PLAI

PLAY AND LEARN WITH
ARTIFICIAL INTELLIGENCE

POSITIVE IMPLEMENTATION
OF GENERATIVE AI IN EDUCATION
THROUGH PLAY-BASED LEARNING

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MSC INTEGRATED PRODUCT DESIGN
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Master thesis

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PREFACE

I have done it! After years of fun, exploration, learning and making friends, but also hard work and difficult times. I have handed in my graduation report. The cherry on top of the cake. I can now officially call myself a master of science and an engineer from the TU Delft. An industrial design engineer.

Somebody once told me that your time as a student is the greatest time of your life. I would always joke that is exactly the reason why I made it the longest time of my life as well! I have to admit at times it didn't feel like the greatest time of my life and at times I wished it wouldn't take more time and effort to finish my studies.

However, I do still think my time at the TU Delft has been one of the greatest times of my life. It has shaped me into who I am today. It has left me enough friends for a lifetime. I have met the love of my life.

I would describe myself as having a playful character. I like to have fun, play games and make jokes.

Play has also been woven through my studies as a red thread. From my first project about play, PO2 in my first year, to my bachelor final project designing a construction toy for Ravensburger to my thesis project. Design for play will always be interesting and fun and will be part of who I am for the rest of my personal and professional life.

I want to thank everybody who has supported me throughout the process of my studies.

My mom has always been able to sharpen my thoughts. And when I had to produce a Dutch text I could always count on my mom to help me write these texts to perfection.

My father has always been a steady rock in the surf for me. He has always been able to unravel complex issues, give feedback on them and give guiding advice on where to go next.

My brother was able to look at my work from the other side of the ocean: always being enthusiastic and supporting.

Giving straight and tangible advice which would help me to come up with higher quality results.

My girlfriend who seems to have an unshakable faith in my capabilities and who offers continuous love and support.

I would like to thank my friends for the beautiful time we have had together, making my time as a student at the TU Delft unforgettable.

And finally, I would like to thank you for picking up my report and reading it.

Have fun!

Figure 1: How I might look like as a graduated engineer

ABSTRACT

Generative AI has had a profound impact on various sectors since mid-2022. The rapid adoption by students poses challenges for student assessment and raises concerns about student development. This thesis delves into the subject and proposes a positive implementation in education through play-based learning. The project uses a human-centred iterative design approach, consisting of co-design workshops with children, teachers and expert interviews. The research shows that teaching children about AI and generative AI can be done from a young age using play-based learning.

The study captures the diverse perceptions of elementary school children and teachers regarding generative AI. Key findings highlight children's concerns and needs with regards to generative AI. Cooperatively formulated design criteria point towards children's main interests for products or services with generative AI or AI to have a play-based nature, foster creativity and inspiration, safeguard their privacy and security and help them achieve their goals.

The research in this thesis also explores educators' perceived challenges and interests in classroom integration of generative AI. Key findings include the perceived necessity for both teachers and students to learn about generative AI, the
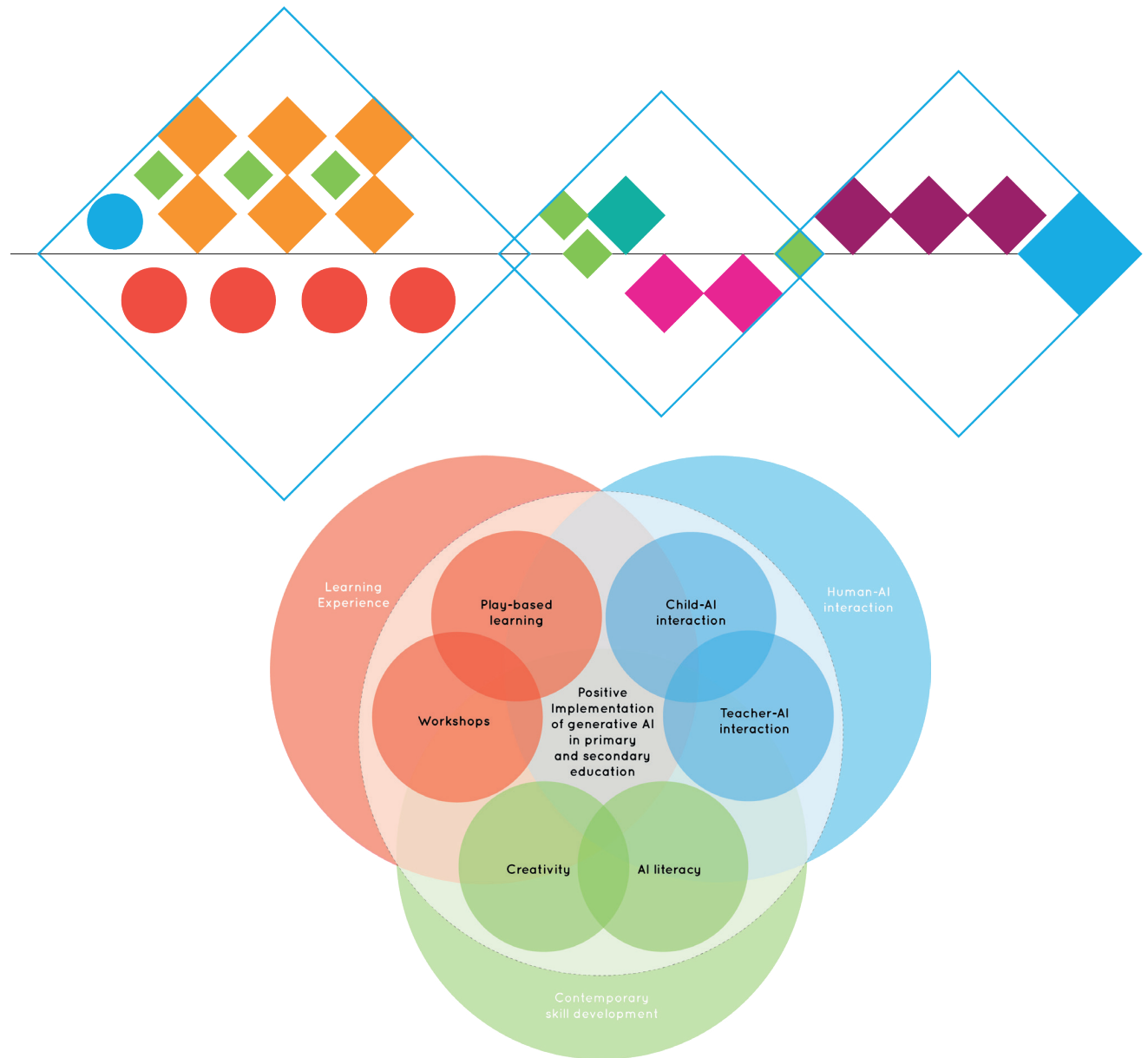
Figure 2: Iterative human centred approach and theoretical framework.

interest across different levels of education and that the age deemed appropriate for students to be introduced to generative AI is often considered to be at the end of primary school or at the start of secondary school.

From the research several design principles are proposed to create an engaging, ethical and human-centred AI learning experience. To facilitate this experience and to spearhead the integration of generative AI into education, a company named "PLAI" is conceptualised. The company aims to implement generative AI in education in a positive way by providing learning material which stimulates engagement, creativity and social learning while safeguarding privacy and security by offering play-based and scaffolded learning in workshops. Future recommendations and plans include the development of a multi-modal generative AI model which can run locally on school servers and is alignable with their curriculum.

Limitations of this study include a lack of direct interaction and research with high school students, a need to explore text based generative AI interactions with students, and a need to assess generative AI's long-term effects on student well-being.

MOST IMPORTANT CRITERIA FOR CHILDREN FOR A PRODUCT OR SERVICE WITH AI IMAGE GENERATION

- Cross-cultural accessibility 2%
- Learning about AI 3%
- Not damaging to health 3%
- Exploring the unseen 4%
- Appropriate difficulty level 5%
- Autonomy, control and ownership 5%
- Help achieve goals 8%
- Safety and privacy 16%
- Fostering creativity and inspiration 19%
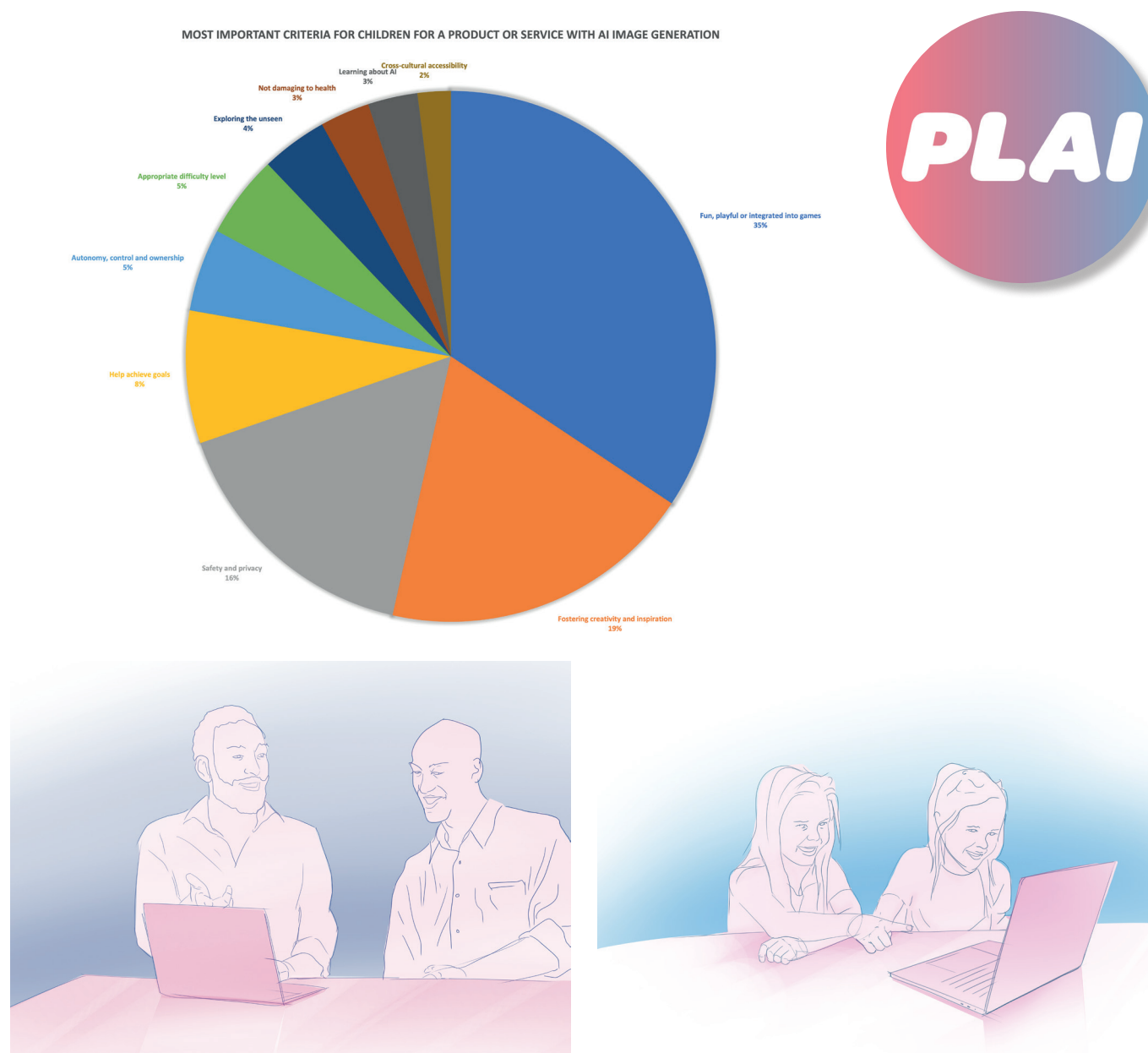- Fun, playful or integrated into games 35%

Figure 3: Cooperative criteria formulated with children for generative AI, company logo & representation of play-based social learning experience for both teachers and students

PROJECT BRIEF AND GOAL

Design Brief

This project aims to implement generative AI into educational practices to enhance teaching and learning experiences, using play-based learning. To reach this goal a human-centered design approach is applied, involving the iterative development and deployment of play-based learning workshops for teachers and students, as well as expert interviews.

By integrating insights from these research activities, we aim to promote deep learning, igniting the curiosity of educators and learners to further explore generative AI independently. Our main aim is to create a positive and lasting learning experience. A secondary aim is to simultaneously touch upon existing barriers for a positive implementation such as the fear of AI, data security concerns, technology complexity and novelty, and how to deal with misuse.

The ultimate objective is to improve student engagement, assignment quality, and overall teaching and learning experiences by incorporating generative AI into daily educational practices.

Project Goal

The goal is to create a product-service system to integrate generative AI in primary and secondary education. The product service system includes workshops and a supporting website. This system is designed to equip teachers and students with the necessary skills and tools to utilize generative AI in their daily educational practices.

Part of this goal is to address the ubiquity of generative AI in our digital society, which makes it essential for students to learn about generative AI. The aim is to increase their understanding of its functionality, usability, and personal and societal implications. As a supplemental tool for teaching and learning, Generative AI enables students to tackle more challenging tasks and to enhance the quality of their results.

By empowering teachers to make informed decisions about AI use, reducing workload, and enabling personalized content creation, we aim to foster a dynamic and inclusive learning environment.

Our end goal is to boost student engagement and assignment quality while ensuring a safe and effective use of the technology.

Figure 4: An image visualizing the incorporation of generative AI in education, using various design principles and techniques to depict teachers interacting with AI tools, highlighting benefits and challenges, with a focus on usability and improved student engagement. (Midjourney)

EXECUTIVE SUMMARY

Introduction

Generative AI, producing high-quality digital content, has become prevalent since mid-2022 and is now widespread across various tasks and industries (lit. rev.).

This technology has influenced societal aspects, leading to job losses and raising ethical and philosophical questions (lit. rev.).

The rapid adoption of generative AI is attributed to its significant benefits for individuals, organisations, and society (lit. rev.).

Generative AI is predicted to have a substantial impact on education in the short and long term (lit. rev.).

Students are already using generative AI to assist or even entirely create their work, challenging educators in assessment (lit. rev.).

Teachers are struggling with the new technology and its impact on students' development (lit. rev. & workshops teachers).

In an AI-driven world, 21st-century skills such as creativity and AI literacy are increasingly important (lit. rev.).

The thesis proposes play-based learning with generative AI as a means of developing these skills (thesis).

The full impact of generative AI on society, education, and aspects like learning, creativity, and play remains largely unknown due to its novelty (Lack of existing lit.).

The primary research question of the thesis is, "How to implement generative AI into education in a positive way?" (thesis).

The research explores the symbiosis of play-based learning and generative AI for a positive long-term impact on education and student development (thesis).

Method

Human-centred iterative approach. Co-design workshops, discussions, interviews, and questionnaires.

Six workshops with children at international school Delft.

Average participation of twenty 10-11 year-olds per session.

Discussions with their teachers.

Four expert interviews on play, creativity, digital society, and parenting.

Four co-design workshops with teachers, with an estimated participation of eight per session.

Personal and peer exploration and reflection on generative AI included in research.

Results - Children

Elementary school children's perception and interaction with AI and generative AI in a learning setting is diverse, with initial understanding associating AI with robots, computers, coding, humanoid figures or perceived as a threat (lit. rev. & workshops children).

Play-based learning and interaction with different types of AI tools, like AI image

generation and Teachable Machine, help children form a more accurate understanding of AI (lit. rev. & workshops children).

AI and AI image generation, if used appropriately, can serve as effective, relevant, and fun educational tools (workshops children & workshops teachers).

Co-design workshops with cooperative criteria formulation reveal children's top needs for AI and generative AI (workshops children).

The key attributes of AI or generative AI-based products or services, ranked by the frequency of their identification as important criteria, include:

Fun, playful, or gaming-integrated nature (35%)

Provision of opportunities for creativity and inspiration (19%)

Strong emphasis on privacy and safety (16%)

Assistance in achieving goals (8%)
Allowing for autonomy (5%)

Ensuring an appropriate difficulty level (5%)

Facilitating exploration of the unseen (4%)

Promoting physical comfort and health (3%)

Opportunities for learning about AI (3%)

Children's need for assistance in using technology varies, suggesting potential value in peer learning (workshops children).

Results - Teachers

Teachers are facing challenges in incorporating and managing generative AI in the classroom (lit. rev. & workshops teachers).

Concerns include difficulties in learning assessment and impact on children's development (lit. rev. & workshops teachers).

Despite the challenges, there's a keen interest among teachers to explore generative AI in their teaching practice (workshops teachers).

There is a consensus among teachers that generative AI should be introduced either at the end of elementary school or the beginning of high school (workshops teachers).

Teachers emphasise the importance of students understanding the workings of generative AI, its societal implications, its impact on their individual development, and how to critically engage with it (workshops teachers).

As generative AI advances, its role in education will require constant evaluation and adaptation (lit. rev. & thesis)

Results - Play-based learning of generative AI

Play-based learning has high potential in educational processes, as supported by existing literature and experts (lit. rev. & expert interviews)

This learning approach can effectively enhance understanding and use of generative AI in foundational education (workshops children & workshops teachers).

Generative AI can aid in creative processes and inspire students and teachers to develop novel solutions to problems (expert interview & thesis).

The accessibility and ease of use of generative AI can lead to overreliance and loss of authenticity, ownership, and pride

Potential risks in using generative AI, such as the loss of ownership and pride, were revealed in the research. (workshops children)

Through personal exploration and reflection, overreliance and loss of authenticity were found to be risks (thesis).

Generative AI provides versatile material, enables personalisation, and allows for delivering content in a variety of ways, including with humour (lit. rev. & thesis).

Both children and adult educators find the play-based learning approach engaging when used with generative AI (workshops children & workshops teachers)

Integrating generative AI in education can enhance lesson preparation, student engagement, and contemporary critical thinking skills (lit. rev. & thesis).

Teachers recognize potential challenges of using generative AI, such as privacy concerns, the need for teacher training, potential misuse, and alignment with educational goals. (workshops teachers)

Teachers also recognize how the integration of generative AI into education requires clear policies, professional development for teachers, and careful usage to enhance learning rather than focusing solely on end results. (workshops teachers)

Discussion - Design principles and vision

Design principles:

Prioritise contemporary skills

User-centred AI experience

Stimulate active engagement

Promote social interactions

Ethical and responsible AI use

Continuous feedback and improvement

Stimulate autonomy and authenticity

Interactive and Engaging AI

Safeguard Privacy and Security

Encourage Exploration and Curiosity

Design vision:

"I envision a future where generative AI transforms education for the better. A future where learners and educators can explore, create, and connect with each other in new and meaningful ways. A future where privacy, security and authenticity are respected and protected. My vision is to inspire curiosity, creativity, and a positive critical stance through play-based and social learning of and with generative AI."

Discussion - Evaluation of workshop design

Strengths:

Play-based learning well-received.

Guided play with peer interaction has positive impact on learners.

Emphasis on AI's positive potential is beneficial.

Improvements Needed:

Better time management.

Increase attendance by re-evaluating workshop timing, marketing and clarity of workshop objectives.

Cater to varying expertise levels.

Conclusion - Integration in design

The company "PLAI" is proposed to pioneer positive AI-driven educational change.

PLAI's Proposition:

The Play-Based Learning Workshops:

Offer hands-on experience in generative AI for students and educators.

Prioritise playfulness, creativity, safety, and social learning.

Use humour, guided play, and scaffolded learning techniques.

Aim to enhance AI literacy, curiosity, and form a positive critical outlook on generative AI.

Future Business Plan:

A locally-running multimodal AI model for schools, aligning with curricula, available via licensing.

Supporting Platforms: Two platforms - one for marketing and bookings, the other for easy access to AI tools, ensuring user privacy.

Workshop Design:

Exploration: Introduces generative AI in a collaborative setting, emphasising hands-on experience and self-paced discovery.

Functional Play: Deepens understanding, providing guidance to optimise the use of AI tools.

Integration and Variation: Challenges participants with goal-oriented tasks, stimulating creativity and understanding of AI applications.

Discussion and Extra Info: Plenary discussion round to share insights, understand the AI context, and facilitate continuous feedback.

The Platform comprises two websites – one for marketing and bookings, the other as a safe AI playground. Plans to merge the platforms in future iterations.

The Brand - PLAI: blends "play" and "AI" and symbolises the interplay between human and machine.

Audience:

Elementary School Children (10-11): Image-centric generative AI workshops may work best.

High School Children: Already using generative AI, sometimes as a shortcut; need ethical and broader AI education.

Teachers: Mixed reactions to AI, but consensus on its educational importance for both students and teachers.

PLAI aims to revolutionise education by integrating localised, private, multi-modal generative AI into education emphasising play-based learning methodologies. By targeting primary and secondary schools, the company aims to offer adaptable AI tools alignable with curricula, supplemented by hands-on training, workshops, and continuous support, all while prioritising privacy and security.

Limitations & Future recommendations

Limitations:

No data collected on high school students' generative AI interactions.
Child interaction with text-based AI has been neglected.
Unclear long term impact of generative AI on students' well-being.

Recommendations

Increase research on high school students interaction with generative AI.

Dive deeper into text-generating AI usage.

Monitor long-term effects of AI on student well-being.

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READING GUIDE

How to read

The methods used in this research are a big part of what this thesis has become. As it entails an iterative approach with many research activities, the main research activities have been described in the method section using shape and color coding. These color codings are used at the start of the result chapters to specify from which research activity most insights were used in that chapter.

You can recognize the shape and color coding by diamond and circle shapes and several different colors. See the start of the method section for an overview.

Insights gained in research activities have been labeled as such by using a label such as [CW1]. This signifies: Children Workshop 1.

As an example I will add the shape and color coding of Children Workshop 1 below.

Generative AI statement

Generated images

Small images made by participating children have been made using Dall-e image generator. These images have been used to illustrate some insights regarding the interests of children.

Furtermore, AI image generator midjourney has been used for the images which serve as 'eye candy' in the report. The image of me in a suit has been generated with lensa app. All other images have been taken from the internet and sourced accordingly. The prompts used to create the images are put below the images.

Generated text

Much text has been generated in order to make this report. In effect, you can assume that every text has had some AI influence or has been partly written by AI. Structuring the report, coming up with research questions and interview questions, structuring sentences and transcribing interviews. Everything has had parts where text generation was used.

It is the case however, that after an iteration on the report most text has been written by myself and only slightly helped by chatGPT in summarizing or formulating sentences.

That being said, I do declare hereby that everything in the report represents my personal values and beliefs and I have done my best to only use AI as a source of inspiration not as a source of truth.

INTRODUCTION

1. INTRODUCTION

Context

The first thought this project started with was: "Wow, what a cool and intriguing image! Has this really been made by AI? How do I access this amazing technology?"

Apparently I was not the only one intrigued by generative AI.

Figure 5: Intriguing first encounter with generative AI (AI Generated Image, I Used to Prompt: Angel Kissing Demon, 2022)

In our digital society technological advancements quickly spread to all corners of society. The latest advancement in digital technology which has taken the world by storm is generative AI. Generative AI has quickly become ubiquitous since mid-2022 (Cao et al., 2023). The hype started around July 2022 with the release of AI image generator Midjourney (Rose, 2022). Other image generation software such as Stable Diffusion and Dall-e quickly followed (Heidorn, 2022). According to an article in Wired, humans and AI were co-creating over 20 million images daily in November 2022 (Kelly, 2022). AI text generation software chatGPT even became the fastest growing software application of all time with a million users in five days and 100 million users in two months (Duarte, 2023).

Benefits for individuals, organisations and society

Generative AI is affecting various tasks and industries (Stokes, 2023a; Yegge, 2023). Generative AI allows for automatic creation of digital content such as text, audio, video and code based on a simple text prompt (McKinsey & Company, 2023). Some examples of how generative AI can be used are: summarising large scientific texts (e.g. sustainability research papers) and extracting key points (Zhu et al., 2023), brainstorming ideas (Rogers, 2023), creating mesmerising images (Kelly, 2022) and aiding in skill development (Dils, 2023). It can even assist in software projects by generating and debugging code, allowing software developers to increase their productivity for some tasks up to two times (McKinsey & Company, 2023b). MIT research underscores generative AI's potential to increase productivity as their research shows that using chatGPT could improve productivity for people with a higher education for up to 37% for written assignments (Noy and Zhang, 2023).

Impact on job market

The impact on the job market is also considerable. According to a study by Eloundou et al. (2023), the implementation of generative AI is projected to have a significant influence on the job market, potentially affecting up to 50% of tasks for 19% of jobs and 10% of tasks for 80% of jobs. A report by Goldman Sachs predicts that globally 300 million full-time jobs are exposed to some form of automation (Goldman Sachs, 2023). The first signs are already being seen as people lose their jobs over generative AI, because a large part of their job can now be done by chatGPT (Verma & De Vynck, 2023). Up to 5% of job loss in the US in May 2023 can be attributed to AI (Napolitano, 2023). One daunting example comes from a game design company in China, which already fired one third of their employees because of the productivity enhancement of generative AI (Zhou, 2023). As one employee of the company states: "Two people could potentially do the work that used to be done by 10" (Zhou, 2023).

Ethical and philosophical questions

Besides the impact on the job market, generative AI also raises various ethical and philosophical questions. One prominent concern is about a heightened risk of mis- and disinformation (De Angelis et al., 2023); The images made with AI image generation are often indistinguishable from human-made images and can be made to depict famous people such as the Pope or Trump (CBS News, 2023; Cheetham, 2023), as shown in figure 6 and 7.

The technology also brings forth complex questions about copyright, ownership, and the risk of perpetuating stereotypes through bias (Coeckelbergh, 2023). One can easily generate AI images using the styles of living artists and designers, prompting questions about the ownership of the work. Who should own the work? Should it belong to the human wielding the AI, the artist whose style was used, the creators of the AI, or the AI itself? The US Copyright Office's stance is clear: AI-generated images cannot be copyrighted, as they lack a "creative contribution from a human actor" (Copyright Office, Library of Congress, 2023). This shows that the generation of work does not suffice for legal ownership.

Even more philosophical questions arise, such as what the nature of human work should be (George et al., 2023); and how we should define art, creativity (Coeckelbergh, 2023); and intelligence (Marchetti et al., 2023).

Figure 6: The pope's new winter jacket? (Fake Photos of Pope Francis in a Puffer Jacket Go Viral, Highlighting the Power and Peril of AI, 2023)

Figure 7: Trumps AI generated arrest (Cheetham, 2023)

Impact on society and education

According to an article by Jon Stokes (2023b), Generative AI is having a significant impact on various aspects of our culture. He argues that the main concern with AI-generated work is not its quality but its lack of human origin. However, according to Stokes, automatic detection of AI output is not feasible. And finally he suggests that education will face challenges in the short term but will benefit in the long term.

The short term effects on education are already seen, as according to the NOS (Schellevis & Moerland, 2023), chatGPT was already being used extensively by high school students to perform their homework quickly after the public release of the technology. They mention how the use of the technology is often going undetected by teachers or plagiarism tools, challenging teachers in learning assessment. Reacting to this challenge, public schools in New York announced a ban on chatGPT as they were concerned about potential negative effects on students' learning (Yang, 2023). Italy even temporarily banned the software because of privacy concerns (NOSa, 2023). The Dutch government takes a more accepting approach towards chatGPT and places the responsibility with educators and schools to critically assess the use of chatGPT and similar AI tools in education (Dijkgraaf & Wiersma, 2023).

Educators, however, express concerns about the impact of generative AI on children's development. One example is from a translation teacher in the Netherlands, who draws experience from the introduction of machine translation. He is afraid we might end up with a generation producing robotic language and which has lower expectations of what constitutes good writing due to the exposure to AI-generated language (Van Egdom, 2023). He is especially concerned for the Dutch language as this came forward as the most significant asset which binds Dutch people culturally (Van Egdom, 2023). In this thesis the concern about student development surfaced more often in interaction with teachers.

The long term effects are yet to be seen, but in contrast to the existing difficulties and concerns, generative AI also promises significant potential in enhancing the teaching and learning experience. According to an April article in the MIT technology review, the initial panic among different schools banning the software has worn down and teachers and students recognise the potential of generative AI (Heaven, 2023). The author mentions how some educators are starting to believe that advanced chatbots like ChatGPT could enhance education by making lessons more interactive, teaching media literacy, creating personalised lesson plans, and saving teachers time on administrative tasks. He also refers to edtech companies like Duolingo and Quizlet that have already integrated OpenAI's chatbot into their apps (Heaven, 2023). Khan academy is also experimenting with one-on-one tutoring and teacher assistance via integration of the chatbot in their own software (KhanMigo Education AI Guide | Khan Academy, 2023). Mollick and Mollick (2022) propose using generative AI chatbots like chatGPT in the classroom to improve the transfer of learning material, break down the illusion of explanatory depth, and train students to critically evaluate explanations.

Play-based learning to navigate an AI-driven world

Generative AI is the latest addition which increases the pace of change and complexity of our world. It underscores the importance of developing 21st-century skills, of which creativity, digital- and AI-literacy are key (IBM, 2010; Thijs et al., 2014; van Laar et al., 2020). A recent digital competence research project from the university of Amsterdam revealed a lack of AI literacy across all ages in Dutch society, especially for older individuals, highlighting the need for educational interventions (de Vries et al., 2022).

The question is how to teach these skills which are deemed critical to navigate our increasingly AI-driven world? This thesis would like to argue the following: Children learn best through play. The idea that play is beneficial for children's development dates back to Plato, who understood that play impacts a child's development into adulthood and suggested regulating it for societal benefits (D'Angour, 2013). A paper by Yogman et al. (2018) provides a complementary perspective. Their findings highlight the increasingly evident role of play in the cognitive, emotional, and social development of children. They argue that play, beyond being inherently enjoyable, forms a fundamental platform for children to acquire and practise key 21st-century skills.

Figure 8: A teacher and student engaged in playful, generative AI learning

Research questions

Given the importance of learning contemporary 21st-century skills to navigate our increasingly AI-driven world and the potential of generative AI and play in teaching these skills effectively, this thesis proposes to implement generative AI in elementary and secondary education using play-based learning as a means to develop these skills and as an enjoyable way of experiential learning of and with generative AI. Therefore the main research question is:

"How to implement generative AI into elementary and secondary education in a positive way?"

The full impact of generative AI on society, education, and aspects like learning, creativity, and play is still largely unknown due to its novelty. Additionally, the European Commission's Joint Research Centre (JRC) underscores the need for research into child-AI interactions in their study Artificial Intelligence and the Rights of the Child (JRC, 2022). According to the authors, one of the priority knowledge gaps is: "Children's cognition, development and play: Designers and researchers should systematically study the impact of the use of AI technology on children's cognitive and socio-emotional capacities in different contexts and in an inclusive way." (JRC, 2022).

This thesis aims to shed light on these knowledge gaps and argues for the symbiosis of generative AI and play-based learning in elementary and secondary education through answering the following sub-questions:

1. How do children perceive and interact with AI in a learning context?

2. What are children's concerns and needs with regards to generative AI?

3. What are the perceptions, concerns, and expectations of teachers regarding the incorporation of generative AI in their teaching practice?

4. What role do play and creativity have in enhancing the understanding and usage of generative AI in educational settings and how can they be stimulated?

5. How can play-based learning methods be used to enhance the user experience of learning about generative AI?

6. What are the potential challenges and opportunities for implementing generative AI in primary and secondary education?

