unity or web programming.

## 2. About GenAI

This brief introduction aims to introduce GenAI. Artificial intelligence (AI) addresses the development of computer systems capable of performing tasks that normally require human intelligence, such as dialogue, visual perception, speech recognition, decision-making, and translation between languages. Artificial intelligence is characterized by adaptivity and novelty, i.e., the ability to adapt to new contexts and situations (Pfeifer, 2001; Majgaard, 2011; Haykin, 1998).

In 2018, Google launched the large language model BERT, which is an extensive artificial neural network and can perform a variety of language-based tasks beyond simple question answering (Søgaard, 2022). These tasks include translation, summarization, content generation, text completion, and the creation of text-based coding solutions. BERT has had a huge impact on GenAI. A key characteristic of these systems is their need for training (Søgaard, 2022). In extensive artificial neural network s like GPT-3, there are 175 billion artificial neurons, surpassing the nearly 100 billion neurons in the human brain. Such a neural network learns by processing input data (prompts) it receives. During training, the network receives feedback on its outputs and attempts to refine future outputs accordingly. The internal workings of what happens between input and output are largely non-transparent and are often described as a 'black box,' since the specific adjustments of individual nodes' weights are not directly accessible. Training data can include a variety of text sources from the internet, such as articles and chats. Learning is a continuous process, evolving with user interactions.

The black box properties in GenAI present a challenge in teaching. These properties result in a lack of links to sources, uncertainty about facts, and a lack of transparency. We cannot see through its way of reasoning. This poses a challenge when we want to understand and work with the students' reasoning in teaching. It also makes it difficult to identify the source of an argument – is it the student or GenAI? Because of this lack of transparency, GenAI can trigger misconceptions and fantasies in the relationship between educators and students.

## 3. GenAI in Higher Education

Numerous experiments with GenAI are underway across all levels of education. In higher education, there is extensive debate about the use of GenAI (For example Eke, 2023; Dai 2023; Stojanov, 2023 or Liebrenz, 2023). Rules for sound academic use of GenAI are being developed. Researchers and lecturers are divided in their views on this technology. On one hand, some educators believe that GenAI is a tool students should learn to use and will need in their future careers. On the other hand, some lecturers argue that students are not learning what they are supposed to and that they rely too heavily on copying from GenAI. However, this debate has spurred the creation of new rules (e.g. SDU rules on GenAI in education, 2024) and a number of exciting experiments with GenAI. Below are some examples.

In higher education, Yosuf et al. (2024) emphasizes the importance of integrating GenAI, highlighting both its potential benefits and drawbacks. They are concerned about the potential for academic dishonesty with the tool and the need for ethical guidelines. Moreover, they argue that responsible use of GenAI tools can enhance learning processes but stress the need for robust policies.

Chan and Hu (2023) explore university students' perceptions of GenAI technologies in higher education, focusing on familiarity, their willingness to engage, potential benefits and challenges, and effective integration. A survey of 399 students showed a predominantly favorable view of GenAI in teaching and learning. Students identified the potential for personalized learning support, writing and brainstorming assistance, and as well as research and analysis capabilities. Nevertheless, they raised concerns about accuracy, privacy, ethical issues, and the

impact on personal development, career prospects, and societal values were also expressed (Chan & Hu, 2023). Chan and Hu's study is very much in line with the experiences from the MYRE (2024) project and the case presented in this paper.

Barke et al. (2023) explored GenAI for use as a programming assistant. They conducted a grounded theory analysis of programmer interactions with Copilot by observing 20 participants with varying levels of experience. Their theory posits that interactions with Copilot fall into two categories: acceleration and exploration. In the acceleration mode, programmers know their next steps and use Copilot to expedite the process without disrupting their workflow. In exploration mode, the programmers are not sure how to proceed and use GenAI to explore their options or get a starting point for the solution. The interactions in this mode are slow and include explicit prompting and more thorough validation. It was this type of interaction that the engineering students in this study described.