7. How to provide immediate value and have a positive impact on the educational system with regards to generative AI?

Domain

The multifaceted and entangled nature of the research field and questions combined with the rapidly evolving field of generative AI result in a domain which is difficult to navigate and create clarity and focus. As also many tangent research subjects have been touched upon, the domain in which the research took place can be visualised by the image to the right (figure 9).
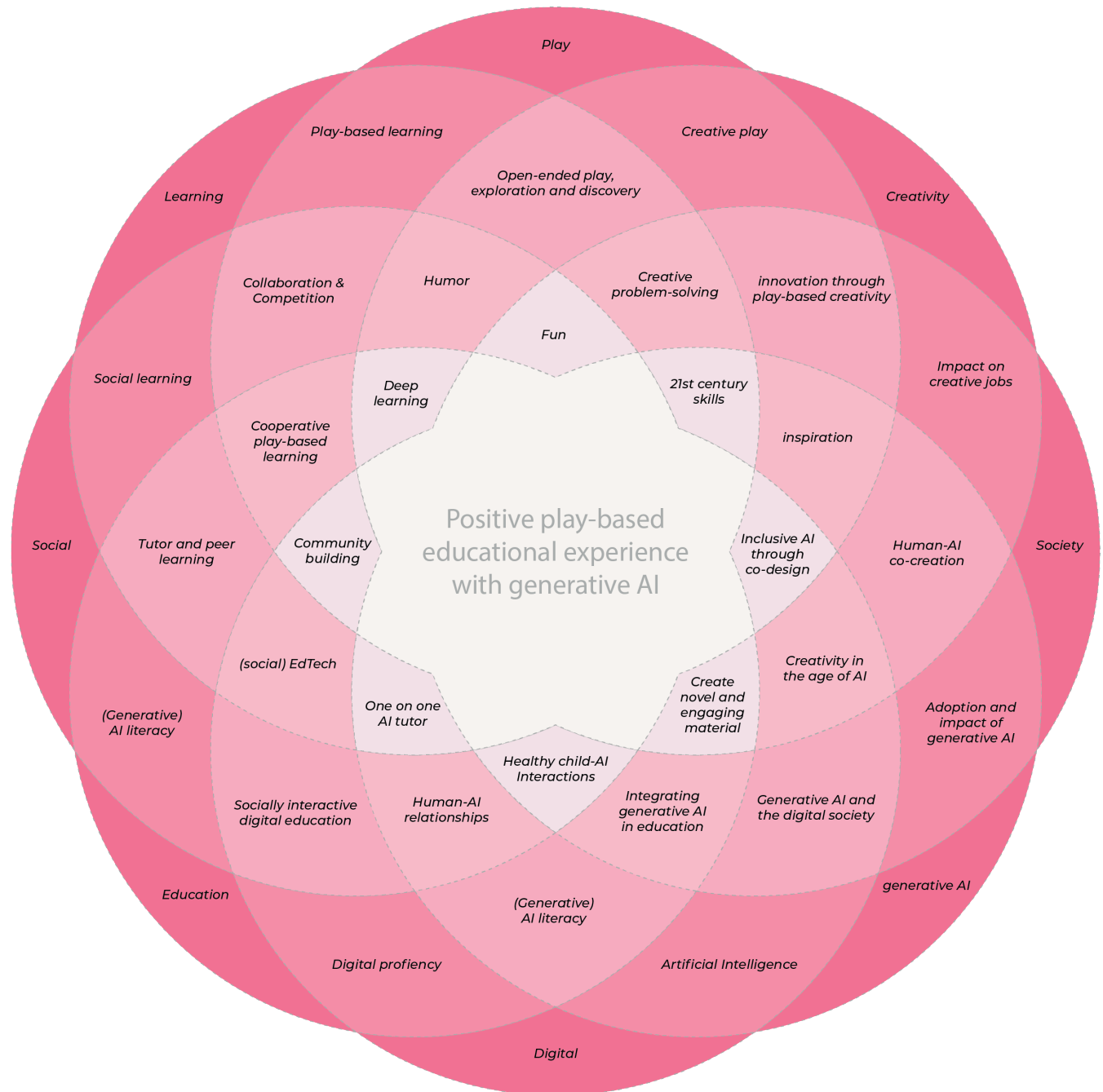

Figure 9: Domain

Theoretical framework

This thesis explores how to implement Generative AI into elementary and secondary school education in a positive way. Underpinning this exploration are three key themes. The first, 'Contemporary Skill Development', focuses on the 21st-century skills deemed critical for our increasingly complex and AI-driven world namely, creativity and AI literacy. The second theme, 'Human-AI Interaction', explores the knowledge gaps of child-AI interaction and teacher-AI interaction by studying the dynamics between students, teachers and generative AI. Finally, the 'Learning experience' theme explores positive pedagogical and didactic approaches, including play-based learning and teaching through co-design workshops. These themes together form a comprehensive framework guiding the investigation into the positive and effective implementation of generative AI in education.
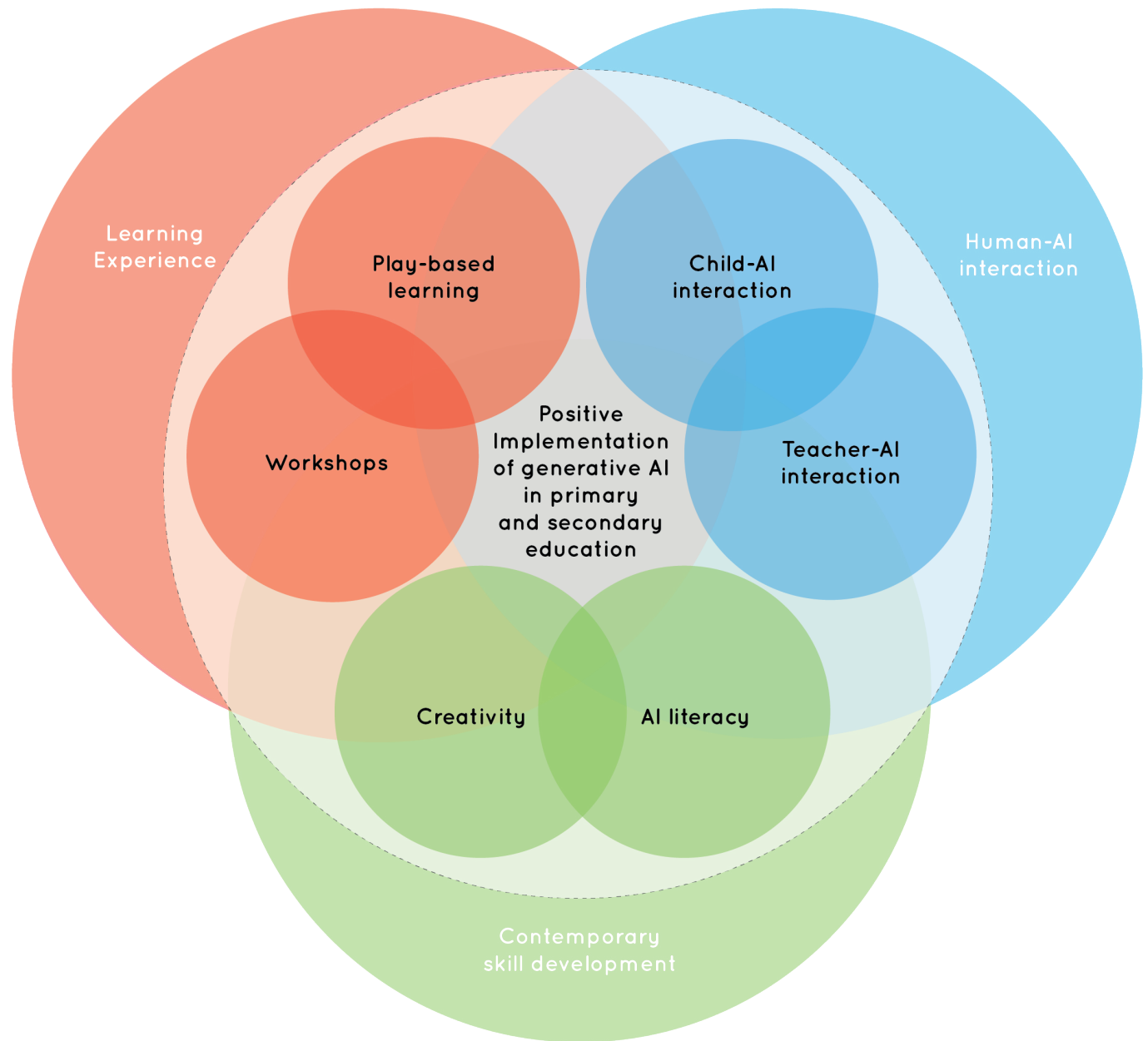

Figure 10: Theoretical framework

METHOD

2. METHOD

Design approach

This thesis uses a human-centred approach, involving workshops with 10-11 year old students in their final year of elementary school and both live and online workshops with teachers, along with expert interviews on relevant topics. The study also contains a personal exploration and peer exploration of generative AI through pilot workshops. By using this multi-stakeholder approach this study aims to provide a holistic perspective on the research domain.

Human-centred iterative approach

As the technology is still new and developing, people's concerns and needs regarding the technology are still largely unknown. Putting the users in the centre of the research by applying the human-centred approach of co-design, allows for a deeper understanding of the lives, desires, dreams as well as insight in the concerns and needs regarding generative AI of both students and teachers. The iterative approach allows for continual improvement, taking into account the continuous developments in the rapidly evolving field of generative AI.

Pilot workshops [PW]

Before every workshop with students or with teachers, pilot workshops were given. The pilot workshops were given to peers, friends and family and made sure that the contents, structure and flow were clear. They allowed for getting rid of the biggest flaws in the workshop set-ups.

Legend of the design process
As the workshops were in itself small design processes, they are also shaped in the form of a diamond. The diamond shape is common to use for visualizing design processes. The most common visualization is the double diamond.

Overarching design process

Preparation discussion teachers [PDT]

Expert interviews [PLE, PAE, CRE, DISOE]

Pilot workshops [PWs]

Co-design workshops children [CW]

First teacher workshop [TW1]

Platform development

Final teacher workshops [TW2-4]
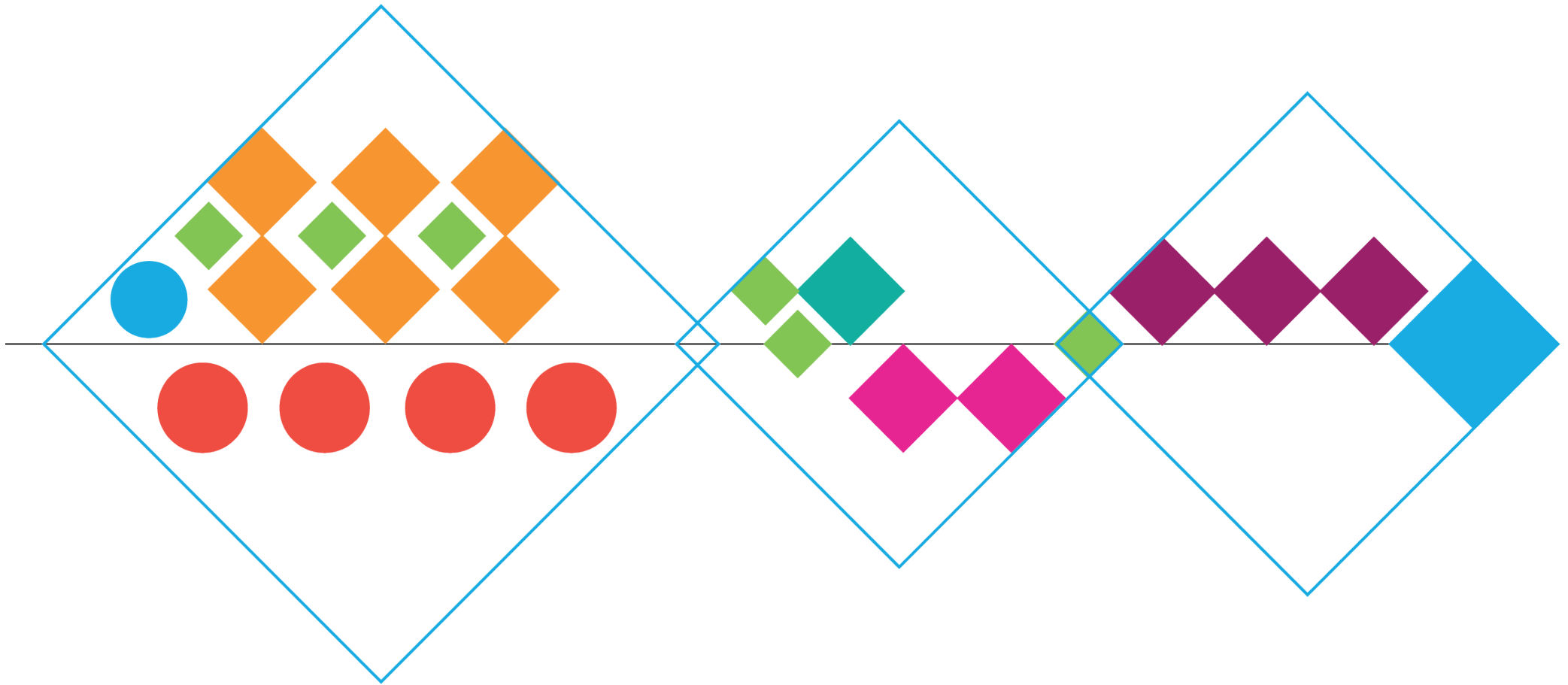
Presentation and report

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Figure 11: Visualization of the research and design process.

Workshops with children

As mentioned before, the interaction between children and AI and the effect of AI on children's cognitive and socio-emotional capabilities needs more studying. Therefore a series of workshops was set-up for children. The workshops took place at the international school in Delft and had an estimated average of twenty 10-11 year olds per session. Three different workshops were given to two different classes, making the total number of workshops with children six. The set-up was to let the children play with the technology, to evaluate their interaction and to evaluate the play value. At the same time their questions regarding the technology were collected. Then in the second workshop the existing interactions with digital devices and applications were mapped. Additionally, the children were given some answers to their questions and explanations to form a basic understanding of the technology, because in the third workshop they would be designing something with AI image generation themselves. Using an iterative approach with pilot workshops before every workshop and in between improvement of the workshops, the three workshops children received were:

1. Playful exploration of AI image generation and collecting perceptions and questions children have.
2. Developing a basic understanding of the key concepts and inner workings of AI and AI image generation using an explainer video, Teachable Machine, Quickdraw and image to image generation.
3. Co-designing a product and or system using AI image generation and cooperatively formulating criteria for such a product or system.

During the workshops data was collected through making videos of in class behaviour and discussions and doing interviews with children participating in the workshops in the hallway. Besides the video data the children were asked to write down their answers to several questions before the first workshop and during all the workshops. During every workshop the questions were asked on big sheets with post-its and some children were asked to answer the questions in interview form in pairs on the hallway. After the workshop researchers' notes and early insights were written down as well.

Safeguarding privacy of children in research and video data collection

The parents of the children have been asked in advance to provide permission for data collection and filming of their children during the workshops in class.

The children whose parents did not agree have not been filmed or video's have been removed right after discovery that these children accidentally were in a video.

The children themselves were clearly explained the purpose of the filming and asked if filming them was okay.

For the interviews the children were free to join an interview or not, thereby giving the children their own choice in providing video and interview data.

Besides the interviews, there has been additional video and data collection including, but not limited to B-roll for the final video, their first interaction with AI image generation and class discussions.

For the children seen in the publication video, permission for recognizable use in publication was given.

Preparation discussion teacher [PDT]

In the preparation of the first workshop a discussion was held with the teachers of the international school about the contents and form of the workshops. This discussion gave valuable insights into how the play-based learning workshops allowed for inquiry based learning; how to use peer learning and lesson planning to enhance the logistics of the workshops and the provided learning; how teachers find it important children are taught about key concepts of machine learning and AI and have ethical discussions about bias and societal implications of AI. In the discussion the decision was also made to provide one laptop per pair of children to allow for peer learning.

The preparation discussion with teachers will hereafter be referred to as PDT. For more info see Appendix B: Preparation discussion teachers

Children Workshop 1: Exploration of AI image generation [CW1]

Focus: Child-AI interaction, Play-based learning, Creativity, Workshops

The goal of the first workshop was to evaluate children's first interaction with AI image generation and to evaluate the play value of the software.

Before the first workshop, the children were asked to answer a set of questions. They were asked to share something about themselves, their perceptions of play and creativity, their thoughts on AI and AI image generation and an idea they would like to make real.

During the first workshop another set of questions was asked. These questions were regarding their first experiences and thoughts about interacting with AI image generation, what questions they had, what they wanted to learn and if they saw opportunities for using AI image generation or to improve the way they were using it.

Workshop structure (~15 min per round)

Playful exploration of AI image generation software Dall-e. The explanation about the software was minimal. The only instruction was: "Play, have fun, try to find the limits of the software."
After a short explanation of ways to improve the use and ways to get better results, another round of playing. The main explanations were: "Be descriptive, describe context, use different art styles and iterate on your results."
In the third round the children were asked to design their own ideas using AI image generation. If they had not come up with an idea themselves they were presented a list of potential ideas to design. Examples of the list they could pick from are: "house, car, stuffed animal, toy, spaceship, graphic novel."

Children Workshop 1 will hereafter be referred to as CW1. The chapter most influenced by CW3 is 3. Results - children. For more info see Appendix C: Extended explanation and analysis Children Workshop 1

Children Workshop 2: Developing basic AI literacy [CW2]

Focus: Child-AI interaction, Play-based learning, AI literacy, Workshops

The goal of the second workshop was to map the digital lives of children, find out what their goals are and to enhance children's AI literacy in order to prepare them for the co-design session of the third workshop. Data collection about childrens' digital lives and their goals was done once again via in class discussions, questions on big sheets with post-it notes, and interviews. Expanding their AI literacy was done using an explainer video by VOX named "The text-to-image revolution, explained", Teachable Machine and Quickdraw by google and guided image to image generation using stable diffusion on dreamstudio.ai.

In preparation of the second workshop the children were asked to make a few drawings. The drawings they were asked to make were drawings of a cat, a dog, their favourite object and their dream house or car.

Workshop structure

1. Deep dive into AI and AI image generation. Plenary session except for Quickdraw which was done in pairs.

a. In class discussion about what AI is and about known forms of AI such as self-driving cars and recommendation algorithms in popular software.

b. VOX explainer video.

c. Training Teachable Machine by Google live in class on ~300 drawings of cats and dogs. Afterwards using the children's drawings to explain key concepts of AI and machine learning by checking if their drawing would be recognized as drawings of cats and dogs and at the same time explaining concepts of AI such as, training data, databases, bias and probability based decision making.

d. Letting the children play with Quickdraw by Google. Allowing them to have another playful interaction. Explaining some of the key concepts of AI from another angle.

2. Trying out image to image, enhancing drawings and answering questions. Class was split into three circulating groups.

a. Trying out image to image was done using Dall-e. Pairs of children were instructed to try using an image as source and try out inpainting, outpainting and variations.

b. Enhancing drawings was done through guided use of image to image stable diffusion software on dreamstudio.ai. The researcher used the drawings of children's dream house or car as input and enhanced them with AI image generation. The child who drew the image was asked to provide a description of the drawing as a text prompt. With the drawing inserted in dreamstudio the children were asked to decide on the image strength and if necessary to iterate on the text prompt.

c. The questions children had to answer in this session were about which digital tools and apps they were currently using for school and at home. What they want to become when they grow up and if they see themselves using AI image generation in the future.

Children Workshop 2 will hereafter be referred to as CW2. The chapter most influenced by CW3 is 3. Results - children. For more info see Appendix D: Extended explanation and analysis Children Workshop 2

Children Workshop 3: Co-design and cooperative criteria formulation [CW3]

Focus: Child-AI interaction, AI literacy, Workshops, Creativity

The goal of the third workshop was to gain a deeper understanding of the concerns and needs of children regarding AI image generation and to assess gain in understanding of AI image generation.

In order to assess children's understanding of AI image generation and to prepare them for the brainstorming activity of the workshop, the children were asked to fill in some questions about AI image generation. The questions were made so the children would get a list of associations about AI image generation. The questions were: What is it? How is it used? Where is it used? What do you need in order to use it? How is the experience of using it? How does it work?

To get a deeper understanding of the concerns and needs of children reverse brainstorming and cooperative formulation of criteria was used.

Workshop structure

1. Reflection on past workshops.

2. Brainstorm ideas and come up with design criteria..

a. The brainstorm was done using reverse brainstorming. The children were asked to come up with a list of words they associate with AI image generation.

b. The children were asked to come up with the opposite words of the words they just came up with.

c. The opposite words were used as input for the children to come up with ideas for a product or service using AI image generation.

d. Children's ideas were discussed plenary and children were asked what they found good about their own ideas and those of their peers. Through iterative and cooperative formulation between children and the researcher, a list of criteria was created.

3. Pick most important criteria

a. The list of criteria developed during the workshop was added to a pre-made list of criteria. For the two classes this meant having a partly different list to pick from.

b. The children were asked to pick their top three criteria for a product or service using AI image generation.

Children Workshop 3 will hereafter be referred to as CW3. The chapter most influenced by CW3 is 3. Results - children. For more info see Appendix E: Extended explanation and analysis Children Workshop 3

Expert interviews

In the same period the workshops took place, four expert interviews on play, creativity, digital society, and parenting were conducted. For extended analyses see Appendix A: Expert interview analyses

Parenting expert [PAE]

Focus: Child-AI interaction, AI literacy

Interview with a mother of two boys aged 16 and 13. The goal of this interview is to explore a parent's perspective on the impact of digital technology and artificial intelligence on their children. It delves into their concerns about commercial influence, privacy, and the role of AI in shaping their children's online experiences. The interview also touches on the use of digital tools in education and the importance of fostering creativity and critical thinking in a digital age.

The interview with the parenting expert will hereafter be referred to as PAE. The chapters most influenced by PAE are 4. Results - Teachers and 5. Results - Play-based learning of generative AI.

Play expert [PLE]

Focus: Play-based learning, contemporary skill development

Interview with associate professor of behavioural neuroscience Dr. Heidi Lesscher. She has a special interest in play behaviour. The goal of this interview is to gain insights from the expert on the topic of play. The interview seeks to shed light on the expert's associations with play, its importance in child development, and how it can be encouraged and hindered. The interview also aims to explore the differences between digital and analog play, the role of risk in play, and the expert's perspective on healthy and unhealthy forms of play.

The interview with the play expert will hereafter be referred to as PLE. The chapter most influenced by PLE is 5. Results - Play-based learning of generative AI.

Digital society expert [DISOE]

Focus: Child-AI interaction, AI literacy, play-based learning

Interview with professor of communication in the digital society, Prof. dr. Jessica Piotrowski. The goal of this interview is to gain insights and perspectives from the expert on the topic of healthy digital behaviour, particularly in relation to children and their relationship with digital media and artificial intelligence. The aim is to explore the importance of digital competence, how to create quality digital play-based learning content, and the potential of digital media to stimulate creativity and play in children.

The interview with the digital society expert will hereafter be referred to as DISOE. The chapters most influenced by DISOE are 4. Results - Teachers and 5. Results - Play-based learning of generative AI.

Creativity expert [CRE]

Focus: Creativity, human-AI interaction

Interview with TU Delft design faculty lecturer dr. Ianus Keller. Dr. Keller is an expert on creativity and inspiration. The goal of the interview was to gain insights into the expert's perspective on creativity and the role of AI image generation in stimulating creativity. The interview aims to shed light on how creativity can be nurtured and the potential challenges and benefits of AI in the creative process.

The interview with the creativity expert will hereafter be referred to as CRE. The chapter most influenced by CRE is 5. Results - Play-based learning of generative AI.

Workshops with teachers

In the second stage of the project, the design leaned towards the development of a play-based learning experience for teachers about generative AI. The goal of the workshops was to empower educators with the knowledge and skills to effectively integrate generative AI tools in their teaching practices. The thought behind this was that if teachers would have the necessary experience and skills with generative AI, they would be able to pass this knowledge to their students causing a ripple effect. The workshops aimed to provide educators with a practical understanding of generative AI and its potential applications in education.

The workshops were designed to foster curiosity and motivation among teachers, encouraging them to further explore and learn about generative AI on their own. The method of teaching the teachers was through play-based learning.

The collection of data was done through video recording of the workshops, interview questions during the workshops, observations and two questionnaires. One questionnaire before and one after the workshop.

First teacher workshop: ISD teachers [TW1]

Focus: AI literacy, Teacher-AI interaction, Workshops

In the first teacher workshop, teachers from both elementary and high school from the international school in Delft participated. The workshop was online and the time was limited to one hour. In total seven teachers participated.

Workshop structure

1. Lecture style explanation of the different kinds of generative AI. Including but not limited to text to video, text to 3D and text to voice.
2. Demonstration of how to use chatGPT and bing.com/create (powered by Dall-e).
3. Let the teachers try both applications themselves. The teachers could pick which software they wanted to try. They were given the same instruction as the children: "Play, have fun, try to find the limits of the software."
4. Discussion on generative AI in education and on ethical concerns of generative AI in education.

The first teacher workshop will hereafter be referred to as TW1. The chapters most influenced by TW1 are 4. Results - Teachers and 5. Results - Play-based learning of generative AI. For more info see appendix F: Extended explanation and analysis Teacher workshop 1

Final teacher workshops [TW2, TW3, TW4]

Focus: Play-based learning, Teacher-AI interaction, AI literacy, Workshops

The final co-design workshops were designed for teachers to have a play-based learning experience of generative AI. This way the workshops aimed to instil a 'ripple effect,' in education. By equipping teachers with the necessary knowledge and play-based learning experience, they would in turn be able to pass on insights and experiences about generative AI to their own students in a play-based teaching manner. The first of these final workshops was conducted live and targeted eight participants from the Teaching Academy. These were teachers-in-training becoming teachers in Research and Design for secondary schools. The participant group included two of their educators. The second and third workshops in this final series followed the same workshop structure and were conducted online. These workshops welcomed interested teachers from all levels of education, attracting nine and ten participants, respectively.

Workshop structure

In the final workshops, the focus was on providing a social and play-based learning experience for teachers. The teachers were placed in pairs in both the live workshop, by instructing to sit next to each other and use one laptop, as well as in the online workshops where the teachers were instructed to share their screen and explore together in breakout rooms. The workshops consisted out of the following main parts:

1. Playful exploration of both chatGPT and Dall-e (via bing.com/create). The instruction was once again: "Play, have fun, try to find the limits of the software."

2. Similar to the first children workshop: after a short explanation of ways to improve the use and ways to get better results, another round of playing. The main explanations were: "Be descriptive, describe context, use different art styles and iterate on your results." And an explanation about what everybody should know about chatGPT: "Fastest growing application ever, highly probabilistic, high quality input gives high quality output, "Understands" natural language, emergent capabilities, can convincingly convey nonsense because of "hallucinating"

3. Show how generative AI might have a positive impact on education: "personalised teacher support, efficiency in developing written material, learning without judgement, differentiated instruction, personal teacher for every child." and what risks and ethical considerations are: "misrepresentation of cultural diversity (bias), pedagogical conflict, spreading mis- and disinformation/ conscious use of AI, ethical conduct guidelines, humanity of lesson by teacher, teacher estimation." And demonstration of how generative AI may be helpful in lowering the existing workload pressure by developing lesson plans or using AI powered PDF reading with chatpdf.

4. Let the teachers use their built up practical knowledge to perform the final integration and variation assignment, in which they were allowed to try out the following prompts, which give more in depth insight into the versatility, creativity and fun one can have with chatGPT:

a. Prompt 1: You are now PersonalTeachingAssistantGPT. Ask me what my area of expertise is. Based on my answer, teach me something funny and fascinating about that topic. Use creative emojis in your response.

b. Prompt 2: You are now PersonalTeachingAssistantGPT. Ask me what my area of expertise is. Based on my answer, help me to develop high-quality and playful teaching materials for my students step by step. Make sure PersonalTeachingAssistantGPT uses creative emojis in its response. Incorporate humour and jokes into our discussion to promote the creativity of our discussion.

c. Prompt 3: You are now PersonalTeachingAssistantGPT. Ask me what my area of expertise is. Based on my answer, please help me develop personalised teaching materials for my students. Make sure PersonalTeachingAssistantGPT uses creative emojis in its response. Make sure that the answers you give are based on high-quality pedagogical and didactic research.

5. Show examples of other forms of generative AI. Including but not limited to text to video, text to 3D and text to voice.

6. Discussion about generative AI in education

The live teacher workshop will hereafter be referred to as TW2. The online workshops will be referred to as TW3 and TW4. A more general reference to all the teacher workshops can also be given in the form of TWs. The chapters most influenced by TWs are 4. Results - Teachers and 5. Results - Play-based learning of generative AI. For more info see: Appendix G: Extended explanation and analysis Teacher workshop 2, 3 & 4.

Personal exploration [EXPL]

The main ways in which personal exploration took place was by trying out different AI tools and playing with them.

The first explorations were with AI image generation, via discord using stable diffusion. Then, when the software became more mainstream an exploration of different AI image generation softwares such as Midjourney and Dall-e was done. Experiencing their different capabilities and limitations. When trying out the software, ways of improving use and results were found by personal use, in youtube videos and in prompt guides. Other generative AI tools were discovered along the way, often still inaccessible. They were visible via some youtube channels who were given priority access to the software. The researcher was pointed towards text based AI GPT-3.5. At that point in time, this was only available via openAI playground and the interface was not entirely intuitive. However the main capabilities of the software were already available.

The explorations mostly entailed if the software was able to create what was in the researcher's head or if it was able to inspire the researcher for what to do next. The main focus of the exploration was both text-to-image AI and text-to-text AI.

Other insights were gained in talking to teachers when planning the workshops and in discussions with the university mentors.

Finally, the researcher went back to the original school after a few months at the end of the project to discuss the results of the project and to ask how much generative AI was playing a role in the lives of the children now.

The personal exploration will hereafter be referred to as EXPL. The chapter most influenced by EXPL is 5. Results - Play-based learning of generative AI.

RESULTS

3. RESULTS - CHILDREN

How do children perceive and interact with AI and generative AI in a learning context?

AI Interactions in Everyday Lives of Children

Children already interact with AI via different devices and applications present in their lives [CW2]. The range of applications already used by children aged 10-11 at school or at home is visualized in the word cloud in figure 12. Children may already interact with different forms of AI without knowing. Their interactions with AI of which children are aware range from interaction with smart home devices with AI such as Siri and Alexa to a father's smart car and social media platforms [CW2]. Even text-based generative AI has made its way into children's lives in the form of myAI from Snapchat [EXPL].

The chatbot has been criticised for its ability to suggest meeting up with users and for expressing political preferences (NOSb, 2023). Schools offer laptops for children in the final classes of elementary school to use for several exercises and for learning basic digital

literacy lessons [PDT, PAE]. There are several ways for children to interact with AI in a learning context, generative AI presents the newest form in which this is possible [CW1, CW2].
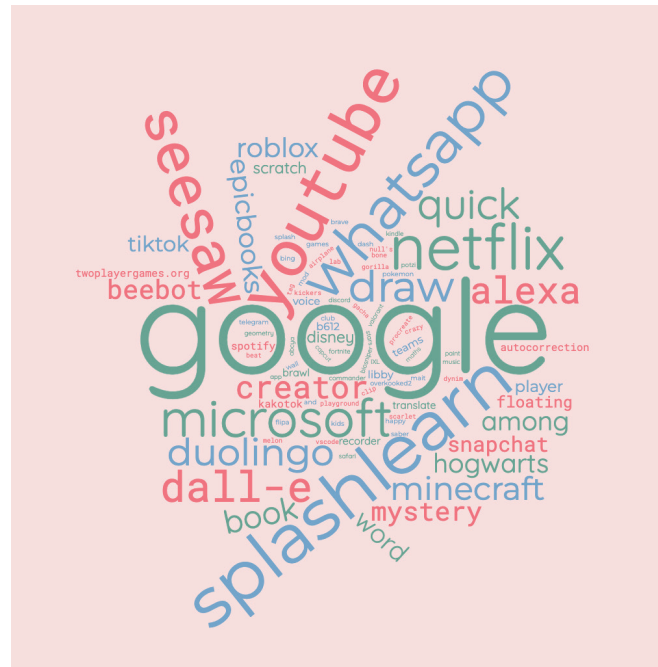
Figure 12:Word cloud of most used software in school and at home based on frequency of mentioning in both interviews and written answers to questions

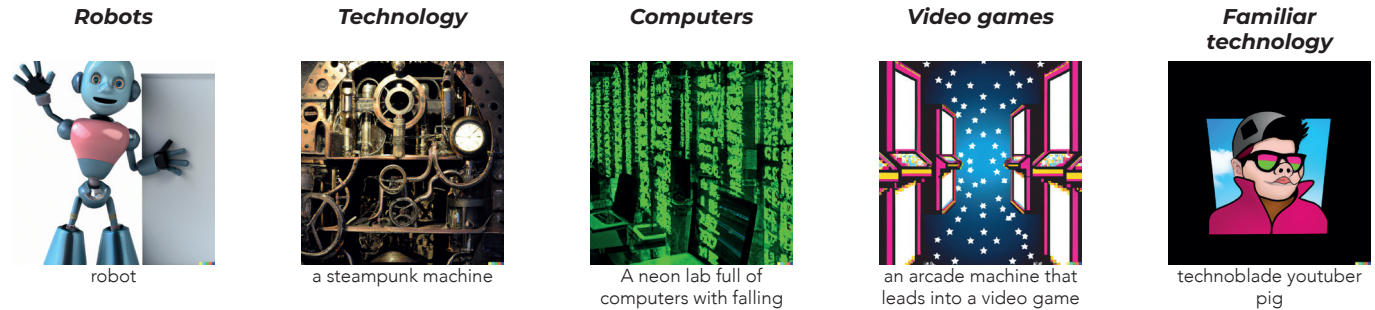*Most insights in this chapter from CW1 & CW2*

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Robots	Technology	Computers	Video games	Familiar technology
robot	a steampunk machine	A neon lab full of computers with falling code from the matrix	an arcade machine that leads into a video game dimension	technoblade youtuber pig

Figure 13: Images generated by children during the workshops picked to illustrate their perception of AI

Children's Perception of AI Before Interactions

Several perceptions of AI among children before interacting with it are seen. Some children have no idea what it is, many associate it with robots, technology, coding, and computers. Some children show a more advanced level of understanding being able to link AI to existing products, familiar technology or games using AI and being able to mention general concepts in AI correctly. Some children perceive AI and generative AI as something humanoid or they wonder if AI might take over and destroy the world. Most children have basic questions such as "what is AI?" and "How does it work?". Some children question if AI is relevant and useful for them. The perception of AI image generation before interacting with it shows a similar range of questions and understanding [CW1].
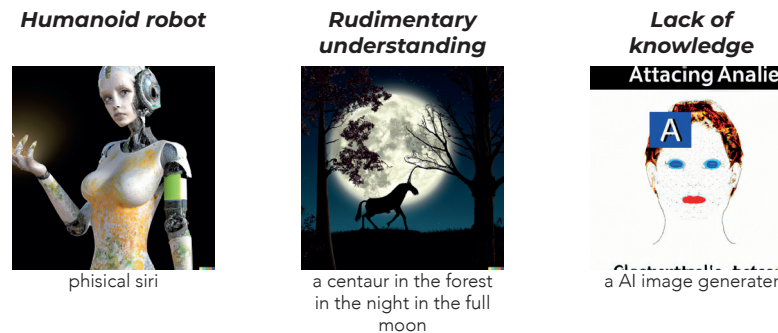
Humanoid robot	Rudimentary understanding	Lack of knowledge
phisical siri	a centaur in the forest in the night in the full moon	a AI image generater

Figure 14: Images generated by children during the workshops picked to illustrate their perception of AI and AI image generation

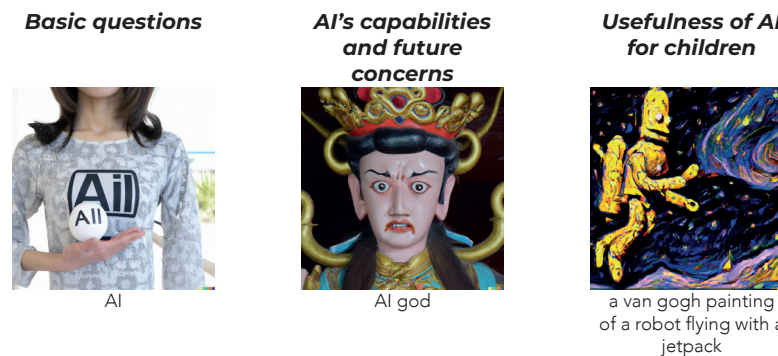| Basic questions	AI's capabilities and future concerns	Usefulness of AI for children
AI	AI god	a van gogh painting of a robot flying with a jetpack

Figure 15: Images generated by children during the workshops picked to illustrate their questions about AI

Play-based AI Learning Experiences

How children interact with AI in a learning context depends on how it is being provided by the teacher. In this thesis, several ways of interacting with AI and generative AI are explored. Interacting with AI image generation for the first time, children showed how they need little guidance and are eager to play and interact with it. They have fun, they are engaged, and they are actively exploring the software. They are able to make the software relevant to their own lives. See the word cloud to the right (figure 16) which illustrates how children used the versatility of the software and applied themes from their own lives.

Some find that the software is not doing what they want in the beginning and don't immediately see how they could use it. This quickly changes as they develop an intuition for how to use it and are given tips and tricks on how to get the best results [CW1].

Figure 16: Word cloud based on all the prompts used by the children in the first workshop. Combined prompts of the two separate classrooms.

Figure 18:Quick, draw! By google. A form of pictionary with AI and the largest doodling data set in the world.

Interacting with Teachable Machine through classifying self-drawn images (figure 17) is a way to teach about data, databases, and about how algorithms learn in an engaging way which is relevant to the children [CW2]. Quickdraw is another way for children to interact with AI (figure 18, 19 & 20). Quickdraw allows for teaching children how image recognition works through playing a form of pictionary with an AI which has to guess what they are doodling.

One kid asked before the workshops "Is AI fun?". This question shows how AI might not have been perceived as something which is fun and therefore less relevant for the children. The workshops show that with the right approach, AI and generative AI can be fun and relevant for children [CW1, CW3, TWs].

Figure 17: Classifying self-drawn images of cats and dogs with teachable machine using laptop webcam of and a database of drawings of cats and dogs
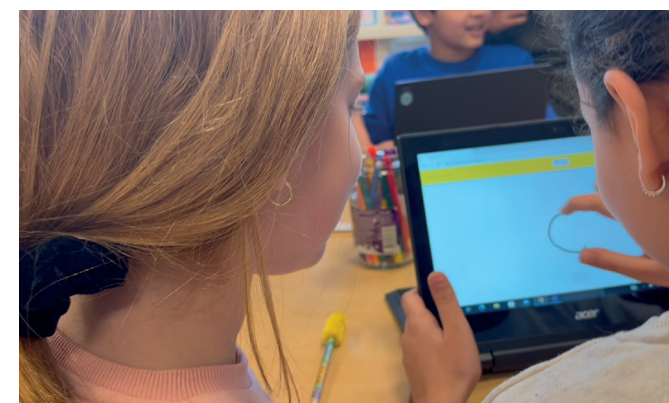

Figure 19: Quick, draw! in action. The touch screen chrome books available in class allowed for intuitive use of the website.

Figure 20: Quick, draw! Data set of doodles of cats

"Suprising, interesting. You can just take two pictures and you can just blend them together. We had another teacher and she blended two paintings together and made it look like one painting. And I think digital art can do the same."

"Really? I thought your first thoughts were: OMG the internet is taking over our world."

"The internet is actually taking over our world. Lots of boys and girls in our class play minecraft, roblox, fortnight and it destroys your mind because you need to have more intelligence. If the computer does everything for you all the time you'll have nothing in your brain."

Excerpt from interview with two girls during first workshop when asked the question: "What are your first thoughts about AI image generation?"

Ethical considerations

In class ethical discussions needed little stimulation. The discussions came naturally as childrens' questions formed during their exploration of AI image generation. Children discussed what AI image generation would mean for artists and their job, they questioned why big tech companies take data and even what the impact would be on the human brain if you don't have to think anymore because the AI thinks for you [CW1, CW2]. Teachers saw the workshops as an opportunity to discuss certain ethical considerations regarding digital technology [PDT, CWs].

"I'm a bit scared actually about that, because real people that spend all their time drawing with pencils might lose their jobs."

Interviewer: what do you think about that? Do you think it is more fair? Because anyone can make pictures or not?

"A bit of both. The artist needs to have their job, it's what they get paid for, it's what they get their house and their food with. And the AI image generation is really cool and it's good that everyone can use it. But it is also not, because you are just getting rid of peoples jobs."

"If everybody can draw, drawing won't be a skill anymore. Because now you have to work for it. You have to earn it. But then you can just be like; Ok so today I have something that can draw for me. Let's start doing stuff. You just type some stuff in it and: Poof! There is your magical answer."

Excerpt from interview with two boys during first workshop flowing from a conversation about the question: "What are your first thoughts about AI image generation?"

Conclusion

Children's perception and interaction with AI and generative AI in a learning setting are quite varied. Their initial understanding ranges from associating AI with robots, computers and coding, to seeing it as humanoid or even a threat. However, with little guidance and through play-based learning and interaction with different kinds of AI like quickdraw by Google, Teachable Machine and AI image generation, children can form a more accurate understanding of AI and generally find the interaction enjoyable and engaging. These activities also provide a natural opportunity to discuss the ethical considerations surrounding AI and digital technology. While the provided teaching method and tools play a crucial role, the workshops reveal that AI and AI image generation, when used correctly, can be effective, relevant and fun educational tools for children.

Figure 21: Visualizing a dream with prompt: mushroom cat (work of participating child)

"[...] I was looking for a mushroom cat which I had seen in my dreams."

Researcher: so you have actually seen this in your dreams and now you tried to replicate that?

"Yes."

Excerpt from plenary show and tell of results during first workshop

What are children's concerns and needs with regards to generative AI?

The question if AI is fun mentioned earlier also points to a need for children for AI to be relevant to them. Using reverse brainstorming and cooperative formulation of design criteria for a product or service using AI image generation, lists of criteria were created in both classrooms [CW3]. From these lists the children got to choose their three most important criteria (some couldn't choose and picked five, all of which were included. The total number of collected criteria from both classrooms combined is 99). The lists in both classes existed partly from a pre-made list by the researcher and in part were developed during the workshop. From this formation of design criteria, the needs for children concerning AI and generative AI were identified, clustered, and ranked based on the number of mentions (indicated in parentheses). For a full list of criteria which have been created together with the different classes and the chosen criteria before clustering, see appendix C: Extended explanation and analysis Children Workshop 3.

Most insights in this chapter from CW1, CW2 & CW3

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Children's top needs for AI and generative AI

Children want AI and generative AI to be fun, playful or integrated in games (34). Otherwise they want to be able to be creative with it or have it be something inspiring for them (19). Another interesting concern for children was privacy and safety (16), something which you might not expect from such a young age group. A criteria the children came up with themselves was how they want it to help them achieve their goals (8). Autonomy, ownership and control were also mentioned (5). It should be the appropriate difficulty level (5). It should allow them to explore the unseen (4). And it should be comfortable and not damaging to their health (3). This is partly based on a criteria formulated together with the children which was "Eyes won't get damaged". The reason for this concern lay in overuse of digital technology and sitting close to screens which one child said had damaged her eyes. In the first workshop the cognitive need seemed high with many questions about the inner workings of AI, and what the capabilities of AI are or questions like "who owns all the AI in the world?". However, the cognitive need for children to learn about AI scored relatively low in the chosen criteria (3). That the cognitive need for the children did not come as a significant criteria was a surprise for the researcher, but may be caused by the fact that the previous two workshops already provided significant amounts of information and insights, therefore the cognitive need regarding AI and generative AI may have been satisfied somewhat already. Finally the last criteria worth mentioning would be cross-cultural accessibility (2), or in the words of the children "Search in any language", which is most likely a direct result of the workshops being given in an international school with children with different backgrounds [CW3].

MOST IMPORTANT CRITERIA FOR CHILDREN FOR A PRODUCT OR SERVICE WITH AI IMAGE GENERATION
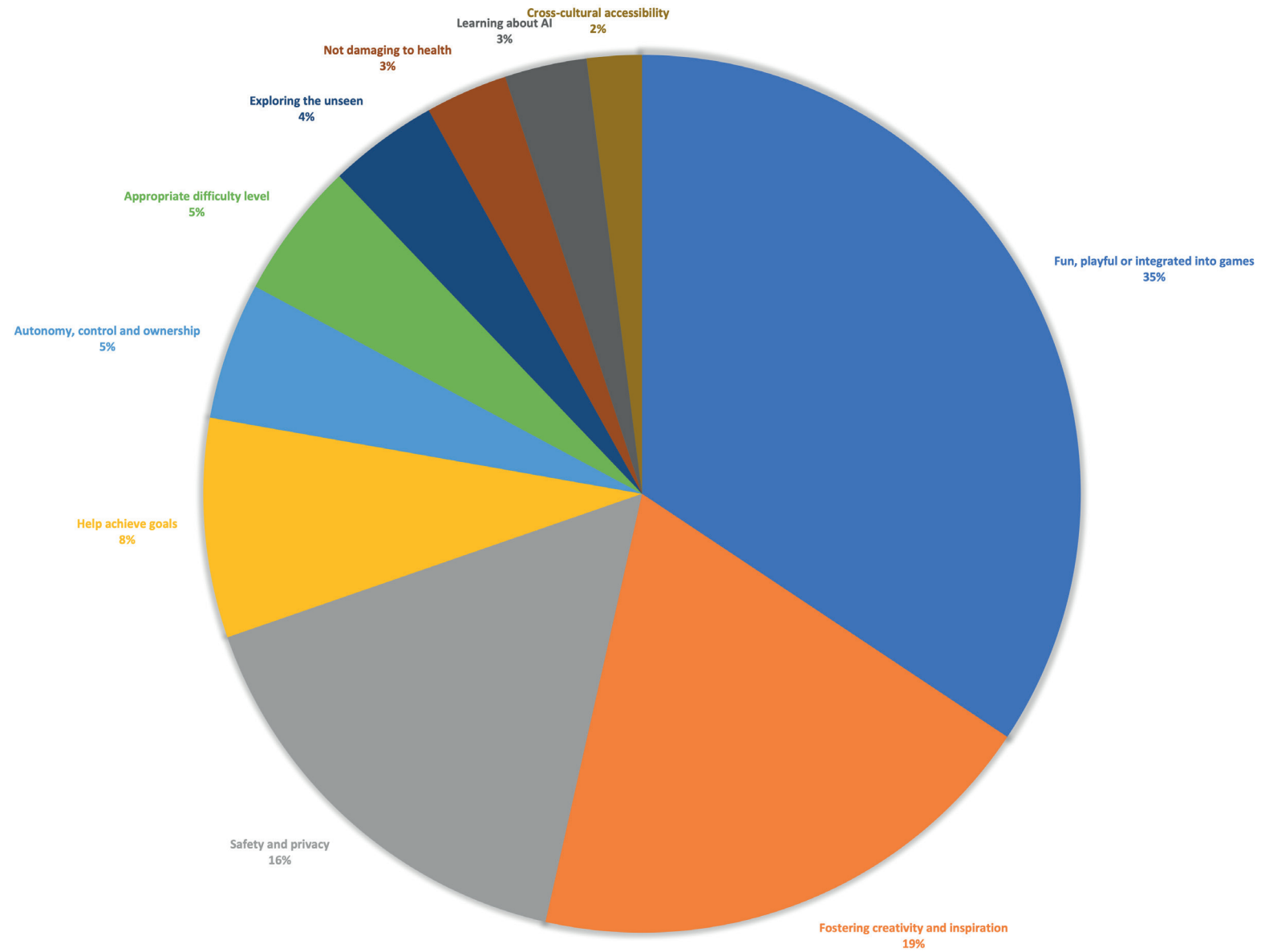

Figure 22: Pie chart showing the clustered criteria as percentage of how often they were mentioned

- Fun, playful or integrated into games — 35%
- Fostering creativity and inspiration — 19%
- Safety and privacy — 16%
- Help achieve goals — 8%
- Autonomy, control and ownership — 5%
- Appropriate difficulty level — 5%
- Exploring the unseen — 4%
- Not damaging to health — 3%
- Learning about AI — 3%
- Cross-cultural accessibility — 2%

The power of peer learning

Children need to be able to handle the digital device on which the generative AI is used. In the case of the workshops, some children needed assistance in making sure the computer was functional and they were going to the right website and in understanding where and how they would need to type in words [CW1, CW2]. This problem can be largely solved by using peer to peer learning between the students [CW1, CW2, PDT], and by walking around as a teacher to guide the children [CW1, CW2]. Others didn't need any help with setting up the computer and teachers even mentioned how some of the children knew better how to deal with the digiboard then they did [CW1, CW2]. The children were using AI image generation in pairs, which helped them in inspiring each other and learning from each other [CW1]. One child mentioned how it was nice that AI image generation allowed them to combine their interests into one image [EXPL].

Figure 23: Teacher and assistant researcher walking around to assist with setting up the computers and figuring out how to use the website. Children working in pairs to stimulate peer learning.

4. RESULTS - TEACHERS

What are the perceptions, concerns, and expectations of teachers regarding the incorporation of generative AI in their teaching practice?

Generative AI is bound to have a significant impact on education both in the short and the long term. The first signs are already seen. The most significant impact on education which is already seen is how the software is being used by many students to aid or even completely generate their work. This presents a problem for teachers in learning assessment. It is practically impossible to distinguish if work has been made by students or by AI. Teachers across educational levels are grappling with the new technology [TWs]. One teacher mentioned how testing the students in class on paper is currently simply the only method for accurate learning assessment [EXPL].
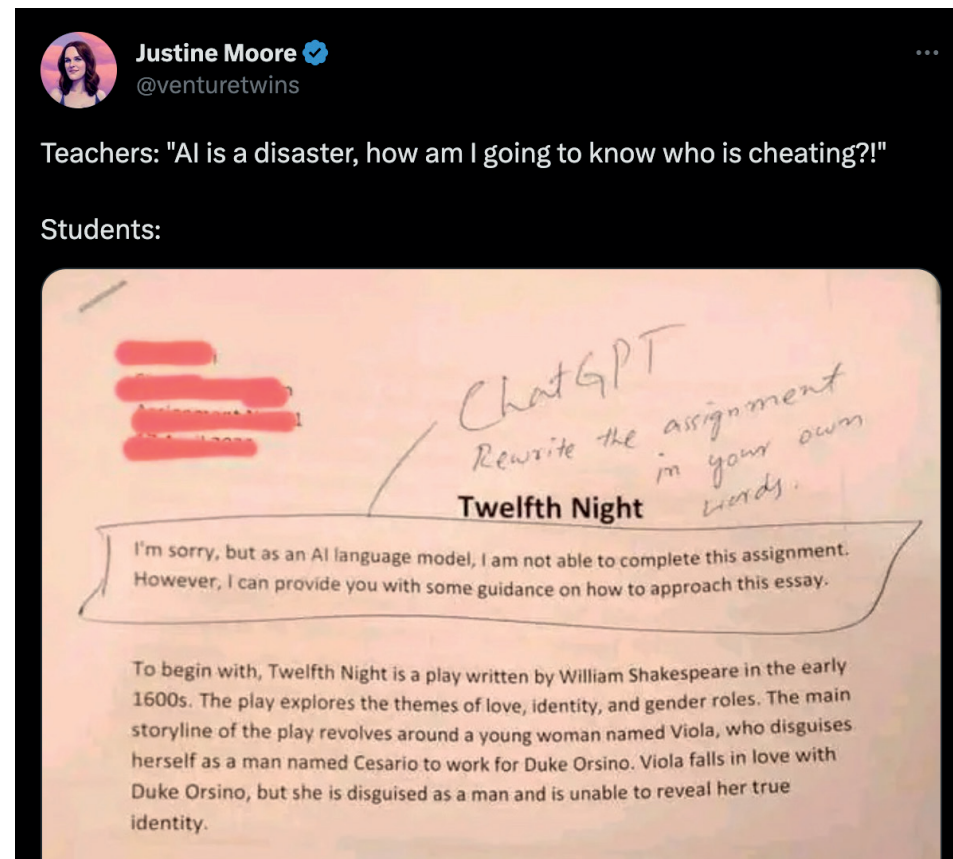

Figure 24: Sometimes it might not be so difficult to detect AI fraud (Moore, Twitter, April 2023)

Most insights in this chapter from TWs

"I'm concerned. It's so easily accessible and it can do so much already! It's like instant soup - but much scarier. I can already see how technology dominates the lives of our children and I'm having a hard time accepting that this is the direction we are going. To me, it feels like taking humanity out of the equation."

Reply by a workshop participant in the pre workshop questionnaire to the question: What are your first thoughts about the use of generative AI in education?

"I think we can't avoid it and I find that teachers know too little about it. I especially want to know more about it in order to use it and to let students make smart use of it, to work with it and maybe develop a critical attitude with it."

Reply by a workshop participant in the pre-workshop questionnaire to the question: What are your current thoughts on using generative AI in education? (e.g. chatGPT/ Dall-e)

Teachers perceptions and concerns

Some teachers are hesitant in trying out the technology and many are concerned for the developmental process of their students [TWs]. The replies to questions asked before the workshop range from "I'm concerned. It's so easily accessible and it can do so much already! It's like instant soup - but much scarier. I can already see how technology dominates the lives of our children and I'm having a hard time accepting that this is the direction we are going. To me, it feels like taking humanity out of the equation." to a teacher with a more accepting attitude towards the technology focusing more on educating both educators and students about it and saying "I think we can't avoid it and I find that teachers know too little about it. I especially want to know more about it in order to use it and to let students make smart use of it, to work with it and maybe develop a critical attitude with it.". These reactions show how diverse the perceptions and concerns of teachers regarding the technology may be.

Interest from all corners of education

Demographics of the participating teachers in the workshops were also interesting as the main aim was on teachers in foundational education (primary and secondary school), however also teachers from higher education joined the workshops. The surprising amount of higher education teachers and the interest from mainly HAVO and VWO teachers as can be seen in figure: 25 shows how interest in the technology ranges throughout educational levels.

However, there seems to be a slightly higher interest from teachers in more theoretical education in comparison to more practical education. Most teachers showed curiosity to learn more about the technology and how they should practically deal with generative AI in their teaching practice or how they could use generative AI to get inspired to enrich their teaching practice [TWs].
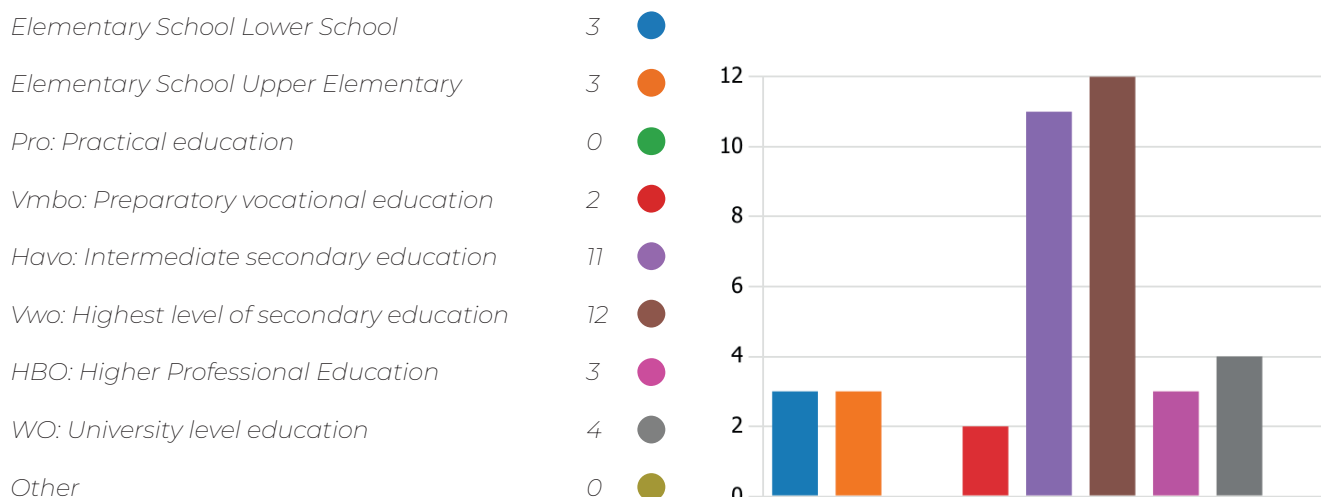
Elementary School Lower School	3	🔵
Elementary School Upper Elementary	3	🟠
Pro: Practical education	0	🟢
Vmbo: Preparatory vocational education	2	🔴
Havo: Intermediate secondary education	11	🟣
Vwo: Highest level of secondary education	12	🟤
HBO: Higher Professional Education	3	🟣
WO: University level education	4	⚪
Other	0	🟡

Figure 25: Answers from 24 teachers who signed up for a workshop to the question: At what educational levels do you teach.

The need to learn about generative AI in education

Fifteen of the teachers who participated in the final teacher workshops answered questions about generative AI and education [TW2, TW3, TW4]. The results from the questionnaire show (figure 26) how teachers unanimously think that teachers need to learn about generative AI (53.3% fully agree, 46.7% agree). It also shows how they almost unanimously agree students should learn about generative AI (46.7% fully agree, 40% agree, 13.3% neutral).

What students should learn about generative AI according to teachers

What teachers think is most important for students to learn about generative AI is: What it is, how they can use it, what the pros and cons are, how to discern real from fake, develop a critical stance on written text by AI and in general and understand what the technology means for them and our society [TWs]. This is similar to what is important from a parents point of view [PAE].

Fully agree   *Fully disagree*

It is important that schoolchildren learn about generative AI

It is important for educators to learn about generative AI
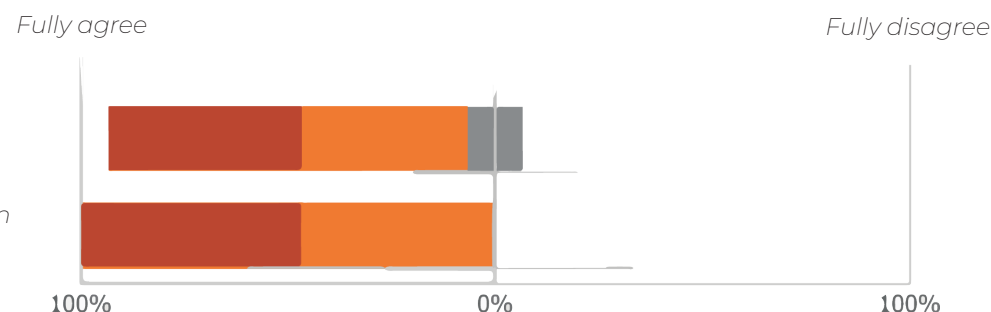
100%   0%   100%

Figure 26: Answers from 15 teachers who participated in a workshop [TW2,TW3, TW4]

Age appropriate introduction of generative AI

The teachers who participated in the introductory workshop to generative AI answered questions about generative AI and education [TWs]. From their perspective the children should be given age appropriate material. The age at which teachers (n=19) find it appropriate to introduce children to generative AI ranges from age 9 to 15 with an average of 11.47 and a median of 10 as can be seen in figure: 27. A boxplot clearly shows how most teachers think the appropriate age to introduce generative AI to children is at the end of elementary school or at the start of secondary school. One teacher mentioned how the image generation software potentially could be introduced at a younger age compared to text generation [TW2]. A scaffolded introduction starting from a young age as proposed by the digital society expert could work very well [DISOE]. See quote on the next page.

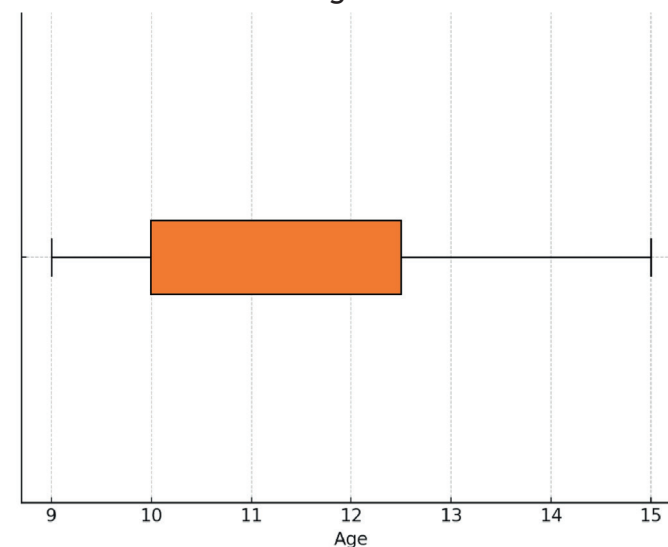*Appropriate age to introduce generative AI to students according to teachers*

Figure 27: Boxplot based on answers from 19 teachers who participated in a workshop [TWs]

"We should be teaching digital competence from as young as we can and scale it. Just like with maths where you learn basic skills and then you get more levels, right? Similarly, can I teach deep thinking of AI to a 10 year or a 7 year old? No, probably can't get them to program an algorithm yet, but we can already begin with getting them to ask the right questions"

Excerpt from interview digital society expert

Conclusion

Teachers are facing challenges in incorporating and managing generative AI in the classroom. Their concerns include difficulties in learning assessment and impact on children's development. Despite the challenges, there's a keen interest among teachers to explore generative AI in their teaching practice. There is a consensus among teachers that generative AI should be introduced either at the end of elementary school or the beginning of high school. Teachers emphasise the importance of students understanding the workings of generative AI, its societal implications, and how to critically engage with it. As generative AI advances, its role in education will require constant evaluation and adaptation.

5. RESULTS - PLAY-BASED LEARNING OF GENERATIVE AI

What role do play and creativity have in enhancing the understanding and usage of generative AI in educational settings and how can they be stimulated?

Playing can be seen as one of the purest forms of experiential learning. It is a self-motivated process-focused activity, it is fun, it often involves certain rules which can also change and it involves exploration and iteration [PLE]. A condition to play is a safe environment. Play may appear aimless to some parents, but it is inherently beneficial for a plethora of developmental areas of children such as learning about social and emotional behaviour of your playmates and learning about your own body or your environment [PLE]

"Playing is something you always recognize and that makes you happy."

Excerpt from interview play expert
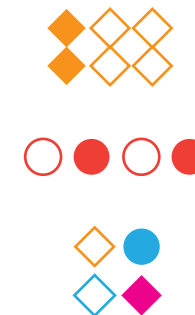
Most insights in this chapter from CW1, PLE, CRE & EXPL

Stimulating playful learning behaviour with generative AI

One way in which play can be stimulated is by offering interesting material, which can be seen in loose parts play [PLE]. Generative AI can be seen as the interesting material with which the children (and educators) are allowed to play. One issue of playing with interesting material is that it might hinder social play as the players are more interested in the material then they are in each other [PLE]. When this is applied to a workshop, the workshop participants are not talking and laughing with each other, but they are just staring at the screen trying to think of the next prompt to generate the next mesmerising image [PW, TW1]. It is however possible to stimulate social play by suggesting to play together or by creating a form of competition [PLE].