Memmert et al. (2024) investigated the use of GenAI as additional input in brainstorming processes, finding that the combination of GenAI and human input improves performance. Brainstorming is a well-established method for generating problem-solving ideas. This study explores how AI-generated ideas impact brainstorming performance in terms of flexibility and breadth. The analysis is based on data from an experiment with 52 participants who brainstormed under two conditions: (1) human-only (baseline) and (2) human+AI (treatment). In the treatment condition, participants accessed ideas generated by GenAI GPT-3.5. The results show significantly higher performance in the human+AI condition compared to the human-only condition, with a large effect size. The reason for this may be that GenAI made the participants think in new directions, which fertilized the brainstorming process.

Sun et al. (2024) explored the potential of GenAI to support experiential learning processes in a college setting. Experiential learning, a widely recognized theory developed by Kolb (1984), was the foundation for this study. A ChatGPT learning activity flow was designed to align with Kolb's four experiential learning steps: Experiencing, Reflecting, Thinking, and Acting. Inspired by this study, we encouraged students to reflect on their use of GenAI during the different phases of their development process.

The MYRE (More Youth Realize Emerging Technologies) project in Denmark illustrates this trend, aiming to integrate GenAI from primary schools to universities (myre.tech). School leaders and educators are concerned about how the future job market will be affected by GenAI, its integration into educational practices, and its role in exam work. A key issue in the MYRE project is teaching students to use GenAI ethically and avoid merely copying information or uploading without reflection. In this initiative, GenAI is used for brainstorming, as a collaborator in defining problems, for aiming and structuring text and for facilitating ethical discussions (myre.tech). The case study discussed in this paper is part of the MYRE project.

No studies have been found on the impact or enhancement of teaching through the development of playful educational technology prototypes using GenAI. The case study in this paper explores GenAI as supporting toll in the development of playful educational technology prototypes.

## 4. Methodology

The method used in this study is qualitative and is merely a pilot study. It can be described as design-based research (Majgaard, 2011). Design-based research can be applied to educational research and is inspired by action research (Lewin, 1946; Barab and Squire, 2004). The purpose is to empower students through an iterative process while concurrently collecting data that can be analyzed. The iterative process involves a series of interventions and reflections that are connected to the educational objectives.

Interventions to promote reflections on GenAI included: (1) presentations about the history of AI and the properties of GenAI, as well as workshop on iterative prompting; (2) scholarly papers titled "ChatGPT and the Rise of Generative AI: Threat to Academic Integrity?" (Eke, 2023) and "Learning with ChatGPT 3.5 as a More Knowledgeable Other" (Stojanow, 2023); (3) in-class evaluations and discussions; and (4) requirements for documentation in the semester report in a clause titled "Reflection on GenAI."

In this case study, the data primarily consist of qualitative data in the form of the students' written reflections related to their project work. These data are supplemented by log notes from classroom discussions and an oral evaluation in the class about GenAI, its strengths, and weaknesses.

The data was systematically coded and categorized based on grounded theory principles (Strauss & Corbin, 1998). Grounded theory involves developing a theory directly from systematically gathered and analyzed data.

The identified codes acted as essential tools, facilitating the extraction of key points from the data. Specific words or themes within the text, like “teammate” and “ethics,” were predefined as codes in this case. Additional codes, such as “saving time” and “knowledge,” emerged during the analysis process. This approach allows the theory to naturally evolve from the data.

The groups were anonymized and only quotes from groups were referenced. A total of eight groups was created from the 36 students. Of these, two groups chose not to work with AI.

The results below describe how the students have used GenAI in their software development processes and their reflections.

## 5. Results

The following describes a few highlights from the students' reflections from the written reports. The digital prototypes were developed using either Unity or web programming. For GenAI, the students employed a wide range of self-selected tools, including Co-pilot, ChatGPT, SchoolGPT, and image generation tools such as Imagine and StableDiffusionXL, as well as the speech generation tool ElevenLabs. However, a few groups chose not to use AI in their project work. The headlines dealt with were: Brainstorming and Customization of AI output; GenAI generated images and colour codes; Potential opportunities for coding; Speech generation saves time and Language improvement. Below is a table of selected quotes from the students' written reflections and the coding of these quotes.