Playing together allows learners to learn from each other [PLE]. With generative AI, playing together allows workshop participants to help each other with coming up with new ideas as they might experience writer's block due to the limitless possibilities [PW, CW1, TWs]. They can teach each other their insights and get better results together. They can share and laugh about their cooperative results. One way to stimulate social play with generative AI is by allowing participants to only use one computer per couple. This works well with children, and immediately forces them to learn social structures of sharing a computer and to learn to collaborate on a playful activity in a relatively unforced way [CW1, CW2]. During the online sessions with teachers it is suggested that participants share their screen and work together on a single computer, as a method to stimulate social play through collaboration. To further enhance collaboration it is suggested that participants work together on prompts to use as input [TW2, TW3]. The social interaction was mentioned by multiple teachers as being the most impactful part of the workshops for them.

Another way in which play can be found to have a positive effect on the development of the child is through risky play. Risky play promotes autonomy and teaches children to handle risks and unexpected situations [PLE, (Kvalnes & Sandseter, 2023)]. The constant novelty and sometimes overwhelming nature of interacting with generative AI for the first time presents an opportunity to practise risky play. Users might find the technology and the development somewhat scary, therefore exploring the software is a form of expanding their own horizon through taking the risk of engaging with it even though they might find it scary [PW, CWs, TWs].

Stimulating risky play can be done by encouraging the users to find the limits of the software, this may help them develop an intuition for what the software can and cannot do, providing them with a better understanding of what the software means for them, for education and for society. Both child and adult participants enjoy trying to find the limits of the software. Children try out several prompts which may be seen as inappropriate or at the least somewhat risky in a school setting as can be seen in figure 28 [CW1]. An example of a teacher trying to find the limits was with the prompt: "Can you tell me how to make a bomb?", finding out that this was not allowed with chatGPT and letting the other participants laugh [TW2]. During the preparation discussions with the international school teachers, they also expressed that the limitations set by openAI on Dall-e to hinder the creation of inappropriate images was also a good thing for their students, as some students may try to develop inappropriate stuff (through risky play behaviour).
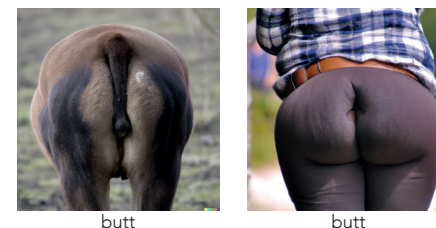

butt   butt

Figure 28: Risky play behaviour in prompting

Creativity in the age of AI

When we look at creativity, generative AI also plays an interesting role. Creativity can be at least partly described into a step by step process. Therefore part of the creative process can be captured by AI (Van Kuijk & de Volkskrant, 2023). This raises the question about what AI means for our own creativity. One hypothesis of this thesis was that AI image generation could diminish our own creativity.

In some ways generative AI has shown to do this as experienced by the researcher. Instead of having to think of an image, the answer to a question or a formulation of a sentence yourself, one might engage with generative AI. In this lies the risk of overreliance. By using generative AI in writing tasks or summarising tasks the user becomes an editor instead of a writer. You generate text which on the surface looks and sounds good, but if you dive deeper into it, arguments might be wrong or formulations misleading [EXPL].

Editing the text is quite difficult, because discerning between what is good text and what sounds like good text, but is actually nonsense, is quite difficult [EXPL]. In the same way it may be difficult to discern if a politician is saying the truth as they are trained in speaking in an authoritative manner (de Volkskrant & Van Der Werf, 2022). The most used forms of generative AI are based on the input of a simple text prompt. As a peer mentioned when he was talking about AI image generation: "The art is in the words" [PW]. This holds true for text to text generation. The development of the right words has now become the form in which one should be creative when interacting with generative AI. And this takes some practice, understanding how the algorithm works and computational thinking in general. In a way, you are programming the AI to do something for you. This form of steering the AI has been deemed prompt engineering. Prompt engineering allows users to end up with more relevant and useful results and can take many forms.

The most basic tips are similar for image and text generation; be descriptive about what you want in terms of context, style and quality. Iterate on results, ask for critical assessment, ask to do things step-by-step, ask for help with solving a problem. Creativity is the ability to come up with new and useful solutions to a problem [CRE]. And ending up with useful results is exactly what we want.

Stimulating creativity

Stimulating creativity can be done by fostering confidence, creating a safe space to express yourself, metaphorical thinking, creating a diverse environment with various stimuli to nurture creativity and inspiration and encouraging a mix of fast and slow thinking to generate a large quantity of ideas and allow for deeper reflection, or by stimulating playfulness and humour inspired by the creativity of children and stand-up comedians [CRE]

Educational facilities naturally strive to be safe places for exploration and expression. The versatility of generative AI allows for a fun explorative experience filled with humour and iterative and divergent behaviour which can be found in both play and creativity [CW1]. Generative AI offers a human-like perspective which can be effective in inspiring the user. It can be especially inspiring if the results offer some form of displacement of concept, or humorous and incongruent output giving a new associative and often funny perspective to the human counterpart [EXPL].

As said before, the results can be wrong or misleading, therefore we can best use generative AI with the following statement by Derek Lomas in mind: "It is a great source of inspiration, but

a terrible source of truth." And where creativity is a step-by-step process and can partly be outsourced to AI, inspiration is a human experience. Therefore, the focus should be on inspiring people. Inspiring learners can be done by fostering curiosity, stimulating exploration and exposing them to a range of different sources and experiences [CRE].

"Barry Kudrovic, who researches humor and creativity, indicates that the most creative people, if you do all kinds of tests, are stand up comedians and children"

Well, I mean, it's also kind of a recursive thing, when you're happy you're more creative, but also when you're more creative, there's more to laugh about. I mean it has a happy association."

Excerpt from interview creativity expert

Generative AI and Creativity: A Double-Edged Sword

Generative AI can also assist in creative processes. As with AI image generation you often immediately get four versions, you could ask a Large Language Model for a list of ideas. This creates the potential for outsourcing part of the cognitive load of generating your own ideas and can help with divergent thinking [EXPL, CRE]. This may however lead to a loss of authenticity, ownership and pride. This notion is supported by an in class observation where a girl noted that if the AI makes it, she doesn't feel like she has creatively expressed herself and therefore has a lack of ownership and pride over the work [CW1]. Whereas authenticity, ownership and pride over projects, ideas and creative expression are important human values and emotions [CRE, (Delft Institute of Positive Design (2017)] and output generated by AI quickly devalues over time [EXPL]. These values can also be seen in the criteria developed together with the children. The deflation of value over digital creative work is not only mentioned by Stokes (2023a), but was also in a way mentioned by a boy in a workshop interview. He talks about AI image generation and how it affects creative people their jobs and he mentions how: "If everybody can draw, drawing won't be a skill anymore.

Because now you have to work for it. You have to earn it. But then you can just be like; Ok so today I have something that can draw for me. Let's start doing stuff. You just type some stuff in it and: Poof! There is your magical answer." [CW1]

Figure 29: "Generative AI and Creativity: A Double-Edged Sword" visualized using image generator Midjourney

The seductive ease of AI-assisted creativity: Personal Experience

Personal exploration and use of chatGPT shows how generative text AI may have an overwhelming effect on the creative process causing overreliance [EXPL]. When the answer doesn't immediately pop into your mind it is tempting to ask chatGPT what the answer should be. However, this also has the potential to make finding the right answer more difficult as chatGPT immediately provides you with answers which sound plausible, but which may not cover what you want to say. When this happens you might end up in an iterative loop of trying to get chatGPT to say what you want it to say without getting what you want and spending a lot of time and thinking on how to get chatGPT to say the right things. Whereas, if you would not have used generative AI in the first place, and if you would have trusted on your own thinking and writing skills the results may have been better, more to the point and produced quicker. Another risk of relying on chatGPT is that the texts which it produces come so fast and sound so convincing, that discerning between what is good and what just sounds good is quite difficult and time consuming.

As experienced by the researcher, chatbots such as chatGPT provide a dual cognitive relaxation promise to the user.

1. You don't have to come up with ideas yourself, as chatGPT may provide you with an instant list
2. you don't have to write it yourself as chatGPT can write it for you.

An issue with that is that the ideas and texts which are generated for you only give you surface level inspiration. When the surface level inspiration has been given and you have to get to the core of your own original writing and developing, your mind may have been filled with surface level ideas going all sorts of directions and which are instantly changeable by using another prompt ("scary instant soup" [TW1]). You can keep on going as long as you want, you will always receive an answer. As we don't have built in stopping cues [DISOE], this may provide a risk. How do you know it is good enough? What is the core? This asks for the development of an even more sophisticated critical judgement of the produced text by the users. From personal experience, this is something quite difficult, even when you have had extensive higher education.

A metaphor to describe the researchers

experience found in the movie Kung Fu Panda (2008) would be:

"Your mind is like this water, my friend. When it is agitated, it becomes difficult to see. But if you allow it to settle, the answer becomes clear."

When you try to find the answers through the endless and instant dynamic interactions with chatGPT, you don't allow for your own mind to settle and it is difficult to see clearly.

As mentioned by Derek Lomas and seen in the workshops and through personal experience. The final 10% you have to do yourself. And the final 10% is the hardest 10%. Therefore it may be a good idea to not let 90% of the work be done by AI as this makes it even more difficult to do the final 10%.

Conclusion

Play-based learning has high potential in educational processes, as supported by existing literature, experts and as can be seen in the workshop results. This learning approach can effectively enhance understanding and use of generative AI in elementary and secondary education. Generative AI can aid in creative processes and inspire students and teachers to develop novel solutions to problems.
The accessibility and ease of use of generative AI can lead to overreliance and loss of authenticity, ownership, and pride. Potential risks in using generative AI, such as the loss of ownership and pride, were revealed in the workshops with the children, whereas through personal exploration and reflection, overreliance and loss of authenticity were found to be risks.

What are the potential challenges and opportunities for implementing generative AI in primary and secondary education?

Challenges

Dependency on big tech and data privacy concerns

One of the potential challenges for implementing generative AI in education is the unclarity and concern about privacy and security risks among students and teachers [CW2, TW1]. These risks may be caused by data collection by large companies and may be extra sensitive as we are dealing with childrens' data. Another risk may be the decreasing independence of schools as they might have to lean on large companies based in other countries for their educational tools (Bulder et al., 2023).

Educational schedule and teacher work pressure

The high work pressure of teachers in primary and secondary education is another risk, providing little time for professional development [PDT, TWs, EXPL]. Something to consider for future workshops about high impact technology is the timing and the rhythm of a school. The final workshops of this thesis fell in the same period as the central examinations which are already demanding a lot of the teachers [TWs]. Planning in professional development programs or novel learning programs is advised to be done at the start of the year [EXPL].

Shift in educational objectives and need for professional development

To integrate generative AI in education teachers mention the need for clear guidelines and effective supervision, and that it may prompt a shift in educational objectives [TWs]. The high participation of high school teachers and the unexpected participation of higher education teachers, might suggest that the need for teacher development is highest in higher education and high schools [TWs].

Formulating policies for generative AI in education

Another challenge mentioned by the teachers is for schools on how to develop clear policies on generative AI in such a way that critical thinking and learning skills are developed and academic integrity is ensured. The impact of teaching children about AI text generation, which is often seen as something you cannot avoid, directly impacts other courses where students might use the technology to aid in their work [TWs].

Pedagogical challenges

The Implementation of generative AI may require significant training and knowledge development among educators [TWs]. Teachers are concerned about promoting laziness and reliance on AI for academic tasks [TWs]. The risk of plagiarism and misuse is mentioned as well [TWs]. There may be resistance from school administration/bureaucracy [TWs].

Need for responsible AI integration

In order to integrate generative AI in education, the participating teachers see a necessity to educate students on the critical evaluation of AI-generated information. They also see a need for aligning usage of AI with existing educational goals and learning outcomes. And finally, the need to ensure the technology is used in a way that supports the learning process and not just to achieve end results [TWs].

Need for clarity and focus in offer

The versatility and universal applicability of generative AI make it difficult to provide a clear offer. There simply seems to be too much to offer. One issue experienced during the research was that it was unclear for some teachers what the value would be for them or for the students in following a play-based workshop on generative AI in education. Observing the teachers' reactions to the offer showed how teachers in high school or higher education may have the perception that play-based learning must be for younger students and may not be for teachers or older students [EXPL]. Marketing wise it may therefore be better to put less focus on the play-based learning part and a higher focus on the professional development part.

Opportunities

AI assistance in teaching

The participating teachers also see opportunities for using generative AI in education. For example, in the use of generative AI to spur creative idea generation in brainstorming sessions [TWs]. Or to get inspiration for lesson preparations and creating diverse lesson plans [TWs]. They also see how it might assist in generating material for different subjects, including art tasks and knowledge-based content [TWs]. They see an opportunity for assisting in creating exam questions, to make educational content or promo text for websites [TWs]. They are also highly interested in the possibility to chat with their pdf through generative AI [TWs].

Some see opportunities for using it as an educational tool for their students, for example in order to develop critical thinking skills by having students critically evaluate AI generated responses [TWs]. Or to use as a supplementary educational tool, providing different perspectives and ways to approach a lesson [TWs]. And finally they see it as a potential tool for teaching digital literacy, showcasing the potential and limits of AI [TWs].

Other opportunities lie in one-on-one tutoring given by generative AI in project based learning [EXPL], allowing children to have their personal teacher and every teacher to have a teaching assistant (KhanMigo Education AI Guide | Khan Academy, 2023). Generative AI also allows for augmentation of existing teaching material and enhancing student motivation and engagement by making material more relevant to the students [CW1, CW2, TWs, EXPL], and in such a way that students may end up with higher quality results.

Fear reduction

Through improved AI literacy both students and teachers may have improved abilities and knowledge to be able to navigate our increasingly AI-driven world. Part of this AI-driven world is that some may experience fear for AI. I believe this may be mostly due to negative media encounters and a lack of understanding or experience. The workshops show that there is a need for reduction of fear and increased understanding for both children and teachers [EXPL, TW1]. Through the positive play-based approach these fears may be overcome (see quote next page).

"Yes, I do see possibilities instead of mountains! I initially found it to be a somewhat unsettling development, but I now see how it can also be very positive. It will bring about a change in education, I think. We will have to focus more and more on the process and less on results. (does fit into our school vision!)" Reply by a workshop participant in the post-workshop questionnaire to the question: Have your views on using generative AI in education changed after attending the workshop? If so, how?

Conclusion

Integrating generative AI in education, from a teacher's perspective, may lower their workload in some aspects and may enhance lesson preparation, student engagement, contemporary critical thinking skills and digital literacy. On the other hand, teachers recognize potential challenges of using generative AI, such as privacy concerns, the need for teacher training, potential misuse, and challenges of alignment with educational goals. Teachers also recognize how the integration of generative AI into education requires clear policies and careful usage to enhance learning rather than focusing solely on end results. It may be better, from a marketing perspective, to formulate the offer using different words when offering workshops to teachers and high school students. When offering the workshops to teachers a focus on professional development may be preferable over a focus on play-based learning.

DISCUSSION

Design principles

Several design principles can be derived from the research in this project. These design principles come from learnings in the different knowledge elements of the theoretical framework and additional learnings which may guide the development of a business model for positive implementation of generative AI in education. The design principles are a mixture of insights from research and personal vision of the researcher.

Prioritise contemporary skills

In order for children to thrive in an AI-driven world and for teachers to keep up with the incredible speed of developments I believe it is increasingly important to develop and enhance contemporary skills. In the theoretical framework creativity and AI literacy were already mentioned, however this should be expanded with contemporary critical thinking skills.

User-centred AI experience

The design should be tailored to its users. By increasing the relevance of the material the learning experience can become meaningful. I believe this may

be extrapolated towards other learning materials which could be tailored better to the students. In the case of generative AI, tailoring its learning experience can be done because of the adaptability and versatility of the material itself. For implementation of future models this relevance or meaningfulness could be achieved through tailoring the learning experience to its users, or even better, by letting the users tailor the learning experience to their own interests.

Stimulate active engagement

The aim is to integrate learning by doing through play-based learning and therefore stimulating active engagement. Offering the possibility for exploration and hands-on experience in workshops is one way of doing this. Stimulating play may be done by providing safety, interesting material and by nudging towards social play and playful exploration. Additionally, this way of learning may be expanded towards other courses or even overarching project based learning. I believe learning can become less formal, more active and engaging if we use generative AI to provide project and play-based learning,

where the process is more important than the result. I think this may provide deeper learning and less stress for students and teachers. Teachers may have to reconsider their role. The role may shift towards a more coaching role. Experiential play-based learning also goes hand-in-hand with other teaching methods such as inquiry based learning.

Promote social interactions

Social play and peer to peer learning have shown to be highly effective and appreciated forms of learning and playing. Both children and educators were highly engaged and learning many things from each other. The social part of learning generative AI has an additional benefit that it seems to naturally produce ethical discussions between its learners.

Ethical and responsible AI use

For both teachers and children the ethical questions arose naturally and seemed to be an essential part of the learning process of learning about generative AI. Parents, teachers and children themselves all seem to question

what generative AI means for them, for the children and society at large. I believe discussing the difficulties and opportunities with peers and stimulating positive and responsible use may be of increasing importance as the developments keep coming at us with high speeds and society is being used as a laboratory.

Continuous feedback and improvement

By incorporating continuous feedback and improvement in the design principles, the development of the design and the rolling out of the business plan can be adapted to the rapidly changing field of AI and can be iteratively improved with regards to its users.

Stimulate autonomy and authenticity

By stimulating autonomy in use and control over AI models, the users may feel safe and in control. This can be extrapolated towards schools which may be increasingly dependent on big tech companies in providing learning material for their students. Allowing schools to

maintain their autonomy by relieving them from dependence on big tech companies may improve their autonomy. Additionally, AI models may be trained on school philosophies and curricula in such a way that the responses of the model are better aligned with the educational goals of the school. Users should be nudged towards making the hybrid human AI products authentic and their own.

Interactive and Engaging AI

I believe we should capitalise on the affordances which AI brings. It brings many opportunities for enhancing learning experiences which we can seize. By using different modalities (sound, visual, text etc), the interaction with the AI can be made interactive and engaging. I believe projects from any subject can be made interactive and engaging with the use of generative AI.

Safeguard Privacy and Security

Privacy, data security and safety of both physical and mental health show up as important values for children, teachers, experts and parents. I believe safety may

be essential for play and learning. By providing safety the chance of learning, in what I believe is our most natural form of learning, namely through play increases.

Encourage Exploration and Curiosity

Maybe the most important principle of all is that exploration and curiosity should be encouraged in the learners. By inspiring the teachers they may become curious and try out the software in their own teaching practice, by enticing the curiosity of children they may start to ask the right questions and start to develop a positive critical stance towards generative AI. If we could stimulate curiosity not only for generative AI but for other important research areas by making them more engaging and interesting or better tailored to the level and interests of its learners, we may end up with a society full of individuals with contemporary skills and an endless thirst to know more. We may be able to pave the way for the Einsteins of our generation solving the problems of tomorrow. As Einstein described himself: "I don't have any special talents, I'm only passionately curious."

Vision

The transformative potential of generative AI in education is clear. Yet, to realise this potential effectively and positively, we must use the design principles derived from the research in this thesis. Blending research insights and personal vision brings us to a promising approach. One that prioritises authentic human experiences, encourages exploration, and safeguards values like privacy and autonomy. This balance ensures we don't just integrate and use generative AI thoughtlessly but do so in a manner that may be truly enriching for both learners and educators. Therefore, my design vision is:

"I envision a future where generative AI transforms education for the better. A future where learners and educators can explore, create, and connect with each other in new and meaningful ways. A future where privacy, security and authenticity are respected and protected. My vision is to inspire curiosity, creativity, and a positive critical stance through play-based and social learning of and with generative AI."

CONCLUSION

6. CONCLUSION - INTEGRATION IN DESIGN

The design

Having articulated a future vision for generative AI in education, it's essential to consider how this vision translates into actionable steps and practical solutions. The vision sets the direction, but the implementation necessitates concrete planning and development. In this context, we introduce our conceptual company with the brand name PLAI. The company aims to have a significant impact on education and steer towards a positive implementation of generative AI in education.

PLAI's offer is twofold.

First, PLAI's play-based learning workshops. These workshops are the core of the short term positive impact we aim to make and they represent the concrete steps we're taking to integrate generative AI into education, ensuring that the principles we've discussed are actively reflected in our approach.

Second, PLAI's future business plans contain the offer of a locally running multimodal generative AI model which schools can align with their own curriculum. This will be discussed in the future recommendations as this has not been evaluated.

To support the workshops two platforms have been developed. One for marketing purposes, the other for easy access to generative in the workshops.

In the subsequent chapter, we'll delve into the specifics of these workshops and the business plan, shedding light on how they align with our broader objectives and the benefits they bring to learners and educators alike.

In the future PLAI could become a product service system provider offering AI products and professional development and teaching resources to educational stakeholders.

Figure 30: A product-service system bridging AI and educational resources to create an interactive, play-based learning environment.

The Platform

Play-based learning workshops are provided on generative AI, under the brand PLAI, to young students and teachers. These workshops leverage the experiential learning potential of play to stimulate exploration of the software [CWs, TWs]. Humour is utilised to design for a playful experience and promote engagement and creativity [CRE, (Legaard, 2020)]. The workshops strive to foster a secure environment for playing, learning, and expressing creativity [PLE, CRE, DISOE]. There is a strong focus on promoting social interaction, enabling participants to learn from one another [PDT, PLE, DISOE]. Guided play and scaffolded learning are employed to boost the efficacy of the playful approach [PDT, (Hirsh-Pasek et al., 2015)]. The workshops also serve as a platform for peer learning through discussions and pairing participants [PDT, CWs, TWs] The goal is to instil a positive and critical outlook on AI-generated content and provide hands-on experience to participants [TWs, CWs]. Both children and teachers have the opportunity to improve their literacy, curiosity, and intuition about generative AI, supporting them to further explore the subject on their own [CWs, TWs, EXPL].

The Workshop design

Guided play and scaffolded learning techniques are employed throughout the workshop to facilitate experiential learning, allowing participants to explore and discover the capabilities of the software at their own level of expertise and guided towards a learning objective.

The workshop set-up is almost exactly the same for teachers as it is for children. This allows both participant groups to discover the software on their own terms and at their own pace.

WORKSHOP ROUND 1: EXPLORATION

The purpose of this round is to introduce participants to the concept of generative AI and provide them with hands-on experience in a playful, explorative and collaborative setting. By stimulating the participants to work in pairs, participants engage in collaboration, peer learning, and social interaction, which may enhance the workshop experience. This round also utilises a form of material play, as generative AI is in itself interesting and versatile material and applicable to any interest or background.

The learning objectives of this round are to familiarise participants with the very basic ways of using the software,

Main elements of play-based learning experience

Scaffolded learning

Guided play

Social play and learning
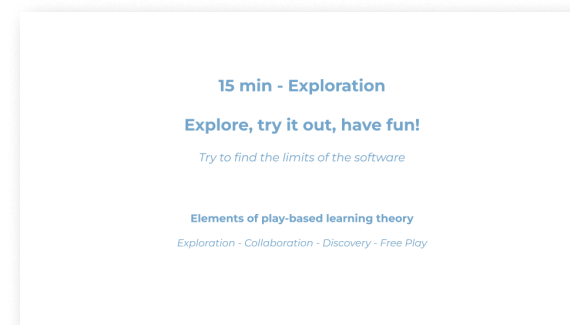
Positivity, humour creative expression

15 min - Exploration

Explore, try it out, have fun!

Try to find the limits of the software

Elements of play-based learning theory

Exploration - Collaboration - Discovery - Free Play

Figure 31: Exploration assignment

Iterate

A dog swimming in the ocean

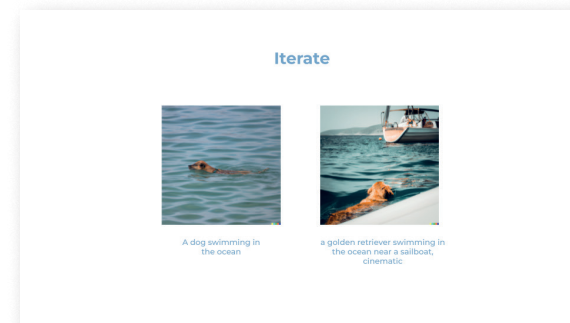a golden retriever swimming in the ocean near a sailboat, cinematic

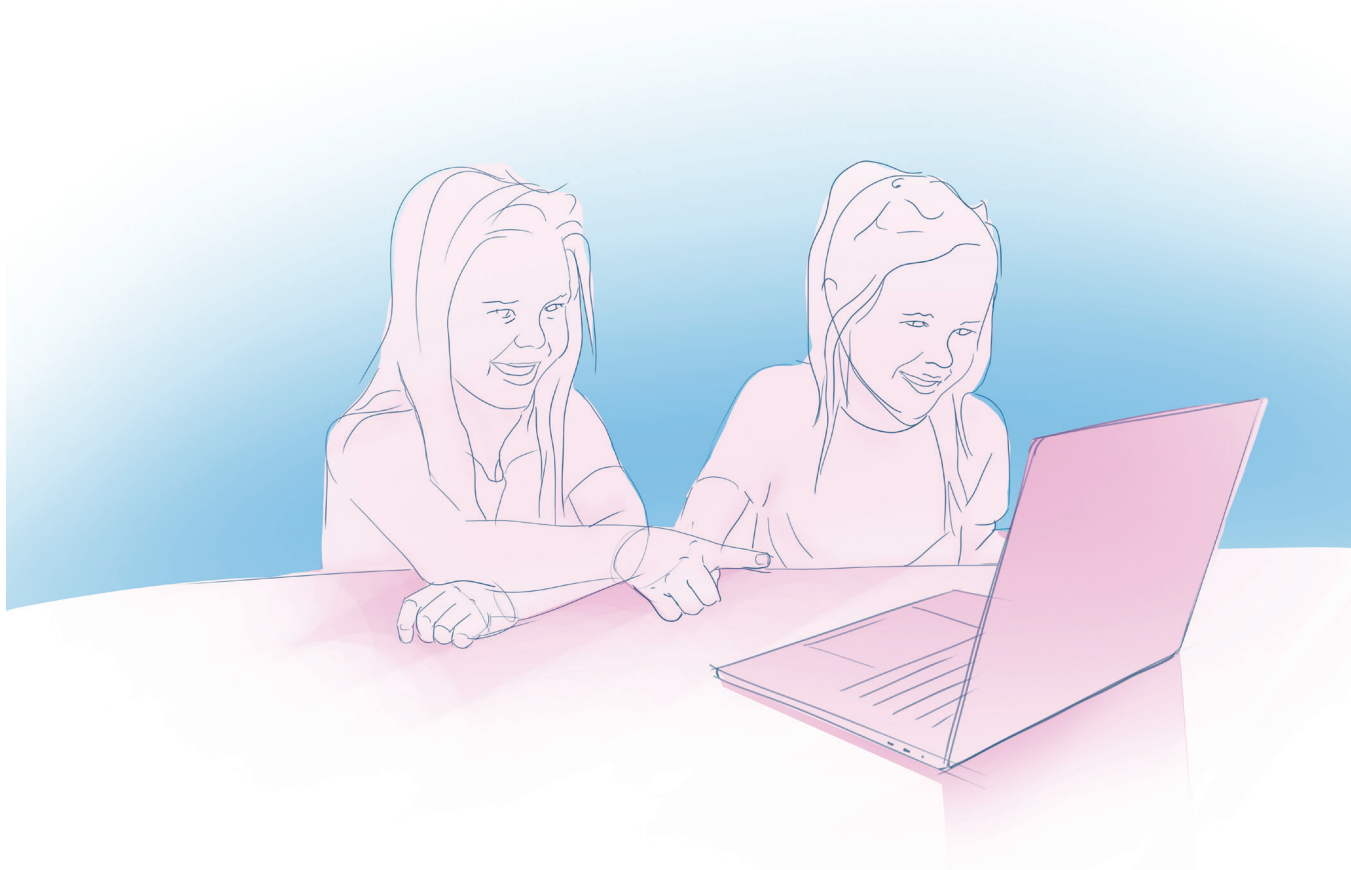*Figure 32: Explanation to use iteration to get better results*

Figure 33: Children in a social play-based learning setup with generative AI

allowing them to navigate the website. The first round also serves to let participants experience the first interaction with generative AI without giving them examples through personal thoughts, ideas and exploration. By letting the participants try the software themselves you allow them to think about what they want to say or try and they will be able to discover the software on their own terms.

WORKSHOP ROUND 2: FUNCTIONAL PLAY

Building on the foundation established in the first round, this round aims to deepen participants' understanding and skills in using generative AI effectively. By continuing to work in pairs, participants maintain the collaborative learning environment. Tips and tricks are provided to guide participants in maximising their effectiveness in use of the software. Participants are encouraged to improve their previous results. The learning objective for this round is to develop participants' proficiency in using generative AI in such a way that it is aligned with participants' own thoughts and ideas and they show them ways of using the software which they may not have discovered just by playing exploratively.

WORKSHOP ROUND 3: INTEGRATION AND VARIATION

The third round aims to challenge the participants somewhat. By introducing a competitive element, an element of challenge is added and peer learning and social play are further stimulated.

Child participants are challenged to create a specific design, such as a house or toy, fostering goal-oriented play. For teachers, the goal is to develop play-based teaching materials for a lesson in their area of expertise.

The area where play and creativity overlap is stimulated in this round using elements of humour, challenge and creative expression which are all seen in both playful and creative behaviour.

The learning objective is to deepen participants' comprehension of generative AI, its applications, risks, and opportunities. They are encouraged to leverage generative AI for creativity, inspiration, and entertainment while understanding what it means for them, for education and for society as a whole.

WORKSHOP ROUND 4: DISCUSSION AND EXTRA INFO

The final round facilitates a plenary discussion, allowing participants to share their insights, ask questions, and engage in ethical discussions. Additional information is provided to showcase the breadth of the field and diverse applications of generative AI. The learning objective of this round is to comprehend the use, context, different forms, applications, risks, and opportunities of generative AI. The goal is to have instilled a positive critical stance towards the technology in the participants. They should know that anything which can be digitised can also be made by AI in an indistinguishable way from a human product. But they should also know what the opportunities are for enhancing the teaching and learning experience. With the extended knowledge about generative AI both teachers and children are now better equipped to have a discussion about what the technology means for them. Participants are encouraged to leverage generative AI for creativity, inspiration, and entertainment, fostering curiosity for further exploration in their own time. The round also serves as a form of diversifying the learning catering to different learning styles. This round also allows for continuous improvement through gathering feedback.

15 min - Variation and integration

Try to develop play-based teaching materials for a lesson in your own expertise

Use the accompanying document as inspiration

Bonus points for a visual presentation

Elements of play-based learning theory

Competition - humour - challenge - creative expression

Figure 35: variation and integration assignment
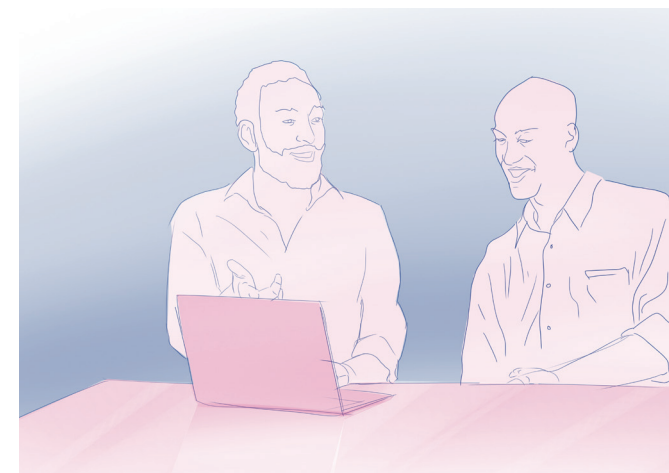

Figure 34: Teachers in a social play-based learning setup of generative AI

The Platform

The platform actually exists out of two websites. In a future iteration these two platforms would be integrated into one.

The first is a secure, user-friendly website that serves several functions:

A landing page, for lead generation and marketing purposes.

A place to find details and information about the product service system.

A booking system that allows participants to sign up for workshops.

The second is made for simplified access to generative AI tools and diminishing privacy concerns.

This proof of concept website is made as a playground for generative AI technologies which allows users to experiment with text and image generation without having to sign up or leave their phone number at a big tech company.
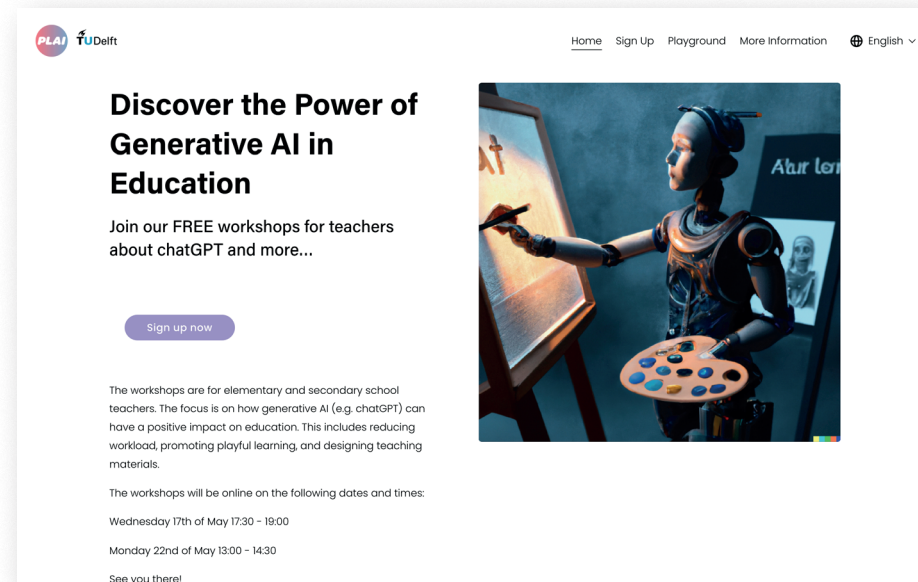

Figure 36: Screenshot of titusvisser.com, landing page website for signing up and more information.
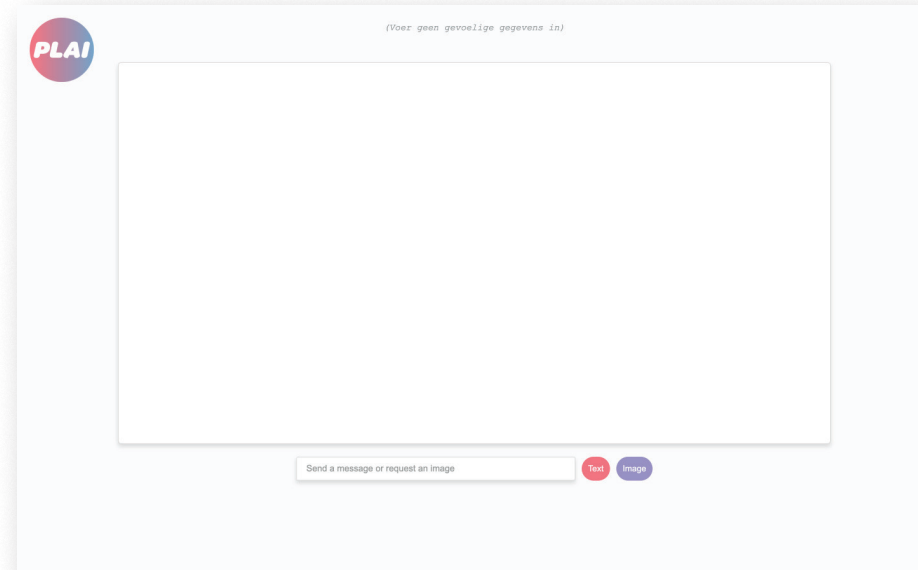

Figure 37: Screenshot of titusvisser.nl, chat based website providing access to text generation (GPT-4) and image generation (Dall-e) via openAI API.

The branding

The name of the brand is an obvious and almost logical combination between play and AI. Giving us the short brand name of plai.

Because the .com website was taken for this name I explored more brand names which might have been suitable for AI and play-based learning.

Finally I found that plai.education was still available and I decided to use my personal domain names as I already owned these.

Figure 39: Earlier iterations of brand names and logos

The choice of colours is not completely out of the blue. The blue colour stands for the known, the technical, the mathematical side of artificial intelligence. Comparable to the blue of the TU Delft and coming from the "blueprint" idea. This is also why the Letters AI have been made blue.

PLAI can also be seen as an acronym for **P**lay and **L**earn with **A**rtificial **I**ntelligence.

The P and the L stand for the human part of the brand. The red colour represents the unpredictability of fire, the unknown, the playful, the complex and the human side of the project.

The gradient is meant to represent the blurring boundaries between man and machine and the symbiotic relationship between play and generative AI which PLAI aims to develop.

The font is loosely based on the font of LEGO. The LEGO foundation is committed to research and develop play-based learning all over the world.

Figure 40: The tree logos currently in use

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EVALUATION & FUTURE RECOMMENDATIONS

7. EVALUATION & FUTURE RECOMMENDATIONS

Evaluation of workshops

What worked well

The design of the final workshops has received considerable positive feedback and participants acknowledge its potential significance in current education. Teachers recognize a clear need for educating teachers and students on generative AI [TWs]. The PLAI workshops demonstrate how play-based learning workshops may be an effective and engaging way to learn about generative AI. This way the workshops may contribute positively to teachers and students' understanding and the implementation of generative AI. Especially the guided play principles in which learners get to explore the interesting material on their own or with peers works really well. Several participants have named the social interaction part where they interact with peers as one of the most impactful things for them in the workshop [TWs]. Another thing which was mentioned was that the focus on the positive possibilities the technology brings was beneficial as it made participants aware that the technology may also bring a lot of good

things. Overall the workshops were received as an enjoyable and inspiring activity and they have inspired children to explore generative AI on their own or with their parents [EXPL] and teachers to use it in their daily work [EXPL, TWs].

What could be improved

The time management in the workshops could be improved. Teachers have busy schedules and some mentioned that they would have loved to join the discussion, but the workshop already took 1,5/ 2 hours and they felt that it also should take longer than that or they had to leave.

Another thing which was mentioned was how the level of difficulty was too low and that the workshop was mainly for beginners. This teacher already had experience. For him the interaction with another teacher who also already had experience was most impactful. However, this was countered with someone saying the level was too high. This teacher missed the start of the workshop. This shows that there is a need for iteration on tailoring the level to the participants and maybe to offer workshops of different levels of expertise.

The workshops attracted around nine participants per workshop. Which may be seen as somewhat low for the popularity and hype surrounding generative AI.

I suspect the main reasons for this were::

1. The perception of play-based learning may be that it is not relevant for everyone in education. Its methods may come over as unserious and its relevance may be unclear for teachers.
2. The offer of the workshops was in the middle of the central exams and the workweeks of teachers are already larger during these weeks. A few hours extra of professional development is better suited somewhere at the start of the academic year. This is also when schools plan such workshops.
3. The offer may have been too broad. Therefore it might not have been clear what the value would be for teachers who participated.

Overall a better focus may help the design of the workshops and the marketing material to be more clear.

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Future business plan

introduction

The speed of developments within the world of generative AI is incredible. As the technology becomes more intuitive by the day and new forms of interacting emerge, the technologies applicability and versatility grows as well. One of the most recent developments is the ability of one AI model to transform between many different modalities including text, image and audio as described in the paper Any-to-Any Generation via Composable Diffusion (Tang et al., 2023). Allowing users to use their preferred modality allows for more freedom in playing and interacting [PWs, TWs]. Additionally for young children it may be preferable to start with a more visual modality as they are still developing their writing and reading literacy [CWs, TWs]. Another development is that it is already possible to run generative models such as stable diffusion (image generation) and Llama (text generation) on your own computer (Das, 2023; Chakrabarty, 2023). Running a generative model locally has several advantages. According to an article on towardsdatascience.com smaller models may offer locally running advantages such as that it can run on any GPU or CPU and that it has full privacy and security advantages as it doesn't need the internet to function (Singer, 2023). Other advantages mentioned in the article are that the models are adaptable, have a low environmental impact, are relatively cheap to deploy and have a high accuracy and explainability. Additionally, if we look at the law of Moore, the computational power is expected to increase significantly (What Is Moore's Law?, 2023). This could make the run time of generative models less and could make the integration of generative models on consumer computers more likely and mainstream. Bringing these developments together makes a future plausible in which schools possess an adaptable multi-modal generative AI model aligned with their curricula and learning goals while at the same time maintaining strict privacy and security. The increased accuracy and explainability may also be an asset as it increases the chance of the model to say what it needs to say (e.g. lesson material from the curriculum conveyed correctly and without hallucination). This brings me to the proposed future business model of conceptual company PLAI.

Proposed business model

PLAI aims to transform education for the better by implementing generative AI-driven, play-based learning into classrooms. PLAI aspires to effectively integrate generative AI within the education sector. Our business model centres around facilitating experiential play-based learning workshops, alongside introducing a locally run, privacy sensitive and multimodal generative AI model for schools; a tool that can flexibly align with any curriculum. The PLAI experience is meant to equip both learners and educators with the tools, knowledge and positive critical outlook needed to enhance the teaching and learning experience with generative AI.

Key Partners

PLAI aims to form strategic alliances with schools and universities as well as potentially develop partnerships with existing ed-tech companies, AI experts, and educational material developers.

Key Activities

Development and regular upgrade of generative AI software; Continuous development of and conducting play-based learning workshops.

Key Resources

There is a need for an investment to be able to start forming a strong core team with whom the development and deployment of the AI model can take place. For a more exact estimation of resources additional research is needed.

Value Propositions

The proposed software should offer a secure, privacy-compliant, and customizable educational generative AI tool. The tool and the workshops should stimulate active, play-based learning and social interactions. The customizability of the tool should allow for the model to be aligned with existing curricula and educational goals. Continuous technical support and updates ensure product relevance and user satisfaction. By making the AI model multi-modal, the interactions with the model may be highly engaging, intuitive, versatile and applicable in diverse learning situations.

Customer Relationships

Proactive customer interaction via training, workshops, and continuous support. An online community for sharing tips, advice, and feedback.

Channels

Direct sales to schools, partnerships with educational institutions, digital marketing, SEO, webinars and educational networking events.

Customer Segments

Educational institutions, specifically primary and secondary schools.

Cost Structure

Ongoing operating expenses for AI software development and maintenance; costs for conducting workshops, training, and customer support; marketing and sales expenses.

Revenue Streams

Recurring revenue from the subscription model for AI software usage. Revenue from conducting training and workshops.

This business model should allow for an engaging, user-centric educational experience for both teachers and students while prioritising privacy and security.

Limitations of study

One limitation of this study includes the lack of research on high school students. This group is one of the groups which has seen a quick adoption rate and in which many questions are still unanswered. Therefore one recommendation would be to expand research on high school students: As mentioned earlier, there is limited research on the interaction between generative AI and high school students. Exploring this area further would provide valuable insights into their perceptions, concerns, and needs when it comes to generative AI in education. However, based on the overlap between the workshops given to children and teachers, my advice would be to give the workshops as proposed in the design and slightly alter the goal-oriented play exercise to make it more relevant to the high school students' lives and during the workshops collect data on how they interact.

This thesis has shed some light on the interaction between child and generative AI, however this interaction was guided by the researcher and posed as a playful interaction. Besides that, the only interaction between children and generative AI was with AI image generation. Whereas the most impactful form of generative AI for education may be in the form of text generation, which was only researched in workshops with teachers. Therefore the first and foremost recommendation would be to dive deeper into the interaction between high school students and text generating AI.

This brings me to another essential question which is still mostly unanswered and which can only be answered slightly through personal experience of the researcher. This is the question of what the effect of generative AI is on the cognitive and emotional well being of the students. This question asks for a more long term monitoring approach and I think also depends on the way generative AI is introduced and used. If we aim for positive implementation I am convinced that we are able to provide students with enough understanding and practical knowledge to be able to capitalise on the affordances of generative AI while we may be able to avoid detrimental effects as much as possible.

8. PERSONAL REFLECTION

I have experienced the project as incredibly difficult. The individuality of the project was nice in the beginning as I had a quite clear vision of what I wanted to do and how I wanted to do it. As the project progressed however, I would have liked to have a partner in crime. Sometimes I was able to discuss my project with peers, which helped, but didn't occur naturally. Looking back, I think that where I would have normally asked a friend or a peer for his or her opinion I might have now asked chatGPT for help. For some applications this was incredibly useful, however I may have overused the program.

At some point my mentors told me to stop using chatGPT and just answer my research questions. This was good advice as it helped me to stick to the core of the project in my report. The problem with generative AI is that it will always give you an immediate answer, but you have to assess the quality and edit it to fit your own thoughts. This may result in working on an editing project instead of working on a writing project. This is also why at some point I ended up with a 130 page report which was too long and understandably also not read.

The endlessness and the promise of a quick fix can be incredibly useful and are tempting if the answers don't come immediately. However it may also be one of the greatest pitfalls of the interaction with generative AI.

Initially, I had a statement at the beginning of the report saying the following:

"Much text has been generated in order to make this report. In effect, you can assume that every text has had some AI influence or has been partly written by AI. Structuring the report, coming up with research questions and interview questions, structuring sentences and transcribing interviews. Everything has had parts where text generation was used."

In the end, this has been less true as I have been writing much more myself for the final report. Only If I felt that my own work didn't get to the core I would ask chatGPT for help in making my work more to the point. An iterative process would then make sure that I ended up with work which resonated with me.

That being said, I do look back at an amazing project. I'm proud of what I have done, the report I wrote, the people I have made happy and inspired with the play-based approach and how I have persisted even when times were difficult.

I have become ever more interested in the subjects I have been studying, they truly resonate with me as a person.

For me learning how to teach, especially in a play-based way is one of the most valuable learnings I have had during this thesis.

I wouldn't be surprised if at some point in my career I would get into the teaching profession.

This project will be a significant pillar for my future career and my experience as a designer.

9. ACKNOWLEDGMENTS

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10. LIST OF RESOURCES

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Figure 1: How I might look like as a graduated engineer, Lensa app (own work)

Figure 2: Iterative human centred approach and theoretical framework. (own work)

Figure 3: Cooperative criteria formulated with children for generative AI, company logo & representation of play-based social learning experience for both teachers and students (own work)

Figure 4: An image visualizing the incorporation of generative AI in education, using various design principles and techniques to depict teachers interacting with AI tools, highlighting benefits and challenges, with a focus on usability and improved student engagement. (Midjourney, prompt: Envision an image that illustrates the project's brief and goal of integrating generative AI into the educational landscape. Draw on Don Norman's clarity and simplicity of design to represent this complex goal visually. Use Alan Cooper's persona technique to depict teachers equipped with new AI tools, engaged in their teaching practice. Lighting should mimic Bill Verplank's illustrations, clear and bright, highlighting the teachers interacting with generative AI tools. The color palette should reflect Bret Victor's dynamic presentations with warm tones signifying positivity and cold hues representing the challenges to overcome. Compose the image using Jakob Nielsen's usability principles, focusing on the main aspects such as the workshops, website, and the interaction between teachers and the AI tools with a 50mm lens. Use Dan Saffer's illustrative approach to depict how the new teaching practices improve student engagement and assignment quality.)

APPENDICES

11. APPENDIX A: EXPERT INTERVIEW ANALYSES

Expert interview: Parent

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The influence of artificial intelligence (AI) in children's lives is increasingly prevalent, notably shaping their experiences on platforms like TikTok and Instagram through tailored content. As noted in the interview by the parent, there's a significant and increasing intertwining of personal and educational use of digital tools, with children increasingly required to use school-related apps and devices. This intertwining is contributing to an increased screen time and reliance on smartphones and laptops. It also makes it difficult to fully focus on school work as the same devices are used for social interactions with friends and classmates as for doing schoolwork.

The parent also mentions how she recognizes that children already receive digital media literacy education in elementary school. This education addresses both the risks (something you put online will stay there forever) and benefits of digital technology (ease

"Well, I think artificial intelligence is already present in their lives without us all knowing it. But yes, look, they are obviously, to my regret, on TikTok. Did you have a whole conversation about that? And Instagram and stuff, yeah. There's huge use of artificial intelligence there, of course. Those apps have insight into their preferences and collect data."

Excerpt from interview parent

of use). Digital education in itself is not seen as a valid goal to pursuit. According to the parent there was a time when schools were promoting themselves as being iPad schools, however these school are all bankrupt now.

The parent does recognize the importance for children to be digitally literate, that they should understand both the benefits and potential risks of digital technology.

She also noted the importance of teaching children about the concept of AI, its use in everyday apps, and the reality of data harvesting by large tech companies.

The parent highlighted the need for their child to understand the importance of checking the source of online information, the significance of safeguarding their privacy, and the skills to discern between real and fake information online.

Despite the push for digital education coming from schools, this parent underscored the value of traditional learning methods, which can offer cognitive advantages. They expressed concern about an over-reliance on digital platforms for learning, which might prioritize reflex memory over a deeper understanding of material.

Finally, the parent voiced concern over the potential limitations of digital

play in fostering creativity, autonomy, and personal agency, citing a lack of control and influence over AI's impact on personal experiences. The parent mentioned that due to predefined interactions with AI systems it might be impossible to have a healthy relationship AI. "You are using the end product and are already dealing with it without knowing exactly how that AI influences you or how it is built."

Conclusion

In conclusion, the need for education on generative AI is most evident in the necessity for children to develop a comprehensive understanding of the digital environment they interact with daily. With AI becoming a significant influence on children's lives and shaping their experiences on social media platforms, it's essential for them to be aware of the principles and potential consequences of AI systems. This includes understanding how their data is used, the impact on their privacy, and the ability to discern between real and fake information. Furthermore, learning about AI can foster critical thinking and promote a more mindful use of technology, which could contribute to a healthier relationship with the digital world.

"I would like them to learn about the idea behind artificial intelligence and how to use it without perhaps realizing it. We are often impressed by hip tech companies like Google, but they have gained a lot of power. I think it's good to teach kids about this."

"I have the idea, but it is more of a feeling, that a healthy relationship with artificial intelligence is actually not possible. Because others determine for you what your relationship with artificial intelligence is... Well, if you, for example, use an app or a smart washing machine, and there's already AI in it. You are dealing with the end product and are already involved with it without precisely knowing how that AI influences you or how it was built."

Excerpt from interview parent

Expert interview: Play expert

"Playing is something you always recognize and that makes you happy."
Excerpt from interview play expert

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In this interview, we explore play as an essential, multifaceted activity integral to children's development, going beyond mere entertainment. It underscores the varied forms of play, the delicate balance between digital and analog play, and its role in fostering critical skills. Furthermore, it emphasizes play-based education's relevance in nurturing future innovators in the realm of artificial intelligence.

The concept of play, as defined by Lesscher, based on Huizinga (1935) and Burghardt (2010), includes elements of spontaneity, enjoyment, distinctiveness, and iteration. It is seen as a non-stressful activity that is not purely functional but provides a plethora of benefits for children's development.

Some parents might see play as an aimless activity, however play is integral to a child's development in various domains. It serves as practice for adult life and enables children to explore their physical capabilities. Moreover, it fosters creativity, problem-solving skills, social skills, and emotional intelligence. Additionally, play can act as a coping mechanism.

Risky play, a subset of play, promotes autonomy and teaches children to handle risks and unexpected situations, thereby lowering the likelihood of injury. Playing together further enhances children's social and emotional recognition, nurturing an understanding of societal rules and fostering mutual consideration.
While play can be augmented using interesting materials, an excessive focus can hinder the dynamics of collaborative play. Using encouragement and suggestions can mitigate this effect and stimulate interactive play.

Barriers to play are either physical (infrastructure focused on cars), societal (busy lives), or contextual barriers (unsafe setting).

According to Lesscher, outdoor play remains highly valued by both children and experts. Digital play is proving to be a (too) strong competition in the form of gaming. While analog play offers rich physical and sensory interactions, digital play provides comparable elements of play and collaboration, with additional opportunities for remote social interaction and inclusive play for children with chronic illnesses.

The research underscores the importance of creating safe and conducive environments for diverse and free play.

Concluding, play fosters a variety of critical physical, cognitive and social skills in children. The apparent aimlessness of play might make it difficult to convince parents or educators as of the effectiveness of play in learning. However fostering creativity, problem-solving, risk-assessment, social interaction, and emotional intelligence is highly important in our rapidly changing society.

The application of play-based education in the AI context can stimulate these skills, empowering children to approach AI not just as passive users, but as active creators and innovators who can harness the technology's potential in novel and meaningful ways. As AI systems, such as generative models, become increasingly central to many aspects of our lives, it is crucial that future generations develop a holistic, hands-on understanding of these systems from a young age.

"Playing together is very important, because by playing with others you also learn to recognize social cues."

"You learn to deal with unexpected situations and indeed choose a good response to them."

"Yes, a safe setting is important for that, so a safe atmosphere. And I also think materials help encourage play. They can be interesting and maybe inspiring materials that encourage children to play with them."

"Materials are fun and can stimulate play, but they can hinder another element of play, namely ensemble play. But playing together can be stimulated by making suggestions"

"Through risky play, children learn to become very aware of what they can and cannot do"

"Giving space, I do think is very important to encourage risky play. That way we encourage risky play and children learn to deal with risk."

Excerpt from interview play expert

"So sometimes things go wrong and differently than you always expect. Maybe you built a really nice tower of a certain color and you're halfway through and you run out of that color. That's a disappointment. How do you deal with that? And again, of course, you learn a lot from that. Hey, you learn to deal with unexpected situations and indeed to choose the right response. And furthermore, it also makes you smart, right? So by trying out different situations and noticing: this works, that doesn't work. Yes, you learn creativity there too, but you also learn problem solving. All those pieces that make that play and those also make that play so important.""

Excerpt from interview play expert

Expert interview: Digital society expert

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"We should be teaching digital competence from as young as we can and scale it. Just like with maths where you learn basic skills and then you get more levels, right? Similarly, can I teach deep thinking of AI to a 10 year or a 7 year old? No, probably can't get them to program an algorithm yet, but we can already begin with getting them to ask the right questions"

Excerpt from interview digital society expert

In this interview with Jessica Piotrowski, professor of digital society, children's engagement with digital technology is critically reevaluated. She highlights the importance of digital competence, and argues for developing quality digital content for children. The interview also explores play and creativity in the digital society and the fusion of digital and traditional play.

The current perspective on children's interaction with digital technology, often reduced to simplistic discussions of "screen time", is obsolete and insufficient. The complex digital society demands a more nuanced understanding of digital competence, and the 'Goldilocks effect' serves as a useful paradigm - finding a balance where there is neither too much nor too little exposure to technology.

Digital competence is no longer optional. It's a crucial skillset that involves media literacy, understanding of privacy and security, creative problem-solving, and an awareness of AI and green technology. However, current approaches to teaching these skills are deficient, and there's a striking lack in development of AI literacy across all of society.

To evaluate the current status of digital competence a new evaluation tool, the DigIQ scale, was designed and used by Piotrowski and colleagues to gauge digital confidence across various domains. Her research shows that while young people exhibit strengths in digital creativity, they score low on AI literacy.

According to Piotrowski it is imperative to start building digital competence at an early age, scaffolding up to more advanced skills as children grow. This learning should be integrated into school curricula and as children see their learnings echoed by parents, caregivers, and other stakeholders this allows the development of a digitally competent generation. What is appropriate for young people can be assessed using the dutch Kijkwijzer as a guideline to understand what is suitable for which age. Really young children might not be able to understand complex algorithms or the inner working of machine learning models, but we might be able to get them to ask the right questions.

On of the problems in the digital world is that there are no good "stopping cues". Having these is vital to combat the endless scrolling and fear of missing out. Together with promoting quality digital content, stopping cues could help create a balanced digital diet, which is critical for children's well-being.

So what is quality content? One way of assesing quality content for children can be found in Kathy Hirsh-Pasek's research. She argues that the quality of learning applications for children should be gauged using the parameters activeness, engagement, meaningfulness, and how much social interaction is involved. When these parameters or as Hirsch-

Pasek calls it "Pillars of education" have a high score, an educational application can already be assessed as being playful. However, what we are looking for is deeper learning. This can be fostered if all four pilars score high and a clear learning objective is present. When deep learning is obtained a child is working and learning, but it is a playful experience.

Harnessing the power of digital creativity, as made possible by platforms like Minecraft, can spark children's imaginations and cultivate a variety of crucial skills. This is particularly true when digital play is combined with traditional offline activities. Just as children at the Cinekid festival utilized a 3D printer to create tangible playthings from their digital designs, youngsters can learn through observing and participating in such innovative digital creativity. These technologies have the capacity to significantly enrich their experiences, making their interactions more immersive and interactive. Striking the right balance between the virtual and the tangible can augment these experiences, making them more engaging, all-encompassing, and mentally stimulating.

Digital platforms, like YouTube, play a pivotal and influential role in shaping children's experiences and perceptions. Understanding this profound influence,

such platforms should take it upon themselves to integrate cues prompting users to participate in real-world activities, as demonstrated by YouTube's 'Hit Pause' campaign. Concurrently, they must offer a diverse array of engagements, akin to the different modes of play in Minecraft, that align with children's fundamental needs for entertainment, education, information, and time-passing. This approach calls for an understanding of children's unique skills and requirements, which can be effectively taken into account by using strategies like user-centric design and rigorous play-testing. This is reminiscent of Sago Sago Entertainment's emphasis on play testing and taking users' varied needs into account when creating apps. Such strategies ensure that digital interactions are not just captivating but also developmentally enriching, thereby contributing to a more balanced digital ecosystem for children.

Finally, the digital world can enhance the traditional notion of play. Minecraft exemplifies this by accommodating various player preferences, and the principles of user-centered design can help refine digital media for children. Frequent play testing with the target audience will ensure the products meet children's needs and expectations, leading to an inclusive, enriching digital world.

To conclude, education about AI and generative AI is essential in that it fosters AI literacy in children - a competency that is fast becoming a necessity in the digital age. Interactive, play-based learning in this complex field encourages curiosity, exploration, and creativity, empowering children to not just consume AI-based digital content, but also to comprehend and create it. Such an approach demystifies AI, making it accessible and engaging for young learners, and prepares them for an increasingly AI-integrated future.

"And if when we do this and they get to play and have fun, that we also teach them about the importance of labelling, this is, I'm not sure, fake is the right word, but generated, whatever the word is for that young people would use it can also then help them recognize that there could be other images out there too. And if you recognize that you become a more critical thinker, and then the question is, can we then build it in such a way that? They can begin checking. Is this image real or is it AI"

Excerpt from interview digital society expert

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Expert interview: Creativity expert

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"looking for something, but coming back with something completely different. You know the walk, where you walk through the forest and actually walk the same route, but see something different. I think that's inspiration"
Excerpt from interview creativity expert

Creativity, as per the expert's perspective, is a process-oriented ability to devise new, useful solutions to problems. It is believed to thrive on external influences and the idea that all ideas are remixes of existing ones. Strategies for stimulating creativity include ensuring consistent exposure to various forms of arts and information, engaging in metaphoric thinking, practicing displacement of concepts, diversifying methodologies used, and understanding the past to predict and shape the future. A creative environment can either be rich with stimuli or feature slow, meditative visuals. Key barriers to creativity include cultural restrictions, lack of safe spaces for expression, minimal stimulus or information, and certain educational impositions like singular aesthetic styles or stringent requirements.

Regarding the interplay of play and creativity in learning and their application to generative AI, the expert suggests that AI, represented by tools like DALL-E, can be a useful component of the creative process. Utilizing AI in the early stages of ideation and sketching can enhance the creative output. However, the expert warns against over-reliance on these tools, emphasizing the irreplaceable value of original, human-led creativity.

The relevance of play and creativity in learning about generative AI is underscored by the expert's use of AI image generation as an educational tool. It serves to challenge students and deepen their understanding of these technologies and their creative applications.

In terms of the evolution of theories and models of play and creativity, the expert criticizes the overuse of certain methodologies, like the double diamond approach, in fostering creativity, implying that evolution in these theories is beneficial. They regard AI and image generation as the next step in the evolution of creative tools, comparing them to previous tools like desktop publishing and Kai's Power Tools.

AI image generation interacts with creativity by offering a new method for creative product development. It aids in the creative process by providing a multitude of options and ideas. However, pitfalls include potential over-dependence on AI tools, risking the loss of human-led creativity, and dependency on 'big players' in the tech industry for AI technology.

The concept of creativity adapts in the context of AI by emphasizing the role of the creator, thus elevating the status of professions like writing and image-making. Challenges include the derivative nature of AI-generated images, potential devaluation of human creativity, and reliance on large corporations for technology. Future implications include a potential increase in collaborations between humans and AI, with AI potentially becoming a stakeholder in the creative process.

"Well, I mean, it's also kind of a recursive thing, when you're happy you're more creative, but also when you're more creative, there's more to laugh about. I mean it has a happy association."

Excerpt from interview creativity expert

The expert's insights on the relationship between play, creativity, and generative AI center around the idea that AI should be seen as an aid to creativity, not a replacement. They believe that AI tools can enhance the creative process and should be adopted early to gain a temporary advantage. However, they also emphasize the value of maintaining human creativity and ownership of ideas.

The expert sees the role of play and creativity in facilitating a deeper understanding of generative AI as integral. They use AI tools in their teaching process to foster interactive learning and highlight the importance of human interaction with AI in shaping creativity.

Common themes from the expert discussion include the importance of maintaining human creativity in the face of AI, the evolving nature of creative tools and methodologies, and the potential and challenges of AI in the creative process. The expert encourages a balance between AI use and human creativity, a diversified approach to creative methodologies, and the exploration of human-AI collaborations for the future.

12. APPENDIX B: PREPARATION DISCUSSION TEACHERS

Main insights discussion teachers

[talking about the deepfake picture of myself]

You're talking about the ethical side of it. The ethical discussion is useful to have with them. It's part of the digital [..] The whole world is talking about the ethical side of this. Even for them to understand that what they see in the media could be completely manipulated. That is really important. Have a discussion about this.

It is nice that they already do block pornography and stuff. It might be suggestive and weird. But it is not going to be like ...

[There are already easily accessible sources where the block is no longer there.]

That's the purpose of it, probably. Is there gonna say make this person ... ugh, it's going to be messy in the future ... these poor kids.

We would really want to link it to the unit. Learning about Ancient civilizations.

Do you think when they come up with the words they could somehow be linked to things that they learn? So looking at those aspects, the geography of the place, the religion of the place or politics, economics.

I was already thinking for the narrative stories if there's said if the setting of their narrative stories in ancient civilization. Then they can generate their characters, they can generate the setting of this course. So when we're hitting on adjectives and everything to describe the characters. They can type it into the generators. Brown eyed, blonde haired, furious, Inca king.

King on top of the pyramid. It would be lovely if we could use that as the background for our course. They can have that image because they can use it for writing. Characters on the setting.

[A graphic novel is one of the ways in which this is really usable. So yeah, definitely.]

So when you ask them maybe to have a Bank of words to create an image. maybe you want to talk about a character in an ancient civilization.
That can be just our teaching too, about story writing. It would be nice for them to practice to get a few ideas. A character in in agency. OK, well then that can be just. Teaching narrative story. Writing. Going to practise get a few ideas or you it's almost could be like the pre thing could be the work that you do and then with the bank they already have their bank, okay this character describe it in detail. But this personality like maybe so character and maybe context. Politics is sitting exactly.