**Table 1: Snapshots of coding**

| No. | Quotes | Code |
|---|---|---|
| 1 | "The AI gave 10 potential titles, which made it easier to agree on which title to use for the game. The group ended up choosing option "Waste Wizard". However, the group was not fond of using the word "Waste", so they changed it to "Trash Wizard". | Brainstorm<br>Editing output |
| 2 | “We have used generative AI models as both sparring partners for idea generation and as help for troubleshooting code…By prompting a precise context of what we wanted, ChatGPT were able to give ideas… As with all brainstorms not all ideas are good, but with large language models … it is quicker and broader…” | Teammate<br>Debugging<br>Brainstorm<br>Saving time<br>Knowledge |
| 3 | “Our project's main menu background is generated by StableDiffusionXL. We recognize the controversial nature of Stable Diffusion and would not wish to use it in a professional setting. We have also generated early concept art for our game’s crops. We used these concepts to find the general style we wished for and made our own finalized versions fit for our game.” | Images<br>Ethical issues<br>Editing output |
| 4 | “When deciding on the color scheme of the product. A draft was produced by ChatGPT. It produced both hex codes and color names. The draft was then altered slightly so that any colors that did not seem fitting were not included in the development of the final product.” | Colour scheme<br>Editing output |
| 5 | "Ultimately, the provided code were not used as there was not enough time to make it work as desired, but using GenAI to help write the code made the process much faster …” | Coding ideas<br>Saving time<br>Knowledge |
| 6 | “LLMs have also been, a valuable asset when it comes to debugging or clarifying subject matter.” | Debugging<br>Knowledge |
| 7 | “…An GenAI voice generator has been used to record the lines that the player will hear through the various minigames. We used Elevenlabs which gave the best voices for Danish speech." | Voice<br>Saving time |
| 8 | “ChatGPT was consulted for refining parts of the report to make the text more proper English…” | Proper English<br>Knowledge |
| 9 | “We are very aware that LLMs have a tendency to hallucinate and not always be right, but even with double checking its statements, it has been a timesaver.” | Hallucinate<br>Time saving |

### 5.1 Brainstorming and Customization of AI Output

Several of the groups that successfully used GenAI for brainstorming and adapted the outcome of AI's output, see Quote 1 and 2 from table 1.

GenAI functioned as an additional team member, providing suggestions for working titles for the prototype. These suggestions were integrated into the group's process, similar to how ideas from other members were handled.

The students reflected that using GenAI in brainstorming was valuable and emphasized the importance of continuing to develop and personalize the generated output. They also noted that GenAI possessed a broader knowledge of the domain topics than they did. This aligns with Memmert and Bittner's (2024) study, which found that the combination of GenAI and humans enhances the breadth and flexibility of brainstorming processes.

### 5.2 GenAI Generated Images and Colour Codes

The AI thus makes it possible for the user to create images based on a text-based description of the image, see quote 3 and 4 in table 1. The groups used a variety of image generators such as Imagine.art and StableDiffusionXL to create a background images and sprites for the games. One of the groups used ChatGPT produce a harmonic colour scheme. The students evaluated the outputs, such as colour codes, to ensure they aligned with their own understanding of colour harmonies.

The students utilized GenAI as an additional team member, specifically in the role of a graphic designer. Since graphic design is not a core competency for these engineers, they freely used the graphics generated by GenAI. When they had precise graphics requirements, they often had to customize or create the graphics themselves, as it was also time-consuming to develop the right prompt for GenAI.

### 5.3 Potential Opportunities for Coding

Some of the groups used ChatGPT to help them write some code. Here, ChatGPT was used as a teammate, where ideas were given to ChatGPT to figure out how to solve a specific problem. See Qoute 5 and 6 from table 1. Examples of coding dialog headlines with ChatGPT were: Coroutine for scaling animations, UI Arrow Line, debugging unmasking an object and shader issues. Clarifying subject matter regarding programming might fall under the category of exploration. Debugging might fall under the category of acceleration since the GenAI helped to solve problems faster (Barke et al, 2023). To get a better understanding of GenAI for coding support better data is needed e.g. in form of interview, better access to dialog between GenAI and the coder.

In summary, GenAI served as a knowledgeable teammate in the context of programming. The students used GenAI to seek help with problems related to development of new algorithms, where they lacked a clear idea of how to develop the necessary logic. They also used GenAI to debug troublesome code snippets.