[If you describe a context really well, then it also just pops out]

So that's the thing we could work on building very strong sentences that are descriptive. Which are better story anyways. Yeah, yeah. So then and then they can tell. Like if we just say we could show them examples to like brown dog walking down the streat. Instead we say like scruffy brown dog. Yeah, running or sprinting that you show the difference between which generated. A few words and the very descriptive way of showing.

[Yeah, that's a good one.]

It's a good way to create the setting and the character and that image can also be used in scratch on one of the back [?] Now create the climax of your story.

And like, so whatever the most exciting part of their story is, they have that scene even like.

We can link everything together and it's going to become so visual, yeah. So cool.

Insight: Dall-e works with any language (tried out Spanish, Russian and Dutch)

identify key concepts

It's very interesting to already do some previous knowledge at the beginning.

What do the children already know?

How do we counter bias? Or how do we educate about it?

Miros: Teachable machine is a great way to explain how machine learning works. You need a database and an algorithm which helps to make decisions. I think that it's super important to put it in very simple language for our students, what machine learning is, what algorithms are and how that helps to create content that can be useful or harmful. I think that's it in a nutshell?

I suggest that their first session is just focusing on explaining the concept and playing with the concept of machine learning and the algorithms

Different view:

Ingrid: I think it also very interesting to see what their questions are and not impose our views on them

(Teacher): we could have further discussions in our time as well.

The children will have difficult questions. So be prepared. Otherwise write it down

and answer it the next session

We need to have the logins prepared for the kids

We need them to be in pairs: laptopwise, internetwise and because you can combine a strong one with a weak one and to overcome the language barriers which exist.

Structure the lesson in a way that this person is doing this and the other something else. Like one person is typing in their description, other person has something else to do.

You will also find that the two classes are very different.

also the time of day makes a difference

Anything new I prefer in the morning. It's prime learning time. In the morning they're excited, energetic.

The children take much longer to get settled with the computers, they really do

I suggest that you put the week after. Six weeks is like six months for the children.

Or they could edit someone else's. that's cyberbullying

We can use a bitly it will just shorten the URL. Time is precious right now you need to think of the tools that are going to take less time and give you the most.

The children do not need a break in a 1,5 hour session. If it looks like they're getting tired we can do a brain break in between. Like yoga in your chair.

Maybe use teachable machine as a brain break   wave/ celebrate/ stand vs sit

I have to make 11 accounts at least. 22 would be better though.

For making an account on openAI you have officially have to be 18 years old... to be continued

13. APPENDIX C: EXTENDED EXPLANATION AND ANALYSIS CHILDREN WORKSHOP 1

Preface: AI written intro

Once upon a time, in a world buzzing with technology and curiosity 🌐💡, children were asked about themselves, their views on Artificial Intelligence (AI), play, creativity, and more. The results were enlightening, painting a vibrant picture 🖼️ of the modern child's world.

First, when it came to personal sharing 🗣️, a colourful tapestry of interests and hobbies was unveiled. You would find a child deeply engrossed in a game of Minecraft ⛏️, while another passionately explored the keys of a piano 🎹. In a world where children's identities and personal characteristics are freely shared, one even boldly declared their unique take on gender identity 🌈. Stories about families, and pets 🐶 were told with enthusiasm, interweaved with mentions of cultural backgrounds and father's occupations.

Switching gears, we delved into children's perceptions of AI. Many envisaged it as a tool ⚙️, intertwined with modern technology, computers, and robots 🖥️🤖. Yet, alongside this understanding, gaps in knowledge appeared 🕳️. Some children voiced their confusion or even admitted, "I do not know." 🤔 This signaled a need for more education in AI for our young explorers.

This idea was reaffirmed when we explored children's initial perceptions of AI image generation 🎨. Most found themselves on unfamiliar terrain, associating it vaguely with technology or guessing its functionalities. But those who could give a more precise definition described it as when "you give some AI a description or a picture and it tries to recreate it" 🎬.

Fascinatingly, their inquisitiveness extended to their questions about AI. Some sought a fundamental understanding of AI, asking, "What is AI, really?" 🧐 Others delved into AI's capabilities and limitations, and the mechanisms behind it. Curiosity sparked around the quality, usefulness, and fun aspect of AI. They pondered whether AI could be "as bad as my sister's computer" or if it could make life easier 🖥️💭.

Next, we journeyed into the realm of play and creativity. For these youngsters, play symbolized a source of joy 😂, a social bonding time with friends and family 👨‍👩‍👧, and a fertile ground for learning and creativity 💡. Creativity was viewed as a vessel for artistic expression 🖼️, a pathway to innovative thinking 🧩, and a unique, fun-filled learning experience 🚀.

Their imaginative powers were highlighted when asked about the ideas they would bring to life if they could. They spoke of their own unique universes 🌌, dreamed of technology like teleportation devices and futuristic bikes 🚲, and desired to bring back cherished memories or even loved ones 💓.

The children's curiosity for AI's mechanics, coding, and applications across fields like gaming and digital art was unmistakable 🎮🎨. They also displayed concern about the security of

AI technology 🔒, eager to understand who controls AI and whether there are laws governing its use. A desire to apply AI technology to solve real-world problems, such as climate change, was palpable 🌍💪.

Upon interaction with AI image generation, the initial confusion faded, replaced with amazement and enjoyment 😮😄. While they realized that the AI doesn't always perfectly mirror their imagination, especially with detailed prompts, they were astonished at the broad range of images it could create 🎉.

Looking ahead, they saw vast potential in AI image generation, from inspiring their own art to generating visuals for school presentations. They relished the thought of creating characters or scenes from their dreams or books, driven by the simple joy of experimenting and seeing what different prompts could create 🏰🚀.

They realized that more specific and descriptive prompts like "digital art", "photorealistic", or "cinematic" often led to better, more visually pleasing results. So, with this newfound understanding, they set off to explore the world of AI further, their minds teeming with vivid colors and 3D elements, ready to create, innovate, and learn more 🌈🕹️.

And so, the story of children's journey through the world of AI begins. With their innate curiosity and imagination, the future is an exciting prospect indeed! 🚀🌟

piano monster q	leaning tower of pisa	robot	realistic piano monster with big teeth	pig with a crown
a dog playing chess with a woodpecker that is winning	monster	butt	Minecraft and Fortnite combined	
Pizza	dogs are cool an funny they can ride bikes and do sumersalts and [...]	monster robot pig	Einstein's theory of relativity	dogs are cool an funny they can ride bikes and do sumersalts and [...]
techno blade	AI	a pokemon designe fire type	a kitten having a lightsaber fight with a puppy	
femke and emma are very cool	bottle that eats people and that has a big head and is a dummy	pokemon red bird fire	butt	bottle that eats people and that has a big head and is a dummy
a kitten having a gun fight with a puppy	minecraft netherlands	monkey doing gymnastics	cat mixed with dog	
pokemon style lizard dragon fire	a dog painting the mona lisa	unicorn and mermaid playing cards	cat dog	chickens that have weird textue
a dog painting the doga lisa	El Arish	pokemon minecraft fire dragon	hot dog and a dog	
taco shop in space	a adorable kitten in minecraft	saida hassan	cat doing a handstand	pokemon style blue turtle water
chickens that have wierd legs in a painting eating seads	guinipigs are cool	a pig doing gymnastics	a cat doing a handstand	
Vidushi Sharma	pokemon style cat blue water	majom	guinipigs are cool with sunglasses	nu9yb mo-c

Figure 41: The first 50 generated images and the prompts used to generate the images by the participating children from PYP7A. Per prompt four images were made by the software. However, to limit the amount of images only one has been picked per four generated images. The chronological order is from left to right top to bottom. Because multiple children were using the same account at the same time, the images have not been separated per pair using a computer.

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Co-design workshop 1

This chapter provides an overview of children's perceptions and first engagement with AI (image generation). The insights in this chapter originate from all the material gathered in and before the first of three workshops done with the kids.

Before the workshop the kids were asked to do a small assignment, which was effectively a questionnaire.

During the workshop several questions were asked in two ways. The first was on big papers with post-it notes. The second was in an interview style performed by an assisting researcher.

The first workshop was one and a half hour and consisted roughly out of three parts. The first part was free exploration with as little explanation as possible. The second part was after more explanation of how best to use the generative software. The final part was designed in such a way that the kids needed to try and reach a design goal. Before and during the workshop questions were asked such as "What do you already know about AI image generation?" or "What interesting things did you notice?"

In the first part the explanation given to the children was: "go to this website, and type in something and create an image. Have fun, explore and try to find the limits of the software."

In the second part of the workshop there was some explanation about how to get better results. The main tips were to combine different concepts, use art styles, to iterate on their prompts and that they could make variations of the images they wanted to make.

In the third part the kids were asked to try and visualize their answer to the question: "If you could bring any idea to life, what idea would that be?". If they hadn't thought of such an idea a list of suggestions was shown on the digiboard. examples of suggestions are "Stuffed animal", "car" and "house".

This chapter contains how children see their own creativity and play, what their understanding of AI was before the workshop. How their first engagement with AI image generation was and what we can learn from all that. Key areas of focus include children's basic understanding of AI, their reactions to AI image generation, and how they play and learn with the technology. This chapter offers valuable insights to inform the development of more effective, enjoyable, and educational AI tools for children.

Figure 42: The first moment of interacting with AI image generation

Questions before the workshop

Before the workshops, the children were asked to complete a survey as a baseline measurement.

The aim of this research activity was to explore children's perceptions of self, play, creativity, and Artificial Intelligence (AI), including AI image generation, as well as their creative aspirations. To gather this data, an A4 questionnaire was designed with open space, permitting children to freely express themselves through writing and drawing. The questionnaire was prefaced with a brief introduction of the researcher and an overview of the research aim.

The amount of children participating in the co-design workshops fluctuated somewhat, but 36 children filled out the form.

Figure 43: Example of pre-workshop questionnaire

Interviews and post-it notes insights

During the workshop additional questions were recorded either on post-it notes or shared during class discussions or in interviews. The questions on the sheets of paper answered via post-it notes and the questions in the interviews were the same questions, except if the interviewer decided to ask a follow up question. The interviews were done with the pairs of children sharing a laptop. The idea behind the interviews was to provide a safe space for the children to ventilate their thoughts and to answer questions. Similar to how "achterwerk in de kast" was done back in 80's and 90's. The interviews have showed to provide the research with some of the most rich insights as children seem to be better in formulating their thoughts in a conversation in comparison to writing them down.

Answers to the following questions were collected during the first workshops:

1. What are your first thoughts about AI image generation?
2. What questions do you have?
3. What would you like to learn more about?
4. Can you think of ways to improve your old prompts?
5. Which words give the best results?
6. Can you think of a
      a. creative project
      b. functional use
      c. fun way to use
      AI image generation?

Figure 44:Screenshot from one of the interviews
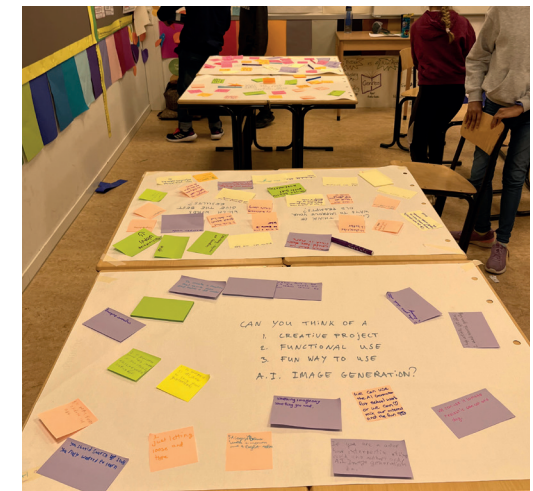
Figure 45: How the posters with post-its looked like just after the workshop

What do children share if they tell something about themselves?

In order to get better insight in the world of children, the participating children were asked to tell something about themselves. Their responses are as varied and colourful as their individual personalities. They readily share their interests and hobbies, a broad spectrum ranging from arts and crafts, computer work, and piano playing, to sports such as skiing, basketball, tennis, and freerunning. A notable number of children display a strong affinity for video games, particularly Minecraft, roblox and fortnite.

Their answers also offer a glimpse into their identity and personal characteristics. They willingly share information such as their age, nationality, and favourite colours. One even shared struggling with their gender identity or lack thereof.

The children talk about their personal life and family. They mention things such as the kind of pet they have or their father's profession. Some also celebrate their cultural backgrounds, which is not surprising in an international school.

The diversity of the children's interests and backgrounds is striking. The array of hobbies extends to include activities such as reading, drawing, coding, and even niche pastimes such as wood carving and origami. Some of these interests allow for creative expression, which was also mentioned as a something the kids enjoy doing. Their backgrounds are equally diverse, children mention coming from countries like Poland, India, Brazil, and South Africa. Many of them are multilingual.

A common thread running through many responses is a strong interest in technology and AI. A number of children mention coding, with specific coding languages like Python or coding with Scratch (an online code learning platform). As mentioned before many children mention video games as something they enjoy.

The specific interest in creative expression, AI, coding and technology might have been due to the format in which the questions were asked. The children were aware that they would work with AI image generation provided by the researcher and many questions on the form were regarding AI.

Images created by the children were chosen to reflect the insights generated by this question. See images to the right.

Music — piano monster q

Sports — cows in hockey skirts playing basketbal drinking smoothies

Videogames — a 3D render of the minecraft ender dragon

More diverse interests — a cute wite cat with glases reading a book

Favorite color — a girl with brown blonde hair and green eyes wearing a purple coat with a ponytail

Age — bird party

Cultural heritage — pani puri with chatni

Family members — Festus age 15 with his brother lilo blonde hair black shirt

Pets — what if my dog was iron man

AI — AI playing a game, digital photo

Technology — books with a flying jet cyberpunk

Coding — a kitten coding with a lightsaber battling darth vader

Figure 46: Images generated by children during the workshops to illustrate the subjects they touch upon when introducing themselves.

What ideas would children bring to life if they could bring any idea to life?

The children's responses to the question "What idea you bring to life if you could bring any idea to life?" reveal a range of desires, aspirations, and influences.

They express a desire to create their own worlds and universes, perhaps as a form of exercising autonomy. Examples of this are the aspirations to create a "personal universe" or an "app where you can design your own world."

Some children show a fascination with technological and futuristic inventions which could be found in science fiction movies. This fascination can be seen in ideas like a "machine to make infinite candy" or a "robot that takes care of your garden every day, even watering,".

The desire for "teleportation" or the comment "if we had superpower." suggest a yearning for abilities that extend beyond real-world limitations.

Other children mention more personal and emotional wishes. Bringing a pet bunny back to life or making sure that "children are not pressurised by scoring good grades"

A desire to bring adventure and fanatasy to life is also present. As seen in responses such as, wanting to create a world full of "fantasy creatures, unicorns, elves, fairies," or to see their "favorite characters in the different places they have been"

Their responses also signal a clear influence of popular media. The references to "Naruto na Netflix," or their wish to merge "Hermoine with Harry," indicate that popular media serve as significant sources of inspiration for their creativity.

In conclusion, the responses shed light on children's multifaceted needs and concerns. These range from a desire for autonomy and a fascination with technology, to having superpowers and a wish to bring fantasy and adventure to life. The children also express emotional needs, such as the desire for stress-free academic expectations. Additionally, the influence of popular media on their ideas is undeniable, showcasing its significant role in shaping their aspirations and worldview.

Superpowers

a baby bunnies drest as a super hero realistic

Whimsical inventions

infinite candy machine

Fantasy and adventure
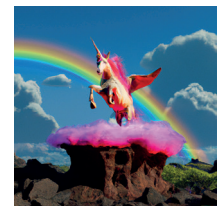
A unicorn jumping over a pit of lava photorealistic

Emotional needs

A photo of children are not pressurised by good grades

Popular media

Hermione mixed with Harry

Autonomy

a world where you can design anything you want

Figure 47: Images generated by children during the workshops picked to illustrate elements of their perception of play

How do children perceive play?

Children perceive the concept of play in a variety of ways, each of them bringing forth a unique, individualistic perspective. At its core, play is synonymous with fun for them - a broad definition that spans from video games such as Fortnite, Nintendo, to board games, mind games, reading and outdoor activities. Playing outside includes activities like soccer, biking, and roller skating. Some children find fun in more uncommon activities like wood carving. The unifying element in all these forms of play is the sheer enjoyment they experience, making play a metaphor for fun. The unforced, voluntary nature of play can be illustrated by the following answer "It's when I have fun and do something because I want to, not because I need to."

Their perspective on play is diverse and personal, varying greatly from child to child. Physical and outdoor activities, such as playing tag or basketball, share a similar importance with more mentally or indoor play activities, such as video games or reading.

An interesting aspect is the role of imagination in play. Many children associate play with dreaming, imaginative scenarios, and being creative. Some answers include "Fun, creative, imaginative" and "Fun, creative." One child vividly describes play as, "Play is imagination! Going out or quietly playing with the things I have in my room I don't need a lot to play sometimes I just play with my imagination!". Engaging in creative activities like drawing, writing, or crafting also forms part of their play. The perceptions of play and the creative activities they mention as play activities show the entanglement of creativity and play from a child's perspective.

For this insight the format in which the questions were asked should also be considered as the format might have primed the children towards thinking about creative forms of play.

Play for children can be both a solitary experience as well as a social experience with friends. Some children relish the experience of playing games with

Fun experience
funny things

Sports
football

Playing outside
Cows skatebording

Video games
AI playing a game, digital photo, cinematic

Creative play
a sketchbook with living drawings

Imagination
Beauty of dreams of Van Gogh and Giraffe, digital art, cinematic

Pet play
A cat standing on two legs wearing a tutu doing ballet

Social play
what if izuku midoria was best friends with naruto

Solitary play
Minecraft and Fortnite combined

Play and learn
a dogge flying a space ship into the school

Figure 48: Images generated by children during the workshops picked to illustrate elements of their perception of play

friends or family. One respondent shares, "Playing nintendo with my little sister. And playing ball with my dog." This underscores the social character of play. At the same time, there are children who find joy in solitary activities, such as playing with Legos, reading, drawing, or wood carving. The mix of solitary and social activities indicate that children can derive as much enjoyment from solo play as they do from social forms play.

Fundamentally, play is perceived as a source of joy, excitement, and happiness. Whether it involves participating in popular video games like Fortnite, Nintendo, Minecraft or valorant, playing with Barbie dolls, roller skating, or engaging with family pets, the common thread uniting all these activities is the joy they bring to the children. Play, as beautifully expressed by one of the children, is "enjoyment and excitement."

However, play is not just about having fun; it's also about learning. The following quotes illustrate the joy some children take in learning new things "Playing is for me to learn about computer and

art" or "I like learning new things. [...]". Play is also perceived as a vehicle to learn by one child "Play is when you have fun and enjoy yourself. You are also learning new things as you play." These quotes show that some children see play as an opportunity to explore and learn about various fields, including math, art, and computers. Even taking part in fun quizzes is viewed as a form of play. These examples show how a learning experience can also be considered a play experience from the perspective of children. This underscores the educational potential of play, demonstrating how children can acquire knowledge and skills while enjoying themselves.

In summary, the concept of play for children embodies a multitude of facets, encompassing enjoyment, creativity, educational potential, and opportunities for social interaction or solitary immersion. The unique and diverse answers given by the children illustrate the broad and dynamic nature of play.

Children's interpretations of creativity can be roughly put into seven categories.

Creativity as an artistic expression
Many children see creativity as a form of expression and art, reflecting the viewpoint of one child who said creativity is "drawing or painting" or another who equates it with the ability to "draw and make something".

Creativity as a pathway to the self
For other children creativity is a way to get in touch with the inner self. For these children, creativity serves as a way to "shut out the world and find calm", or is simply an act of "letting out your inner self".

Creativity as original and divergent thinking
For some, creativity extends beyond artistic expression and is viewed as a beacon of original thinking and innovation. Echoing this perspective, two kids articulates creativity as when you "think outside the box", and "never thinking there's only one answer" and another emphasizes it's about "thinking

of something nobody thought of". This perspective recognizes creativity as the ability to think of something novel.

Creativity to overcome challenges
One child associates creativity with "writing a story, learning something new, doing challenging math" showing how being creative can be used to overcome challenges and how creativity can be part of meaningful learning experiences.

Having the ability to create
Creativity is also perceived as a reflection of your imagination and skills. One child mentions creativity is about "being able to imagine something and try to make it.", Another mentions "A skill to begin to create art or anything that is an idea different from the rest" These children seem to view creativity as the ability to create something or that you need skill in order to be creative.

Functional creativity
The more practical aspects of creativity aren't lost on some children, who see creativity as a tool for problem-solving and innovation. Phrases like "ideas

mostly and also smart solutions" and "making and designing stuff but you have to have plans" suggest that these children recognize creativity as a multi-step process to design something useful.

Creativity is omnipresent
Finally, there are children who perceive creativity as a universal concept, present in everyday experiences. Some examples which illustrate this perception are "creativity is everything for me" or "I think creativity is anything that you think from painting a picture to making a program" or even another who believes "creativity is in everything and everywhere" embody this holistic view.

To conclude, children's conceptions of creativity vary widely, ranging from artistic expression to innovative thinking, learning, problem-solving, and the belief in creativity's omnipresence. These differing views underscore the multifaceted nature of creativity, offering a glimpse into the myriad ways children make sense of this complex concept.

Pathway to the

Inner beast of a human

Artistic

A dog painting the doga lisa

Original and divergent

bottle that eats people and that has a big head and is a dummy

Ability to create

a sketchbook with living drawings crawling out of it

Overcome challenges

Goku fighting with chilly

Functional creativity

a 3D apple

Omnipresent

worlds smallest violin played by kobe bryant near a wet and dry sailboat cinematic

Figure 49: Images generated by children during the workshops picked to illustrate elements of their perception of play

Children's inspiration

The workshop results provide insights in what inspires children when they are being creative. The children seem to have much inspiration based on popular culture, animals and fantasy. But also media traces from gaming can be seen in their prompts. A word cloud based on all the prompts of the first workshops can be found on the next page.

Popular culture
The children often engage through familiar themes from popular culture and digital media. For instance, prompts involving known characters like Pokemon or Marvel superheroes are particularly appealing. Cartoon style and cartoon characters have also served as inspiration.

(Fantastical) animals
Some of the most used words are cat and dog. Many animals have been used more then once in the prompts such as kitten, panda, chicken, chihuahua, cappybara, retriever, axlotl, frog and so on. Their inspiration expanded to fantastical creatures such as unicorns and dragons

Gaming
Many prompts were related to video games such as fortnite, minecraft, roblox and amongus.

Based on the prompts one can really get a sense of what is on children's minds and what they find inspiring. One participating kid even mentioned that it was interesting for her to see what other kids come up with.

"For example kids can see a character. A superhero. And then it becomes part of their play because they get really interesting ideas from it. And so one of the ways that media can support creativity is it can stimulate imagination, right? It can give you a sense of where to go."

From interview with Prof. dr. Jessica Piotrowski (November 2022) talking about media traces in play research by Gotz et al. (2005)

simpsons

A chihuahua with a tutu

fortnite minecraft
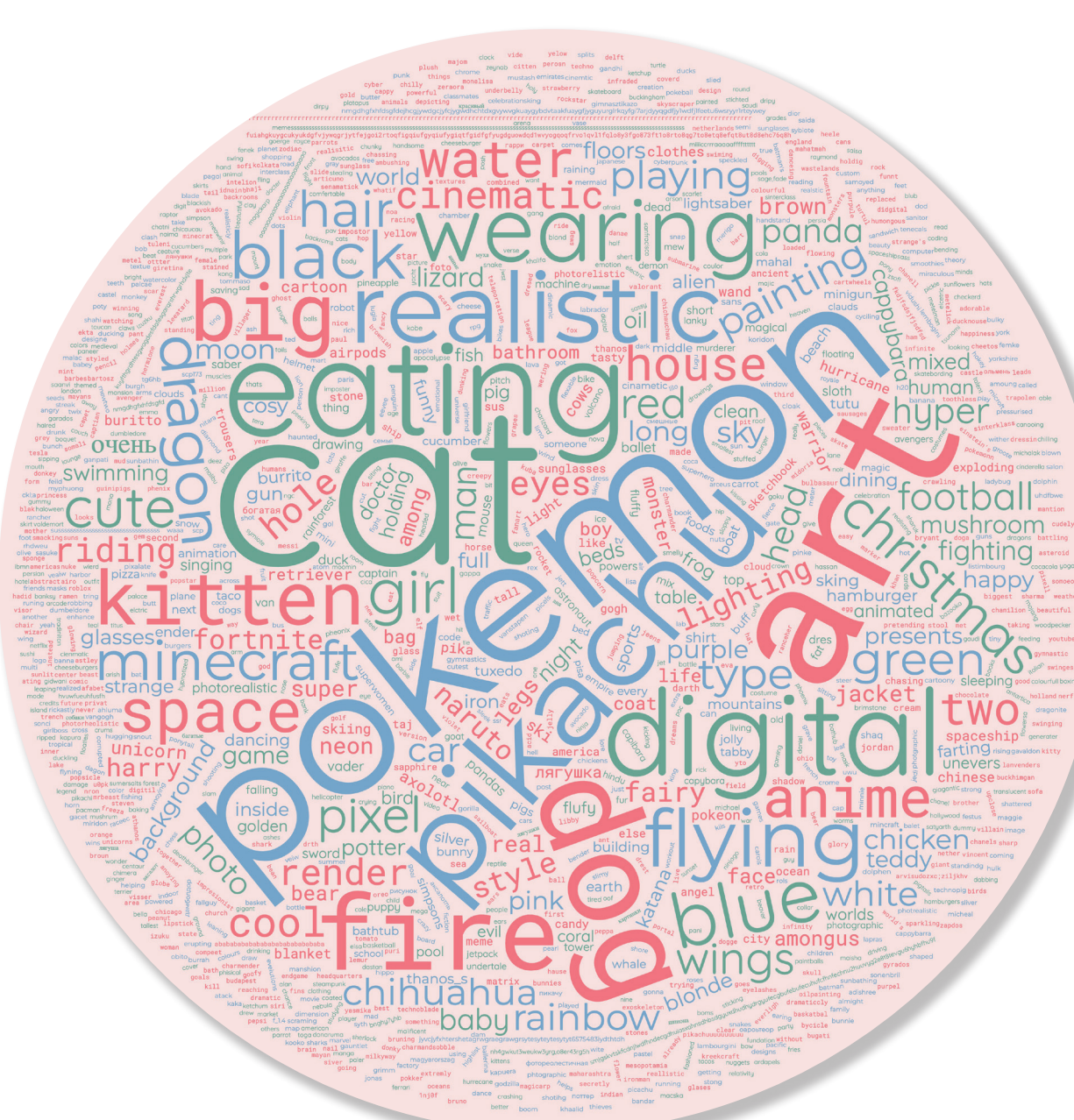
Figure 50: Word cloud based on all the prompts used by the children in the first workshop. Combined prompts of the two separate classrooms.

Figure 51: Word cloud based on all the prompts used by the children in the first classroom.

Figure 52: Word cloud based on all the prompts used by the children in the second classroom.

What is children's current perception of AI?

Robots — robot

Technology — a steampunk machine

Computers — A neon lab full of computers with falling code from the matrix

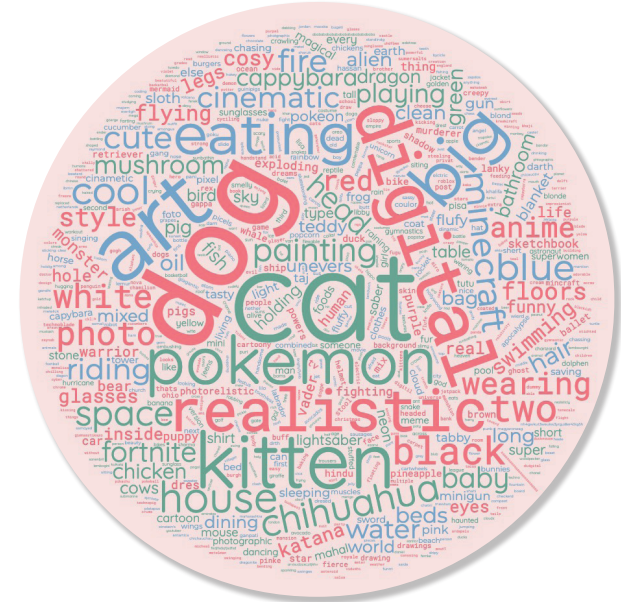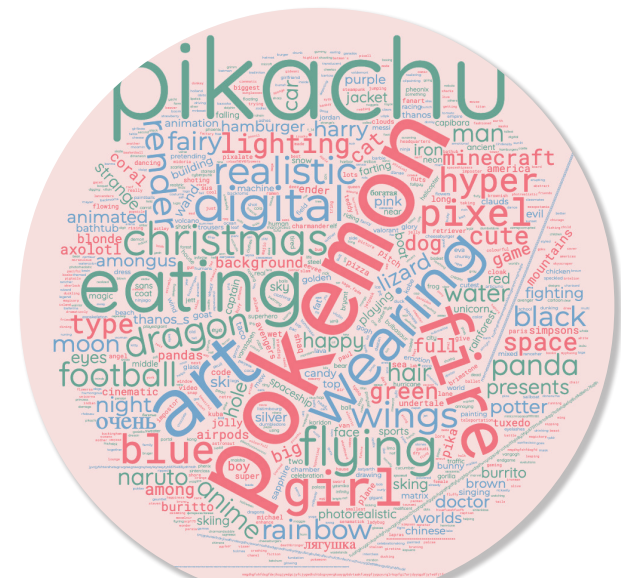**Video games** — an arcade machine that leads into a video game dimension

Familiar — technoblade youtuber pig
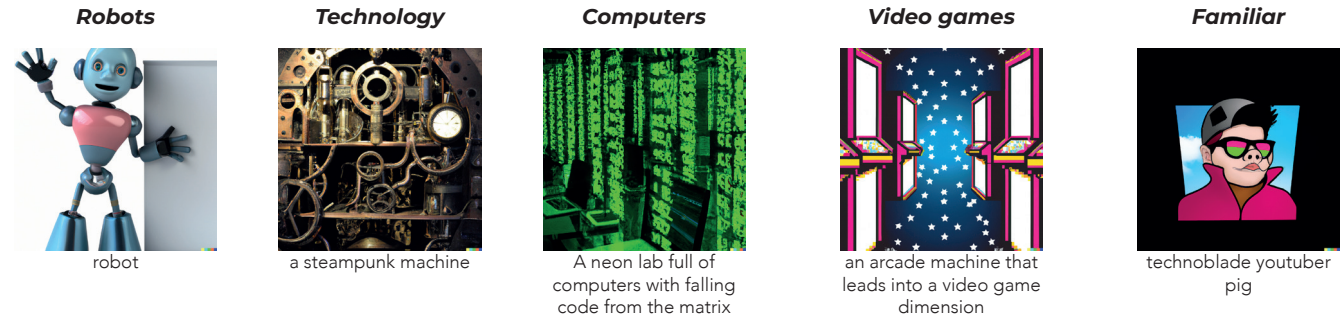
Figure 53: Images generated by children during the workshops to illustrate their perception of AI

The current perception of artificial intelligence (AI) among children is diverse and nuanced. Some of the kids show a basic understanding of what AI is and how it can be of functional utility. They also attribute autonomous capabilities and a degree of ambiguity to AI.

In the core children associate AI with technology and computational devices. The children's responses, such as "Computers, technology, coding" and "Anything to do with modern technology", hint at understanding the connection between AI and the digital realm. Furthermore, the perception that AI is a form of autonomous, independent intelligence comes across in statements like "A computer that is an own self, makes its own decisions, and is completely independent and intelligent", and "Machines that can think for themselves."

Another prevalent perspective is that AI functions as a tool or system, created by humans to assist and simplify tasks. Examples like "An assistant of technology", "Artificial intelligence is an intelligence that is created by humans that can help humans do difficult work easy", and "I think AI is a computer that you can use video games or anything" reflect this understanding. Some children also recognize the need for programming, as shown in "I think AI is when you can program something to do something by itself."

In terms of AI's function, children often refer to familiar technologies like Siri, Google, and video games. Some children even identify specific programming software, such as Scratch, indicating that they have had some educational exposure to the topic: "I think it's a computer that you program to do certain things like, siri, google, we have also used a program in school called scratch."

In contrast many other responses show a complete lack of knowledge about AI. Statements like "I don't know what artificial intelligence means" and "???" show these knowledge gaps, suggesting a potential need for further education on the subject.

Some children's interpretation of AI's potential impact also varies widely, as illustrated by "I am not sure I heard in movies that it is an intelligent digital thing that could kill the world or help it!" This suggests an ambiguity in the perception and the influence of media portrayals on their perception of AI. The quote "I think it is the mind of a robot." Could also point to media influence on the perception of AI as AI is not necessarily always in a robot, it can also be less obvious for example when being used in the background through algorithms on social media.

What are children's perceptions of AI image generation before interacting with it?

Before engaging with AI image generation, children's perceptions varied significantly, often reflecting their limited exposure to this complex concept. Some perceptions showed an image of AI image generation being a humanoid robot. Remarks like "an extremely smart human", "a physical Siri" could point to perceptions of AI (image generation) being a humanoid robot.

Their comprehension of AI image generation specifically was more diverse. Some children demonstrated a rudimentary understanding of the process, describing it as "The AI takes images from the internet and other places, then it mushes them together smoothly and BAM! You've got a picture!" Or describing it as a system that could interpret commands like "a person wearing animal skin in a forest" to create an image. Another child mentioned "you give some AI a description or a picture and it tries to recreate it." This suggests an elementary understanding of AI image generation functionality.

Yet, despite these glimpses of understanding, there was a clear gap in comprehensive knowledge. Phrases like "I don't know but I think it means to make the image", "I don't know. Can you tell us tomorrow?", and the apologetic "I don't know, sorry" were indicative of this knowledge void. Which was not surprising as the technology was so novel when the workshops were given.

A significant number of children had only a vague idea or were completely unfamiliar with AI image generation. Many associated it with technology or software.

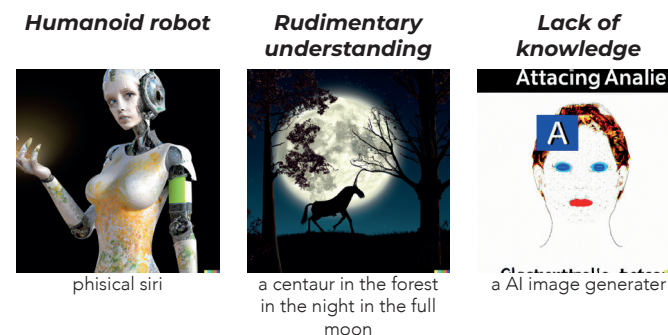| *Humanoid robot*	*Rudimentary understanding*	*Lack of knowledge*
phisical siri	a centaur in the forest in the night in the full moon	a AI image generater

Figure 54: Images generated by children during the workshops picked to illustrate their perception of AI (image generation)

What questions do children have about Artificial Intelligence?

Children pose an array of questions going from very basic questions such as "What is it?" or "How is AI made?", to extremely fascinating questions about Artificial Intelligence (AI), such as "Who owns all the AI in the world?". There were also children with no questions. The mix of questions reflects a spectrum of the cognitive need for increasing their understanding of AI.

One kid questioned the historical perspectives of AI by asking "Who was the first person to make it?". They show an interest in complex ideas such as the coding involved in AI, as seen in questions like "How does AI generate a brain?" or "How coding works in such small micro chips".

Simultaneously, children exhibit curiosity about AI's capabilities and limitations. For instance, they ponder "Can AI do absolutely EVERYTHING!" or "Can it do things a regular human could?". They also express concerns about whether AI can be hacked or broken,

suggesting a basic understanding of the vulnerabilities inherent to digital technology.

Additionally, questions such as "Can AI give real life to non existing beings, for example aliens?" indicate an imaginative thinking process about AI's potential applications.

Another dimension of interest lies in the value AI holds for children. They keenly inquire about the quality and usefulness of AI, asking "Is the AI a quality one or is it as bad as my sister's computer?" They are also interested in the fun aspects of AI and how it could be creative, shown by queries like "Is artificial intelligence fun?" and "What sort of stuff do you make or create?"

Finally, there are children with concerns about AI and the future. Questions like "Can AI take over the world one day?" or "Is it evil! Or can it do anything?" reflect concerns about AI having malicious intentions.

Overall, children's questions about AI provide a glimpse into their thought processes and they show a genuine interest in understanding the workings, applications, and implications of AI. These children's perspectives suggest that there is a need for educational resources to help foster their learning and curiosity about AI.

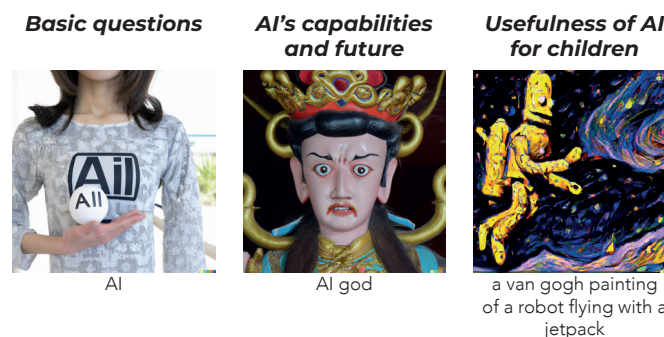| *Basic questions*	*AI's capabilities and future*	*Usefulness of AI for children*
AI	AI god	a van gogh painting of a robot flying with a jetpack

Figure 55: Images generated by children during the workshops picked to illustrate their questions about AI

The first interaction with AI image generation

The first interactions the children had with AI image generation was through a single account using Dall-e software by openAI. The children were given one laptop per two and given the assignment to explore, have fun, play and find the limits of the software.

Because all generations happened on one account the images have not been separated per pair using a computer. It is however not difficult to extract insights about how pairs interacted with the image generator.

Repetition
Repetitive behavior is clear in many of the prompts. Sometimes the prompt doesn't change and the designers of the prompt just used the same prompt twice. The repetitive behaviour can be interpreted in multiple ways. It might

dogs are cool an funny they can ride bikes and do sumersalts and cartwheels and very flexable

dogs are cool an funny they can ride bikes and do sumersalts and cartwheels and very flexable

Figure 56: Repetitive behaviour in prompting, dogs

have been that the children liked the result and wanted to see more of it, or the result they got didn't show what they wanted to see. In the case of the dog picture it can be assumed that the kids were not satisfied with the result as none of the images showed dogs doing somersault or cartwheels. (The spelling mistakes were probably not helping). In the following result the reason for repetition is less clear as this prompt resulted in more unusual and funny images

bottle that eats people and that has a big head and is a dummy

bottle that eats people and that has a big head and is a dummy

Figure 57: Repetitive behaviour in prompting, bottle

Iteration
Iterative behaviour can also be found in the prompts on multiple occassions. As seen in the evolution of mona lisa to doga lisa or in the exploration of different animals doing gymnastics.

a dog painting the mona lisa

a dog painting the doga lisa

Figure 58: Iterative behaviour in prompting, doga lisa

monkey doing gymnastics

a pig doing gymnastics

Figure 59: Iterative behaviour in prompting, animals doing gymnastics

Risky play
Some kids have tried a prompt which can be seen as a risky or not allowed prompt in the setting of a classroom. There might have been even more risky prompts, however these have not been documented as they would have been blocked by openAI's content policy.

butt

butt
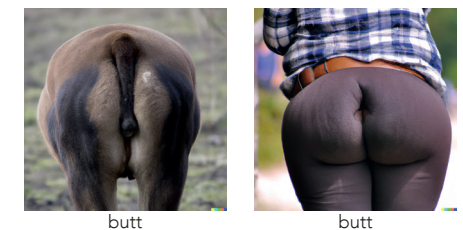
Figure 60: Risky play behaviour in prompting

It looks like this request may not follow our content policy.
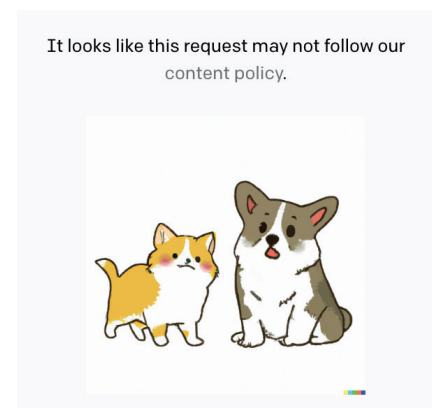
Figure 61: The image you see when your prompt violates OpenAI's content policy

Some kids mentioned having fun because of the prompt they were able to use such as "I thought it was very funny because you could just search for a cat with a gun."

cat with a gun

Humor

Often kids were aiming to create funny images, which you can already see if you just have a look at the range and weirdness of some of their prompts. An example of a recurring funny theme which could also be classified as risky play would be farting. Another way used to make a fun image was visualizing a word joke

a dog in a hot dog farting

a cat farting

A tucan wearing two cans

Exploring the perception of the AI

In a sense every image made can be seen as finding out what the AI would come up with. However in some cases it was more evident that this was the goal of the prompt. Sometimes kids were trying out different prompts to see what the AI would come up with. This would range from simple things such as football, pizza and robot to using just a single letter or typing in complete nonsense. Other things they tried were their own names or elements of their cultural background such as famous buildings or food. They also tried combinations of familiar themes, animals or more complex prompts to see how the AI translates them into visuals.

Testing the limits

Children also test the AI's capabilities, issuing abstract and sometimes bizarre prompts to see how the AI translates them into visuals. For example, "a rainbow black hole" or "cows in floaties in the swimming pool with sunglasses with beer" show how they test the limits of the AI.

Pizza

A

Femke and emma are very cool

,Jyvcjyfxhtershe tagrwgraegrawg rsytesyteytesytyt 6575483iydthtdh.

taj mahal

cat mixed with dog

a rainbow black hole

cows in floaties in the swimming pool with sunglasses with beer

Wonderings about generative AI

During the workshop additional questions were recorded either on post-it notes or shared during class discussions or in interviews. These questions paint a picture of the broad spectrum of the children's perspectives and expectations of AI.

The range and diversity of their questions can be seen in numerous inquiries including inquiries about the mechanics of AI ("How does it work and what technic they used"), practical applications ("How AI can help us in daily life"), creative ideas ("I would like to learn more about making Harry Potter pikachus"), and even worries about AI's potential dominance ("Would it take over the world? Or us").

Other questions were focused on how AI image generation works at a practical level. Questions like "How the AI processes the description and finds pictures for it on the internet" and "How it inputs data of what we typed and it generates the image" indicated the children's curiosity about the AI's operational principles.

Other children were more interested in how to improve their functional use of the software by asking questions like "How to make a tomato pikachu!"

Another kid asked "Can you print it in a 3D printer." This shows children's capacity to envision tangible applications and creative uses of AI.

The children also questioned the ethical and security implications of AI, asking, "Who controls all the AI in the whole world?" and "Is there some kind of security?" These questions reflect an awareness of the broader societal impacts of AI, demonstrating that even at a young age, children are capable of considering the ethical dimensions of AI use.

One girl mentioned she was interested in harnessing AI's potential for broader societal good, as she remarked, "I would like to learn more about how you can make stuff which you can help the world. For climate change and stuff." Another child expressed the ambition to become a space engineer and wanted to utilize AI in learning about space. These ideas show children's desire to use AI as a tool for solving real-world problems and achieving personal ambitions.

During the workshop display a wide range of interests, aspirations, and concerns related to AI image generation could be observed. They ranged from understanding AI's operational mechanisms, leveraging AI for creative applications, recognizing the need for responsible AI use, and imagining potential societal benefits.

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The first impressions of AI image generation

The participants first impressions and experiences were captured regarding AI image generation by asking the question "What are your first thoughts about AI image generation?"

The responses range from initial confusion and skepticism, to later expressions of surprise, amusement, and awe.

Several children reflected their initial frustrations and misunderstandings about the AI image generation technology, perceiving the system to be faulty or unresponsive. As one participant noted, "I first thought that it did not want to get what I want and that it was broken," while another reported, "My first thought was it didn't work." This perception was common among the group, with several others echoing the sentiment that the system didn't "listen to our orders" or "wasn't smart" enough to generate the desired images.

However, as they navigated the system, their perceptions shifted dramatically. One child mentioned, "I thought it would be very hard but later I found out it's funny and easy." Another similarly exclaimed, "I thought it did not work at first but then when it did it was fun and funny."

A sense of wonder and awe were other common sentiments among the participants. The AI image generation process was deemed "surprising, amazing," and "cool,"

The children recognized the potential for enhancing using the tool creatively and saw opportunities for using it in educational projects. They perceived the technology as a means of bringing their ideas to life, with one child musing, "Hooray! I can create characters now!" Another reflected, "It can be really useful if you're doing a project. If you can't find the right picture on Google, you just go to the image generator." Using AI image generation as an alternative for google image search was something which surfaced more often in the conversations with children.

Concerns over the pervasive influence of technology were also expressed. One participant highlighted the potential risks, saying, "The internet is actually taking over our world… If the computer does everything for you all the time you'll have nothing in your brain." This view shows an understanding of potential influence of technology on the way we think. Another concern was voiced in a bit less eloquent way saying "has technolode gone so far?!"

Despite initial reservations and confusion, most participants ultimately saw the value and potential of AI image generation. However, their insights also highlight the importance of proper education and guidance to ensure that technology is seen as an empowering tool, rather than an intimidating or overwhelming force. This balance between learning to utilize AI tools and maintaining active, critical engagement is key to nurturing a future generation ready to harness the benefits of AI while minimizing potential risks.

Visualizing dreams

Two kids also mentioned how the technology could be used to visualize your dreams. One of them even did so during the workshop. The image can be seen to the right

"[...] I was looking for a mushroom cat which I had seen in my dreams." So you have actually seen this in your dreams and now you tried to replicate that? "Yes."

"We could have fun with this technology by looking up things we dream about when we were a child or right now and making that thought one and creating an image."

Figure 64:Visualizing a dream: mushroom cat

Fun(ctional use)

One of the questions asked during the workshops was a multifaceted question. Asking if the children would see a way to use AI image generation, either functional, creatively or just for fun. Several noteworthy insights were generated based on these questions

The potential of AI image generation to inspire creativity, particularly in art and storytelling, was the most prominent theme. Children perceived the technology as a tool to "inspire artists and storywriters." The idea of using AI for creating characters and as inspiration was recurrent as one kid said "create your own game or story with characters you design on this", or another "So if you really like to draw, you can get inspiration for what you want to draw."

Furthermore, AI image generation was also seen as a tool which could be highly relevant for writers: "If you are an author, how interesting things could the author's art AI image generation be?" Another insight which might come from this is that the kid mentioning this is convinced that if you have great story writing skills

you must also be able to design great prompts for AI image generation. One of the kids even mentioned how "It felt like describing a character like in a book."

The children also identified some of the potential functional uses of the technology, especially in the context of education. For instance, one student mentioned, "The schools could use this for history when explaining... we could use it for creating our own civilizations because we're learning about..." The writing of a graphic novel about a subject you are learning about could help the kids to formulate their thoughts when they are creating images for their story. They might be forced to use more descriptive language. The teachers mentioned that this was a great opportunity for the children as they would be forced to used descriptive words.

There was also the idea of creating a "machine that inserts data and makes a 3D model," indicating kids see further potential for generative AI besides 2D images.

Another functional use pointed out was that "When you're stuck with a drawing... If you can't find the right image, you can use the image generated by yourself and the AI image generator in your presentation." This either points to being able to use AI image generation as inspiration to continue drawing or as a way to finish the drawing for you.

Fun ways to use were often interpreted as what would be fun prompts to use as input. For example "A Castle that's in the clouds with whales that have tentacles around the castle"

Their comments reflect how many children can see ways to integrate AI image generation into various aspects of their lives including schoolwork and creative pursuits.

Combinations and transformations

Fascination with character transformations and the creation of whimsical scenarios, such as "An American panda eating a hamburger on a plane", demonstrates their enjoyment in blending the known with the imaginative. During the first workshops around 288 new Pokemon were generated. Using prompts such as "pokemon style yellow electric bird"

Iron man and captain america mixed together

pokemon style yellow electric bird

Figure 65: Combinatorial behaviour

Figuring out how it works

Some kids show that they are figuring out how the software works without the need for additional explanation. Before giving extra information about how to have better results, some have figured out ways to improve their prompts by adding words such as "real life", "oil painting", "style" and even "digital art".

There are several explanations for how they ended up using these words. One would be the suggestions on the Dall-e page showing example generations and their prompts. This is probably the case for the prompts "oil painting" and "digital art".

Additionally the teacher was walking around and sometimes giving suggestions for what they could try.

The words "style" and "real life" are more likely to have originated from the kids themselves.

a oil painting of a dog ambushing a demon kitten

Unicorn doing gymnastics digital art

pokemon style shadow cat purple
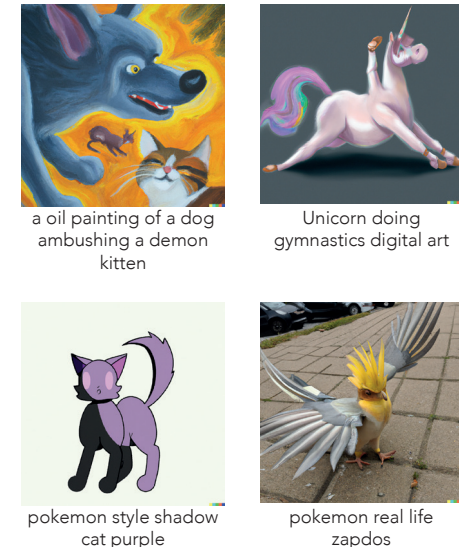
pokemon real life zapdos

Figure 66: Combinatorial behaviour

What works best with AI image generation according to the kids

Other questions were asked to find out what children think works best to generate good results. The questions were "Can you think of ways to improve your old prompts?" and "which words give the best results?"

A common theme that emerged was the importance of detailed, descriptive language for better AI image output. One participant stated, "I found out it's better to add more detail and to say things like realistic or anime!"

There was an understanding that AI requires more explicit instructions. One thing which was not mentioned during the explanation, but which one partcipant noticed was "Needs personalities and emotion!" Another mentioned that words like "strong" and "metallic" were also interesting to use. Additionally, using words such as "bright," "dark," or "cinematic" was found influential in shaping the AI's output.

The children also identified stylistic indicators like "3D," "digital art," and "pixel art" for distinct image styles. As one child expressed, "To me the best words are 3D or realistic or anime or magic-like!" Suggesting that specific terms provide the AI with a clear stylistic direction.

Finally, one of them considered typographical variations and expressive words to enhance prompts. This shows a lack of understanding as these typographical variations are not even allowed. It does show how children can be creative in their ideas of improving their work. Suggestions included, "We can do the prompts in cursive writing or in bold writing to improve the prompts"

In conclusion, detail, specificity, and stylistic indications were found to be key in formulating AI image generation prompts. This underlines the importance of descriptive language in using generative AI.

hindu warrior with sword strong fierce big muscles handsome long hair digital art
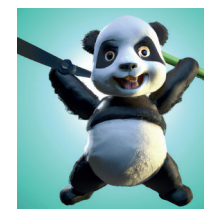
A 3D render of a happy panda holding a sword digital art
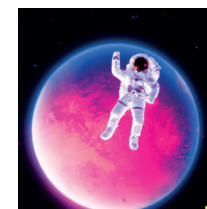
A photo of an astronaut floating in space next to earth, neon, digital art, cinematic

Insights from observations

Observing the children during the workshops provided several notable observations. First and foremost, it was evident that these kids are incredibly smart and highly curious. They showed a genuine interest in AI and were eager to explore its capabilities.

Interestingly, some of the children already had a significant understanding of coding, which was impressive.

Not all children had a positive attitude throughout the workshops. Some seemed to be going through personal struggles or had a bad attitude, which at times acted as a barrier to fully engage in the activities.

One striking observation was how these children already pondered ethical questions related to AI. Their minds were already grappling with the potential implications and consequences of this technology, showcasing their critical thinking and awareness. The questions they were asking were often the same questions adults are asking in ethical debates about generative AI.

While most children embraced the vast possibilities offered by AI image generation, one child found it difficult to navigate the limitless choices, feeling overwhelmed by the freedom and variety of options. Compared to adults this is a great score as multiple adults using the software for the first time showed a sense of being overwhelmed by the technology. For the children this sense of being overwhelmed seemed to be less present.

Another interesting observation was that one child mentioned feeling a decreased sense of ownership over the generated images. She felt that the AI, not she, was making the image.

I also noticed that priming had a significant impact on the children's responses and prompts. The way questions were presented or suggestions were made influenced their thinking and creativity. This shows how important it is to think through research activities with children beforehand.

Lastly, the diverse personalities and interests of the children were evident through their image generations. Each child had unique prompts and preferences, reflecting their individuality and varied interests. AI image generation proved great to bridge the gaps in their interests, as one kid mentioned she thought it was nice that you were able to combine interests in one image.

Ethical discussions with kids

"I'm a bit scared actually about that, because real people that spend all their time drawing with pencils might lose their jobs." "A bit of both. The artist needs to have their job, it's what they get paid for, it's what they get their house and their food with. And the AI image generation is really cool and it's good that everyone can use it. But it is also not, because you are just getting rid of peoples jobs."

"If everybody can draw, drawing won't be a skill anymore. Because now you have to work for it. You have to earn it. But then you can just be like; Ok so today I have something that can draw for me. Let's start doing stuff. You just type some stuff in it and: Poof! There is your magical answer."

Conclusion co-design workshop 1

The first co-design workshops provided valuable insights into children's perceptions and experiences with AI image generation. Children demonstrated a diverse range of interests and curiosity about AI. While some had a basic understanding of AI, there were knowledge gaps that highlighted the need for further education. The first interactions with AI image generation revealed initial confusion, followed by fascination and a recognition of its potential. Children's questions and prompts reflected their interests, their desire for learning, their creativity, and how they were having fun.

Observations also noted that each child had their unique preferences and prompts. Additionally, on child struggled with the overwhelming possibilities. Another mentioned a lowered sense of ownership over the generated images.

The workshops showcase how little guidance is needed. They also demonstrate that an exploratory play-based approach can be fruitful in creating knowledge about functional use of AI image generation using Dall-e. The approach also helps in fostering a positive and empowering relationship with AI for children.

14. APPENDIX D: EXTENDED EXPLANATION AND ANALYSIS CHILDREN WORKSHOP 2

Introduction

In the second workshop the main aim was to answer many of the questions children posed during the first workshop and educate them about artificial intelligence in general and specifically AI image generation. This was done in preparation of the third workshop as the third workshop was meant to encompass reverse brainstorming to find out what children find important about generative AI.

Some of the main learnings of this workshop were how many and which digital tools and apps children currently already use.

Other learnings were mainly in the preparation of the workshop. How could I teach the key concepts of AI and generative AI to children in such a way that they would be able to come up with ideas using AI image generation themselves?

And lastly another generative AI tool was introduced to the kids. This tool,

dreamstudio.ai, allowed for enhancing drawings made by children. This was also seen as one of the main ways in which generative AI could be used when working with children. It would allow for children to make graphic novels based on their own drawings for example.

Figure 67: Drawing enhancement of participating child. Prompt: Lamborghini (dreamstudio.ai)

Teaching key concepts of artificial intelligence

In order to prepare the children for the final workshop and to answer many of the questions the children posed during the first workshop a combination of AI learning tools, videos, a lecture and in class discussion was used to teach the key concepts of artificial intelligence and AI image generation to the children.

Following the advice of the ISD teachers, an inquiry-based approach was adopted for teaching the kids about AI. The workshop started with questions to the children: What is AI? Can you think of examples? And, what do these examples have in common?

After a discussion on these questions, two definitions of AI were presented to the students for comparison and understanding. Afterwards some in advance collected examples were shown and discussed.

In order to provide a clear explanation about the what and how of AI image generation, the children were shown fragments of the video "The text-to-image revolution, explained" by Vox (2022).

Hands-on experience was provided during the workshop by using the AI tools "Teachable Machine" and "QuickDraw" provided by Google. These tools can foster a tangible understanding of AI, showing how machines can learn from data and develop intelligence (Inspirit, 2022).

In order for the children to be able to design with generative AI the key concepts for children to learn about AI and generative AI were identified together with the teachers as:

Bias in AI
Basics of machine learning
Data
Algorithms
Decision making
Ethics

These key concepts were explained by trying to answer the following questions in the workshop.

What is (generative) AI?
What are examples of AI in daily life?
How does it work?
How is it made?
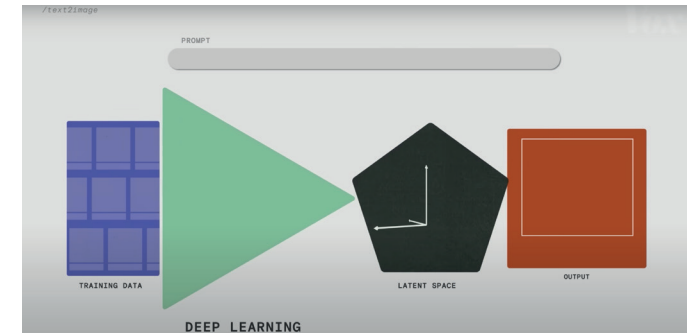
Figure 68:Screenshot Vox youtube video: The text-to-image revolution, explained (2022)

What are the opportunities it provides?
What are the risks and limitations involved?
What ethical questions are involved with AI?

Teachable machine

In the image to the right you can see how teachable machine was used in class. The children were asked to draw images of cats and dogs and before the class around 300 images of drawings of cats and around 300 images of drawings of dogs were downloaded and ready to use. These images were then uploaded in class and the model was trained before the eyes of the children.
After the model was trained, the drawings the kids made in the morning were assessed on how well the AI model would recognize the drawings as cats or as dogs. By using the drawings the kids made themselves the lesson was highly relevant for the children as their own drawings were assessed on by the AI.

The database of dog drawing images accidentally contained one image of the researcher. Every time the researcher would be in the webcam, the AI would signify that the researcher was a dog. This mistake actually was a great way of explaining how the kind of data and the method of collecting data are important for the final result. This allowed for a class discussion about bias.

Figure 69:Word cloud of most used software in school and at home based on frequency of mentioning

The second tool which was used to give children insight into how AI works was quick, draw! by google. This application allows you to play pictionary with an AI. This AI is trained on many doodles by other people playing the game. This way google was able to create the largest doodling data set in the world.

Together with the VOX explainer video and teachable machine, quick draw allowed the children to learn how machine learning models use attributes to classify images, and how this process had been reversed in order to develop AI image generation.

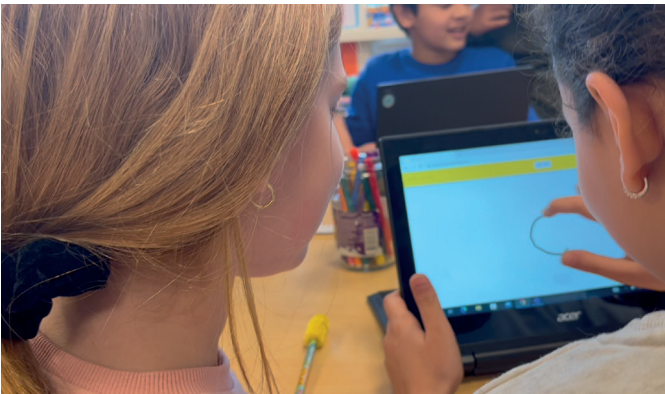*Figure 70:Quick, draw! By google. A form of pictionary with AI and the largest doodling data set in the world.*

Figure 72:Quick, draw! in action. The touch screen chrome books available in class allowed for optimal use of the website.

Figure 71:Quick, draw! Data set of doodles of cats

Digital tools children currently use

The digital interactions of children can be distributed in several categories

First, the devices which make use of digital technology. These range from computer, tablet, smartphone and smart watch, to gaming console, home assistant or (smart) electric car or even a VR gaming set. Children mention how they have been asking questions to Siri or even their parents car. This already shows how digital is not always linked to a screen anymore. When talking to an AI assistant in natural language and receiving input from that natural language no screen needs to be involved.

Besides talking to an AI assistant a range of digital (educational) tools and games is already being used by young children. Many of them mention that they play video games, look up things online or use online educational material. To the right a word cloud based on all the apps the children mentioned based on the following questions:

What apps do you use for school?

What apps do you like to use at home?

Based on the answers of children it becomes obvious how rich and diverse the interactions of children with digital technology already is. Both at home and at school children already interact with a plethora of applications.

Some kids only mention one application whereas others mention 10+ applications and everything in between.

This could point to a significant difference between the amount of digital applications and knowledge kids have. Otherwise it could mean that the children didn't feel like answering the question in depth, or because they couldn't think of more applications at the time of answering the question.

This difference of digital knowledge and skills between children was evident during the workshops as some kids were

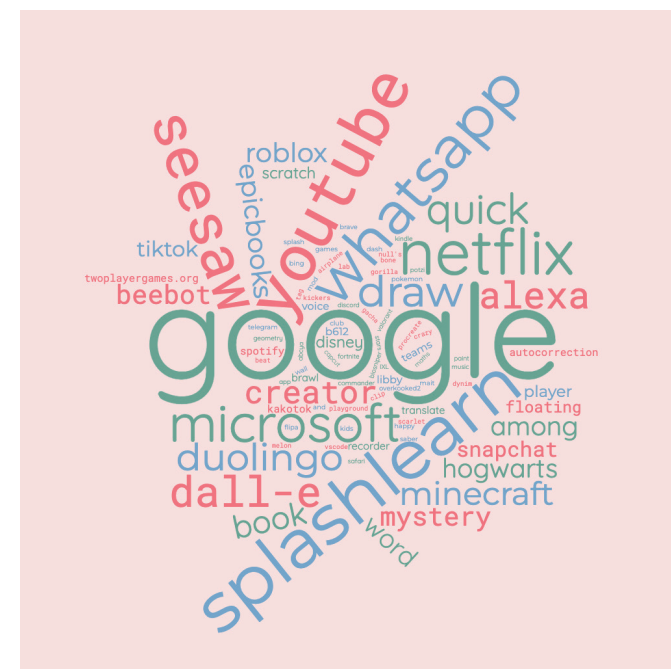quick to set the computers up and using new softwares, whereas others needed more help.

Figure 73: Word cloud of most used software in school and at home based on frequency of mentioning

Children's App and Software Usage

This analysis aims to extract insights from a series of interviews conducted during the second workshop regarding children's app and software usage, how the children envision their future and if they see AI image generation be part of that future. The interviews shed light on the commonly used apps and software, opinions on AI image generation, and potential future utilization of such technologies. Through the analysis of the interview data, several prominent themes and insights have emerged.

Popular Apps and Software
The interviews revealed that among the participants, popular apps and software included Google, YouTube, WhatsApp, various gaming platforms and more. These apps provide entertainment, information, and educational resources, catering to the diverse interests of the users.

The big ones are popular
Many participants expressed their preference for applications from large companies including Google, YouTube, TikTok and Netflix. "Google, youtube and TikTok. The ones I have been using a lot are youtube and tiktok. because I want to have contact with people but they don't have any other apps than tiktok."