Since programming is a core competency for the students, they were less precise about their use of GenAI. They emphasized that they did not directly use code from GenAI. Additionally, several students mentioned the difficulty of formulating prompts precisely enough for the generated code to be immediately usable.

### 5.4 Speech Generation Saves Time

One of the groups experimented with text for audio, which saved the group a lot of time. See quote 7 in table 1. The students gained an extra teammate who could read texts aloud in various Danish voices. Occasionally, they needed to adjust the spelling slightly to ensure the pronunciation was correct.

The students found this method to be much faster than recording multiple takes themselves. Additionally, using GenAI helped them overcome the discomfort of hearing their own voices on recordings, which can be a common barrier.

### 5.5 Proper English

The students were Danes, and they could write their reports in English or Danish. GenAI was used to improve the Danish students' written English. See quote 8. The students gained an extra teammate who surpassed at correcting grammatical errors and adapting Danish colloquialisms to English equivalents.

The students emphasized that they wrote the texts themselves, using GenAI solely to enhance grammar and language quality.

### 5.6 Hallucinations vs Knowledgeable Teammate

The students recognized that GenAI occasionally "hallucinates," as noted in quote 9 of Table 1. Consequently, they knew to verify facts and check for any omitted sentences during proofreading. Despite this, students found that GenAI helped them save time. Essentially, GenAI was like a somewhat unreliable knowledgeable teammate whose eagerness to please sometimes outweighed its accuracy.

In many of the quotes, students express how GenAI introduced new knowledge and ideas, ranging from coding ideas to broad overviews of new domains and skills, such as proofreading. Stojanow (2023) discusses how ChatGPT served as a knowledgeable other, offering knowledge that was sometimes superficial and occasionally contradictory. According to Stojanow (2023) the interaction often led to a state of flow (Csikszentmihalyi, 2008), making the students more receptive to the responses at the moment. Consequently, students needed to use

their reflective skills to distinguish between useful insights and superficial or erroneous information, even though GenAI might have lulled them into a state of flow where their critical guard was lowered.

### 5.7 Reflection in Class About Revolved Around Ethical Issues and GenAI as Sparring Partner

In the classroom, the application of GenAI in software development processes was evaluated through oral discussions, and key points were logged on the white board. Highlights of this evaluation are summarized in Table 2 below.

**Table 2: Overview of strengths and weaknesses of GenAI in the students' opinion.**

| Strengths | Weaknesses |
|---|---|
| GenAI is an efficient sparring partner<br>Efficient for brainstorming<br>To get an overview of a topic<br>Simulation of user tests<br>Generation graphics, lines, and stories<br>Proof reading<br>Time saver | Sound academic practice vs academic dishonesty<br>GenAI hallucinates<br>One must fact-check<br>We do not know how chatGPT use and store input data.<br>Time consuming to develop efficient prompts. |

The students noted that crafting effective prompts was time-intensive and emphasized the importance of fact-checking. There was a lengthy debate about what constituted cheating and how much editing was appropriate for texts written or revised by GenAI. Additionally, they highlighted time savings in areas such as graphic design, brainstorming sessions, debugging, and proofreading.

The students had numerous concerns about the reliability of GenAI's information and its appropriateness for academic work. They were concerned about navigating the fine line between adhering to sound academic practices and committing academic dishonesty. They questioned when a proposal from GenAI could be revised and processed sufficiently to be included in an exam paper. These considerations highlighted complex questions without straightforward answers.

## 6. Discussion

In the following, I will discuss how generative AI can save time; ethical issues, erosion of our classical competencies and emerging of new competences. In the table below, the results are summarized. The columns display the distribution of efficiency, reliability, and ethical issues across the various themes.

**Table 3: Summary of results**

| | Efficiency | Reliability | Adapting output | Ethical issues |
|---|---|---|---|---|
| Brainstorm | x | x | x | |
| Images & colour codes | x | x | x | (x) |
| Coding ideas | x | x | x | (x) |
| Speech generation | x | x | | |
| Proof reading | x | x | x | |
| Hallucinations vs knowledgeable teammate | (x) | (x) | (x) | x |

The table indicates that the students utilized GenAI in areas they found effective for time savings, where GenAI proved reliable, and where there were no insurmountable ethical issues. The students avoided using GenAI in areas where they recognized significant ethical dilemmas. For instance, they refrained from having GenAI prepare article summaries, generate core code, or write entire sections of their reports. Engaging in these practices would raise ethical concerns and constitute poor academic conduct.

### 6.1 Efficiency, Reliability, and Adapting Output

Regarding efficiency, most students agreed that GenAI could save time by making it easier and quicker to brainstorm, gain an overview of a new domain, or generate solutions ideas for programming problems. They viewed generative AI as an additional participant in group activities.

However, obtaining precise results from GenAI that could be used directly, proved to be time-consuming. Students often had to modify the output themselves. Tailoring the prompt to yield an immediate solution was

seen as an unnecessary complication. For instance, when using GenAI to enhance language, the intended meaning could sometimes become distorted, or the development of complex images with both text and illustrations could be time consuming.

About reliability: In connection with evaluation in class and written student reflections, the word hallucination often appeared. The students felt uncertain about GenAI's results. They were generally critical of GenAI and fact-checked results. However, talented students tend to be better at fact-checking and adapting results from GenAI compared to their less adept peers. This disparity presents a potential area for further research. Additionally, it's worth exploring how GenAI can be utilized to enhance the skills of less proficient students and thereby narrow the educational gap. In this context, AI could serve as a personalized learning partner.

Adapting the output was essential for effectively using GenAI. There were three main reasons for this: first, adapting and processing the output allowed students to take ownership of the results, aligning with good academic practices. Second, it was crucial to tailor the output to fit seamlessly with the context of their other work. Third, as noted previously, modifying the output was quicker and more efficient than attempting to get GenAI to produce a perfect result on its own.

### 6.2 Ethical Issues

There are several ethical issues associated with GenAI. Such as, what is the line between plagiarism from GenAI and text you have written yourself? (Yosuf et al., 2024) This was one of the big questions during the evaluation, it was also difficult to answer precisely. How much do you have to customize an autogenerated text before it is your own? It falls within what is considered good academic practice to be able to find this balance. The students were also worried about how the data they used for input would be used by GenAI.

The students were also worried about how GenAI could be abused on social media with deepfakes, among other things. The extensive debate about GenAI in local Danish media gave the students the opportunity to take a critical view of the technology, informed by their own technical background and experience from the semester project. These ethical issues are also addressed in Chan & Hu's (2023) study.

### 6.3 Limitations and Future Research

There are several limitations in the collected data, such as the sporadic access to the students' dialogue with GenAI. Access to these dialogues would have provided insights into the number of iterations and how students refined their prompts. Additionally, there was a sense that some students were reluctant to discuss their use of GenAI, possibly due to concerns about being accused of plagiarism.

Discussions about GenAI in education are set to persist. The implications of GenAI on teaching justify ongoing research. Both lecturers and students require deeper knowledge of AI and its application in educational settings. It is essential to create a research-based toolbox for educators, enabling them to better understand AI and incorporate it ethically into their teaching practices.

Exploring whether and how GenAI will erode our classical competencies and foster new ones is crucial. Specifically, it would be valuable to examine if GenAI's integration into educational settings leads to the erosion of existing skills while fostering new ones, such as in programming. A study could be conducted within the Danish context to assess how GenAI supports programming education, investigating whether students might lose certain competencies even as they gain others. In other contexts, this would point at competencies for writing. This research could employ grounded theory and base its findings on dialogues between students and GenAI.

## 7. Summery and Conclusion

The paper explored the question: How can GenAI be used in the development of playful educational prototypes in engineering programs? Including, how can it promote students' meta-reflections on GenAI?

The paper explored the innovative use of GenAI in an engineering course focused on development of game-based learning prototypes.

It was an eye-opener to explore the many different ways GenAI could be applied in the design and development process, including brainstorming, graphics generation, automated speech, code debugging, text editing, and grammar. The students emphasized that GenAI as a teammate could save time, but also noted that it could be

time consuming to achieve a very refined output if desired. According to the students, they mostly adapted the output from GenAI, were inspired by it, but also often discarded it.

In the project report, they were asked to reflect on the use of GenAI without any special additional requirements. Should we need to run a similar study again, the students must submit links from dialogues with GenAI, making it easier to qualitatively assess how they work with the GenAI tool and how they derive useful outputs.

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