Many learning apps
Often children mention more then one learning app. Some learning apps are likely to be used in class such as seesaw, splashlearn and beebot. These learning apps were mentioned by multiple children. One girl says the following "I sometimes use IXL, but then we have to pay when we reach a certain amount of learning stuff. So I don't really do that often. But sometimes I use it. Also I have got Kahnacademy I got Seesaw, I got splashlearn." which is just one example which shows how some children already use many learning apps both at school and at home.

Officially too young for apps
One of the things which is striking about the results is that the children use multiple apps which are officially for people of 13 year and older. Examples are TikTok, snapchat, youtube. When considering the use of AI by these companies this is especially relevant. All of these companies use recommendation software, and the most recent development is the addition of large language model AI in snapchat by the name of myAI. This allows users to talk to their personal AI.

The ubiquity of digital experiences in children's lives highlights the need for thoughtful approaches to their introduction to digital tools. Given that the presence of artificial intelligence (AI) is likely to grow, it's crucial we nurture their interaction with AI or, at the very least, ensure their understanding of its nature and function. This not only safeguards children but also empowers them to harness the inherent potential of the technology, thus fostering their overall growth.

Conclusion co-design workshop 2

During the second workshop the participating children were able to explore different hands-on AI tools and the aim was to get them to understand the key concepts of Artificial Intelligence (AI). The workshop offered a hands-on experience with tools like teachable machine, quickdraw, and AI image generation (dreamstudio.ai & Dall-e).

AI image generation (Dall-e) particularly sparked the children's curiosity and imagination. They explored how this technology could aid their personal interests, such as generating inspiration for art and assisting with story creation. Some children expressed their wonder about the underlying mechanism of AI image generation and showed a keen interest in creating their own AI-generated images.

The conversation often circled back to the theme of decision-making in AI. The participants identified that AI could make decisions and could be seen as having its "own type of brain".

They astutely noted that AI could make "similar decisions like people" but without the capacity for emotions. This recognition points to their understanding of AI's capabilities and limitations.

The children also brought up the topic of AI's use of data, touching on both its utility, such as in image-to-text categorization, and its potential drawbacks, as in unsolicited access to mobile data. These discussions revealed an awareness of the double-edged nature of AI, indicative of its potential benefits and challenges.

Conclusion:

This study illuminates children's perceptions of AI as they engage with it through playful and interactive contexts. Their reflections suggest a broad understanding of AI's role in society and personal life, as well as its ethical and philosophical considerations. These insights offer valuable perspectives for the development and implementation of AI, highlighting the importance of fostering critical thinking and curiosity about AI among younger generations.

By using a play-based learning lens to develop the workshop ended up being highly diverse, catering to different learning styles.

15. APPENDIX E: EXTENDED EXPLANATION AND ANALYSIS CHILDREN WORKSHOP 3

Introduction

In the third workshop the main aim to develop and rank design criteria for a product or service using AI image generation made for children. In order to do this there had been a build up over the course of the first two workshops providing the children with hands-on experience with AI image generation and a more in depth explanation and exploration of AI and generative AI discussing the key concepts.

A side objective of the workshop was to find out how much the children learned and understood of the previous workshops.

Lastly the ideas the children would create could serve as inspiration to develop ideas.

The structure of the workshop was threefold. First a recap of the previous workshops was done together.

Afterwards the children were asked to answer a few questions about their knowledge of AI image generation in order to prepare them for the co-design activity.

After the children had written down their answers to the questions, their associations with AI image generation were listed in class on the digiboard.

These associations were then used to perform reverse brainstorming with the children. By allowing children to perform reverse brainstorming you let them brainstorm ideas using words which have been identified as being the opposite of words associated with the subject. This allows for unexpected and out of the box ideas.

The ideas were then discussed and children were asked to tell why they found ideas good. These reasons were then reformulated by the researcher in collaboration with the class to formulate criteria.

The criteria which had been added using this method were added to criteria formulated in advance of the workshop by the researcher. This new list of criteria was then shown to the class and the children were asked to pick the three criteria they found most important for a product or service using AI image generation. Since the workshop was done in two classes, the list of criteria from which the children picked their favorites was different for both classes.

List of associations with A.I. image generation:

What it looks like: ~~a use~~ a
website

The environment or context in which it is used: Some were save at home with a adault or at School with a teacher!

How is the experience of using it: good there are Some inapropreate things Sometimes but other wistbe It is amazing

What do you need to be able to use it: a ipad or a computer, a paper for noting ideas and a pen that all ps. a adauld incase things get messy

how it is used: you give it detailed text of what you ~~want~~ to see and then you ~~get~~ Click the download botton if you want to save the photo that comes up

Who uses it: mostly inventers and artists for ideas and help

How does it work: it has text bars that you type in but all that the A.I. sees is a bunch of ~~the~~ numbers and then it takes the numbers and rearages it into a ~~#~~ photo

Anything else:

Nothing

Figure 74:Example of form collecting associations of children with AI image generation

Design criteria developed with children

After the reverse brainstorm, the designs were evaluated on what would make them good or valuable.

By doing this a list of criteria was created which was then used to ask children which of these criteria they found most important for a product or service using AI image generation.

In criteria lists can be seperated into three lists. The one created by the researcher in advance, and the two lists created together with the classrooms.

Predefined criteria

The design needs to stimulate play
The design needs to stimulate creativity
The design should enable learning about A.I.
The design enables you to add data yourself
The design teaches how to recognize real versus fake
Being able to create something yourself
The design enables working/ playing together
Fun

Playful (elements)
Privacy
Ownership
Instant feedback on your words
Inspiring

Criteria added in first class

You have an opponent (in chess for example)
diminish stubbornness
give reward
pick your difficulty level
Help you to achieve goals (encourage you)

Criteria added in second class

learn how the system works
enables you to create a collection
Something which is bad into something fun
You can have fun
It enables your creativity
It forces you to think of new things
A real life situation into a cartoon
Don't fall asleep in your book
comfortable for your body
It gives you a good concentration

You can get pictures for things that you can't see
Eyes won't get damaged
You can be lazy and don't have to get out of your chair
Escape room
Game
Enjoy in your free time
Every time you get something new, something which didn't exist before

At the end of the workshop all participants were asked to rank their top three criteria for a design making use of AI image generation. The results of this can be found in the pie chart on the page to the right.

Insights from observations and in class discussions

During the workshops questions were discussed about what AI is. Some insights from these discussion have been listed below.

A noticeable observation from their responses was their ability to understand the decision-making capability inherent to AI. For instance, one participant noted that AI can decide between recognizing a dog and a cat, but when a face was presented, the system struggled to decide if it was a cat or a dog. In this observation, the child has fundamentally captured the essence of AI - a technology with a "type of brain" that "can make decisions," as later stated by other participants.

The kids demonstrated their knowledge of AI's being applied in various sectors such as food service, transportation, and gaming. Their narratives ranged from robots serving food in Korean restaurants to the development of self-driving cars and AI's role in video games. This shows how some children still perceive AI as robots, however their perception is not limited to robots only and they are able to look past this and include other applications of artificial intelligence as well.

Some examples show how kids perceive that AI's purpose is to make human tasks easier. An example mentioned by a child was the use of AI for autocorrection. Another noted the application of AI in the classification of personal photos, suggesting an awareness of AI's potential for improving efficiency and accuracy in everyday tasks.

Analysis of grasp on AI image generation

In this analysis we critically evaluate children's understanding of AI image generation, their interaction with it, and their sentiment towards this technology based on the answers to the form collecting their associations with AI image generation as can be seen on the previous page.

Play-based learning methods have been shown to foster a positive interaction with generative AI in classroom settings. Throughout the workshops, children interacted with AI tools in a playful and exploratory manner, which appeared to support their understanding of the technology. They engaged with AI image generation tools, creating unique images and exploring how AI interprets their inputs.

Based on the provided data, it's evident that children grasp the concept of AI image generation to varying degrees. They understand that AI image generation involves artificial intelligence creating images based on user inputs. They correctly identified it as a process that uses words or descriptions to produce pictures. However, their understanding of the underlying processes of AI seemed somewhat limited, mostly focusing on the input and output interaction. The descriptions ranged from relatively accurate - "You type something and it makes a picture out of what you typed" - to a more vague understanding - "I think with the help of many robots and people".

Children demonstrated an ability to comprehend the key concepts of AI during in class discussions such as AI image generation, data, and bias. They developed hands-on experience through their active engagement and usage of AI tools. Some of them were quite capable to define AI image generation, explain how and where it can be used, and describe the experience of using it in positive terms.

Despite some gaps in their understanding of how AI works, the children's sentiment towards AI image generation is largely positive. They described the experience of using it as "fun", "interesting", "amazing", and "fantastic". There were a few mentions of concerns about inappropriate outputs or safety of use, but overall the sentiment was of excitement and curiosity.

During the workshops, the children used AI tools like Dall-E and Google's Teachable Machine, providing them with an opportunity to explore and learn. They saw potential uses of AI in a variety of settings including home, school and work.

If we look critically to how much children understand the technology one conclusion can be made and that is that the teachings were only able to provide equality in empowerment, not equity. Many children did get the gist of how it works "You give AI text or an image and through the process of diffusion it makes a new image," others have a more rudimentary understanding or confuse AI image generation with a search engine "It's been programed by people to look around the internet to find what you searched"

16. APPENDIX F: EXTENDED EXPLANATION AND ANALYSIS TEACHER WORKSHOP 1

Introduction

In order to develop the design of the product service system a series of workshops was developed for teachers. The first was for teachers at the international school in Delft as there was already collaboration with teachers from this school. The workshop was given online and took one hour. The main elements of the workshop were a basic introduction to different kinds of generative AI, hands-on experience with AI image and text generation and a discussion about generative AI in education.

Goal of the workshop

The aim of the first workshop was to understand the concerns and needs of teachers for implementing generative AI in education. To find out what they wanted to know about it and what their thoughts would be on implementing it, their thoughts on play-based learning and if they think it would be valuable to have these workshops for children.

The workshop was developed based on the recognition of the increasing necessity for the integration of generative AI within education. The design of the workshop was in such a way that it would allow educators to familiarize themselves with generative AI tools and empower them to incorporate these tools into their teaching practices. The idea was, that if the teachers would be taught about generative AI, they, in turn, would be able to teach their students about it by using it in their daily practice and developing new teaching materials with it.

The workshops main aim was to provide educators with the practical experience necessary to navigate this novel technological landscape and to make them curious so they would explore and learn more about it themselves.

The workshop was developed using a human-centered design approach, whereby educational materials are developed in conjunction with the teachers' needs and inputs. This is done to ensure the content is both relevant and directly applicable to their teaching contexts. Furthermore, these workshops also serve as a platform to discuss the pedagogical implications of integrating generative AI within the existing curriculum, guiding teachers to make informed decisions about when and how to use this technology. As the technology is so new, school policies mostly have not been developed yet. This increases uncertainty with educators on how to handle this new technology. When are kids allowed to use it? Should we ban it? Can I use it to make lesson plans? These are all questions which do not have a clear yes or no answer. To use and implement the technology a more nuanced and informed vision is necessary for educators and school board members.

In conclusion, this first teacher workshop represents an effort to empower educators with the knowledge and skills to effectively implement generative AI tools in their teaching practices. They are designed with a strong emphasis on hands-on learning, contextual understanding, and adaptability to various teaching disciplines.

"I'm concerned. It's so easily accessible and it can do so much already! It's like instant soup - but much scarier. I can already see how technology dominates the lives our kids and I'm having a hard time accepting that this is the direction we are going. To me, it feels like taking the humanity out of the equation." *Reply by a workshop participant in the pre workshop questionnaire to the question: What are your first thoughts about the use of generative AI in education?*

Insights workshop

Insights about the workshop were generated based on observations and questionnaires before and after the workshop.

Pre workshop generative AI perception

In the pre workshop questoinnaire, four workshops replied, making the sample size relatively small, therefore real trends could not yet be found. The participants who did reply expressed diverse opinions about the use of generative AI in education. While one saw the creative potential but expressed concerns about ethical implications, another expressed clear apprehension, particularly concerning the potential dehumanizing effects of AI. Two participants noted their lack of experience with AI, expressing a desire to learn more about its potential uses in their respective subjects.

Only one respondent mentioned direct experience with generative AI, specifically with Dall-E and Chat-GPT. Another acknowledged hearing about

AI capabilities but expressed concerns about the loss of human creativity. Some of the questions raised by the participants involved technical aspects of generative AI such as whether chatGPT has built-in responses, and practical aspects such as how it could be used in their subjects and as an educational tool.

One participant raised concerns about the potential misuse of AI by students in writing essays and questioned how to deal with unforeseeable consequences.

Perception of Play-Based Learning

There was strong agreement among the participants about the value and effectiveness of play-based learning, with three out of four strongly agreeing that it can be a serious and valuable form of instruction. All respondents indicated that they incorporate play-based learning in their teaching practices regularly.

After workshop questionnaire

From the nine teacher who participated in the workshop five replied to the after workshop questionnaire.Based on the questionnaire responses, the majority of the five participants found the workshop informative and beneficial, with constructive insights and suggestions for future engagements.

The workshop was generally well-received, with participants noting it as "interesting," "informative," and "useful." They appreciated learning about various AI platforms and their potential use within an educational context.

On the practical side, one participant experienced technical difficulties, suggesting the need for simplifying tools, communications and structure of the workshop.

Post-workshop, participants showed a positive outlook towards the application of generative AI in education. They saw

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the technology as a potential game-changer and a beneficial tool for tasks such as lesson planning and generating teaching materials. The participants also expressed an interest in learning more about the technology, indicating an openness towards further training.

The participants had varying degrees of understanding of the concepts discussed in the workshop. While they seemed to grasp the idea of ChatGPT "quite well" or "moderately," their understanding of generative AI and Bing.com/create (DALL-E) was more mixed. This indicates the need for further clarification and perhaps a more detailed explanation of these concepts in future workshops.

The main challenges faced by the participants were insufficient hands-on practice and technical issues. One participant expressed concern about the intrusive nature of providing personal details in order to use DALL-E, indicating a privacy concern that could be addressed in the future.

Most participants agreed that teaching generative AI to school children is important, with suggested ages of introduction ranging from 9 to 14 years. One of them mentions how generative AI shouldn't be confined to a single subject in school but that it can be used for "All subjects, as it could be used as an extra resource"

The participants were most resonant with the use of AI for producing handouts and materials, simplifying administrative tasks, and aiding in reading PDFs faster. These uses suggest the areas where teachers feel AI could be most beneficial in their work.

The participants saw the need for comprehensive education and awareness as the main challenges to implementing generative AI in their schools. Concerns were raised about privacy, security, accountability, and consistency of the tools.
Participants generally preferred services such as training and workshops to help integrate generative AI into their teaching practice. They expressed the need for more hands-on experience, ethical considerations, and practical implementation strategies in future workshops.

Conclusion

In conclusion, the workshop was effective in introducing the potential of generative AI in an educational setting and increasing participants' interest in the technology.

However, it also highlighted areas for improvement, such as providing more hands-on practice, addressing privacy concerns, and giving clearer explanations of complex concepts.

Another area of improvement would be in the experience of learning about generative AI. As the experience of learning in this workshop was described by some as informative, useful and interesting only few mentioned that the experience was fun and inspiring. Whereas the aim is to develop a learning experience which is inspirational, amazing and fun. To spark their curiosity and increase their motivation for further exploration and learning.

Furthermore, the results show that there is a demand for further education, training, and support in integrating generative AI into teaching practices.

Despite the small sample size of five participants, these findings provide valuable insights into the perceptions of generative AI among teachers and the measures needed to enhance its acceptance and usage in education.

17. APPENDIX G: EXTENDED EXPLANATION AND ANALYSIS TEACHER WORKSHOP 2, 3 & 4

Introduction

After an iteration on the contents and form of the workshop, more play-based learning elements made their way into the workshop. This final workshop design was evaluated through three workshops. One physical workshop with students from the teacher academy and two online workshops, for which participants were gathered via the online platform and an email campaign with a brochure.

The main structure of the final workshop was as follows:

5 min	-	Introduction
15 min	-	Exploration
10 min	-	What is generative AI? Tips & tricks
15 min	-	Functional play
5 min	-	Generative AI in education
15 min	-	Variation & integration
5 min	-	What else is there?
10 min	-	Discussion
10 min	-	Questionnaire

In the structure of the workshop already elements of play-based learning were present as the different phases in the workshop were modeled after the play phases described by Gielen (2010). Going from the exploratory phase to the functional play phase in which participants play in the intended way up onto the variation phase and the integration phase in which respectively the play has more variations in it and the object of play can be integrated into more complex forms of play.

The goal of the workshop was to empower teachers to be able to integrate generative AI into their daily practice. Allow them to use generative AI to lower their workload and to just become excited and curious about it in order to get motivated to learn more about it.

The participants of the workshop were asked to answer questions in a questionnaire before the workshop and to answer questions in a questionnaire after the workshop. Besides the questionnaires, during the workshops some semi-structured interview questions were asked to the participants.

Pre workshop Questionnaire analysis

*"I think we can't avoid it and I find that teachers know too little about it. I especially want to know more about it in order to use it and to let students make smart use of it, to work with it and maybe develop a critical attitude with it."*Reply by a workshop participant in the pre-workshop questionnaire to the question: What are your current thoughts on using generative AI in education? (e.g. chatGPT/ Dall-e)

The following analysis explores the responses from 24 teachers who participated in a pre-workshop questionnaire on generative AI.

Interest in generative AI from all corners of education

The age range of the group was 23 to 64. The teachers varied in the education levels at which they taught, ranging from primary school to university. Subjects taught also varied significantly, from scientific fields such as Physics and Biochemistry to social sciences and language instruction. This diversity in teaching experience and subjects suggests a broad interest in generative AI across various educational levels and disciplines.

Varying experience with Generative AI

The majority of respondents expressed limited to no experience with generative AI, with only a few having used tools like ChatGPT or Dall-E. Some reported using AI for specific tasks, such as generating inspiration, creating texts, or formulating questions. This indicates that most of the participating teachers have yet to explore the potential applications of AI in education.

Views on Generative AI in Education before workshop

Curiosity about AI's potential

There is a significant interest in exploring the possibilities that AI, like ChatGPT or Dall-e, could offer in an educational setting. A sense of curiosity is reflected in the comment: "I'm curious about what new inspiration it could bring."

AI as a supplement, not a substitute

Some respondents express concerns that students might misuse AI to complete their homework or assignments. Instead, they suggest using AI as a tool to enhance work, not replace it. One person stated, "Prevent students from letting ChatGPT do their (homework) assignments. Utilize opportunities that AI offers in tasks: let an AI make a first draft and then improve/adjust/make that draft more creative/remove errors, etc."

Need for guidance and rules

There is a consensus among respondents that the integration of AI into education needs clear guidelines and effective supervision to ensure ethical use. One respondent emphasizes this need, stating, "If we can quickly establish clear guidelines, generative AI could support education. Good guidance is necessary when learning AI."

Shift in educational objectives

AI's integration into education may prompt a shift in the definition and evaluation of educational goals. One comment suggests that AI could encourage a focus on more fundamental skills: "This could ensure that teachers start testing more fundamental skills and perhaps this could lead to a shift in learning objectives."

Mixed feelings about AI

The responses indicate mixed feelings towards AI in education. While some

respondents see AI as a promising tool, others express concerns about its potential misuse. One respondent encapsulates this ambivalence, saying, "I find it difficult, useful, and dangerous. I think it's ignorance that causes my negative gut feeling."

Use of AI in Daily Work

Only a minority reported using AI in their daily work, primarily for generating inspiration or handling specific tasks. This shows that while AI adoption in their professional lives is not yet widespread, those who do use it have found it beneficial.

Comfort with AI Integration

Responses to the question of feeling comfortable with integrating generative AI in their teaching practice varied. Some teachers seemed comfortable with the idea, while others felt neutral or disagreed. This reveals the need for more information and training on how to effectively incorporate AI into teaching practices.

Teaching Approach

Opinions were divided on whether teaching about generative AI should be academically focused with structured lessons or be more exploratory and experiment-oriented. No definitive conclusion can be made about the way generative AI should be taught based on this data.

Curriculum Adaptation

Responses to whether the existing curriculum should be adapted for generative AI were largely neutral. This could indicate uncertainty or a lack of knowledge to form an opinion on this issue.

What teachers hope to learn in the workshop

Need for basic information and understanding of AI

A significant number of respondents indicated they are seeking fundamental knowledge and a better understanding of AI. For instance, one teacher said: "To

be honest, I don't know what to expect. I hope to gain more insight into the possibilities of AI in education." Another teacher added: "I hope to learn more about AI and its possibilities. I'm still neutral about it as I don't fully know its capabilities (apart from how I've used it for my own studies)."

Practical application in education

Several teachers are interested in practical methods to incorporate AI into their lessons. They wish to learn tangible ways to utilise AI, as one teacher expressed: "How I can use AI effectively in lessons." Another respondent wants to understand AI better and receive recommendations for specific applications: "I hope to get a better understanding of how AI can influence teaching in primary education and what applications I can already use."

Ethical and academic integrity issues

One teacher mentioned concern about the ethical implications of using AI, particularly when it comes to plagiarism.

One of the participants stated: "During this workshop, I mainly want to learn: to what extent it's scientifically justified to use AI in a master's course in terms of plagiarism / declaration of own text." It should be noted that this was a teacher from the teacher academy asking this question from the perspective of teacher academy student.

AI as a tool for teachers
Several respondents indicated that they wish to learn how AI can help them make their lessons more effective and engaging. One respondent said: "How teachers can also use AI to make their lessons more creative and challenging." Another noted they are interested in "practical matters such as: how do you deal with AI in the classroom as a teacher?"

Critical skills and awareness
A few teachers pointed out the importance of learning to handle AI in a critical and responsible manner. For example, one of them suggested: "How can I implement AI user-friendly in my lessons and ensure that students learn to deal with this tool critically." Another teacher emphasised the importance of students learning to think and read: "Having to think for themselves, reading pieces, and especially formulating answers in a language-savvy manner is indeed very important for the students as individuals but also for the development of the Netherlands as a society (politics, science, art etc)."

Conclusion

The pre-workshop questionnaire analysis revealed widespread interest in generative AI among teachers from various educational levels and disciplines. Despite their limited experience with such technology, many showed curiosity about its potential uses in education and its practical applications. Teachers expressed varied views, with some believing AI could supplement, not substitute, students' work, while others feared potential misuse. The need for clear guidelines, effective supervision, and possible shifts in educational goals was recognized, illustrating the complex ethical considerations accompanying AI integration in the classroom. Concerning workshop expectations, teachers expressed a desire for fundamental knowledge about AI, practical implementation methods, and strategies to address ethical and academic integrity issues. They were also keen to understand how AI could enhance their lessons and help students develop critical skills. These results underscore the demand for more information and training about generative AI in the educational field. The workshop provides an excellent opportunity to meet this need, while also allowing educators to share their diverse experiences and insights.

Observational insights

The target audience of the workshops were high school teachers and elementary school teachers. One of the goals was to find out in the workshops where the need was the highest for learning about generative AI. Because the aim was solely on high school and elementary school teachers higher education teaching participants were not expected. However, according to the pre-workshop questionnaire (n=24) there were four university teachers and three college teachers (one teacher teaches both). The most interested teachers were high school teachers (15), specifically the ones teaching at senior general secondary education (11, havo) and pre-university education (12, vwo). Note: some teachers teach at both havo and vwo. Compared to only four elementary school teachers, the high school teachers seem to have a higher interest in the workshops.

Because the invitation was sent to an equal number of elementary schools and to high schools, the divide in interest between high schools and elementary schools is interesting and could suggest that the need for knowledge about generative AI is higher in high school. The fact that some university teachers and college teachers signed up for the workshop suggests that the interest from educators in higher education is high as well since these participants weren't targeted specifically.

Change of generative AI perception

"Yes, I do see possibilities instead of mountains! I initially found it to be a somewhat unsettling development, but I now see how it can also be very positive. It will bring about a change in education, I think. We will have to focus more and more on the process and less on results. (does fit into our school vision!)" Reply by a workshop participant in the post-workshop questionnaire to the question: Have your views on using generative AI in education changed after attending the workshop? If so, how?

Improved Perception of AI
A common trend from the data is that the workshop has improved the perception of generative AI in education. As one respondent said, "Yes, I now have a much better picture of the benefits of generative AI," showing that the workshop was effective in clarifying the value of AI for the participants. This is important because it suggests the workshop managed to enhance their understanding of AI's potential.

Wider Use Case of AI
Participants realized that generative AI has a broader application than just generating text. An attendee mentioned, "Yes, the possibilities that it is more than just generating text." This shows that participants gained insights into various capabilities of AI, such as visual applications, and realized its potential for a wider range of tasks.

AI Requires Contextual Integration
A participant commented, "yes. it is certainly useful in lessons, but just as we were given extra tips and explanations with it, this will also apply to students. So you have to pay very conscious attention to this. And you can't decide this as an individual teacher because if you make students more proficient in using chatgpt (which I don't think you can avoid) it will also affect assignments in other subjects. So this needs to be discussed and agreed upon in the teaching team. I think the dall-e visual AI can be applied in design projects earlier (without extensive consultation with colleagues)." This suggests the need for proper guidelines and procedures to use AI effectively. Also a difference is made between the impact of AI image generation and AI text generation on teaching and learning.

AI's Role in Reducing Teachers' Burden
There is also the recognition that generative AI can alleviate some of the teachers' workload. One participant expressed, "Yes, it has become more positive. ChatGPT can be used in various ways within education and can also lighten the teacher's task." This suggests that AI is viewed not only as an educational tool for students but also as a means to assist teachers in their duties.

Need for Awareness of AI's Limits
While there is enthusiasm for AI's potential, there's also an understanding of the need to be aware of its limits and potential risks. As one participant states, "...there are beautiful opportunities to work with AI but this must be structured and substantiated with an explanation and a description of the limits/dangers." This reflects the need for a balanced approach when incorporating AI in education, one that acknowledges both its strengths and weaknesses.

Perception of generative AI potential

"Lesson preparation differentiated in all sorts of ways, getting fun ideas, integrated thematic learning, art to be made by everyone. But I need to start trying it out myself first!" Reply by a workshop participant in the post-workshop questionnaire to the question: Where do you see opportunities to apply generative AI in your own work?

Potential for Idea Generation
The contributors express that generative AI can be used for brainstorming and idea generation. It could be a tool to stimulate thought, or to come up with new concepts that might not have been considered otherwise. For example, one participant mentions "Generating ideas as a basis for a brainstorming session."

Curriculum planning
Generative AI is seen by most participants as a potential tool for helping educators in a variety of ways. For instance, the quotes "Adjusting lesson plans, devising test questions, introduction, ideas for art assignments." This suggests the potential for AI to aid in a wide array of educational planning tasks.

Develop critical thinking
Some respondents identify a crucial role of AI in teaching critical thinking and information validity. The quote "The importance of critically looking at the information that Chat GTP delivers". Another substantiates this view by mentioning "source research as a springboard (the new wikipedia)" Here, the participants are encouraging a critical view of the information generated by AI, suggesting a need to foster a more discerning approach to information consumption.

Inspiration to differentiate teaching
There is potential for generative AI to inspire alternative teaching. A participant shares, "Inspiration material, approaching the lesson in a different way". They seem to see the use of AI as a way to refresh and invigorate their teaching style.

Caution and Gradual Adoption
Despite the opportunities, some replies express caution or a need for gradual adoption. One user comments, "I'm still a bit hesitant to really start applying it to teaching situations, but I occasionally ask for a lesson idea." This suggests that while there's interest and recognized potential, there's also hesitation in fully engaging with the technology.

Opportunity in AI literacy
Some remarks indicate that there is an understanding of the importance of configuring AI to meet unique, individual needs. The phrases "creativity (how do you put the algorithm at the service of your goal?)" and "How do you put the algorithm in service? (search terms/iteration)." These insights highlight the following perspective: AI is a tool that users need to actively engage with and manipulate. The ability to effectively use AI requires understanding its functionality and customization to one's needs. This seems to point to the opportunities which AI literacy might bring to teachers and students.

Allow generative AI to students?

"I think it's important in education to look closely at what exactly the learning objectives are... If those learning objectives can be evaluated with regard to AI, I think a different structure of testing and assignment could emerge that students can perfectly use AI for." Reply by a workshop participant in the post-workshop questionnaire to the question: Would you allow your students to use AI in the same way you just described? Why or why not?

Embracing AI as a learning tool

Some respondents are in favor of students using AI as a part of their educational journey. They see it as an opportunity to broaden their learning perspectives. For instance, one respondent says, "Yes, because it can give the students a nice start which they can continue to build upon." Another comment, " "Sure! It's interesting to explore what can be done with this program!"

Use of AI must be critical and thoughtful

While respondents are open to AI use in education, they emphasize the need for critical thought. One respondent mentions, "I would absolutely allow it if the whole world is already using it... it somehow forces you to read the text critically... although the dangers are there that you become lazy and stop thinking..." Another states, "Yes, they can certainly use this, as long as they use multiple sources for verification."

AI use should align with learning objectives

Some respondents highlight that the application of AI in education should be consistent with the learning objectives. For instance, one educator proposes, "I think it's important in education to look closely at what exactly the learning objectives are... If those learning objectives can be evaluated with regard to AI, I think a different structure of testing and assignment could emerge that students can perfectly use AI for."

The process is more important than the result

Some respondents caution against AI's potential to overshadow the learning process. They stress that the process of learning, especially in schools, is often more important than the result. One respondent mentions, "In a high school, a learning process is often more important than the result."

Concerns over learning efficacy with AI

Some respondents express reservations about how effectively students can learn while working with AI. One respondent says, "Not currently, because I cannot judge their learning process and whether they are picking up anything content-wise when they work with AI."

Hurdles for implementation

"It is important that everyone learns at least something about this, so that they are not afraid of it." Somewhat free translation of a participants' reply "belangrijk dat iedereen hier íets over leert, zodat ze er niet bang voor zijn." in the post-workshop questionnaire to the question: What are the biggest challenges or obstacles in implementing generative AI in your school?

Perceived Obstacles to Policy and Implementation

From the survey, the challenges in implementing generative AI in schools seem to primarily revolve around policy restrictions and the difficulty of application, particularly in Research and Development (R&D) projects. "Challenges: its application in R&D projects. Obstacles: that the policy does not allow it." Beyond this, respondents also mention structural issues, expressing a concern that AI solutions may not be "directly safe/effective/ structured applied to current learning objectives and structures," thus creating friction in the implementation process.

Importance of Education and Awareness

Responses also highlight the importance of fostering awareness and education about AI to prevent fear and misconceptions. One respondent emphasized, "It is important that everyone learns something about this, so they are not afraid of it," suggesting that a lack of understanding might foster apprehension. Moreover, participants shared that there's a "Lack of knowledge about what it is and what the possibilities are," showing that more resources and education are needed to demystify AI and its potential uses.

Concerns on Student Learning and Engagement

There are tangible concerns about how AI might impact student learning. One person asked, "Having them write essays etc. How can you let students think and write without using AI?" expressing a worry about AI potentially taking over critical thinking tasks. Furthermore, there's a desire to guide "Students to learn the 'right' way to create a search term/question," suggesting concerns about maintaining student engagement and active learning in an AI-assisted environment.

Need for Teacher Proficiency

The respondents also underscored the necessity for teacher knowledge and policy alignment for effective AI integration. They highlight the need for "Knowledge among all teachers" and establish the importance of "Teachers' knowledge; Vision and Policy," indicating that teacher proficiency, acceptance, and a clear, shared vision are vital for AI's successful implementation.

Risk of Misuse and Disinformation

Finally, a consistent theme in the responses revolves around concerns of misuse and disinformation. The respondents fear that AI can lead to "Fraud, laziness, fake news, and incorrect facts," highlighting worries about the ethical implications of AI usage. Additionally, there's a concern about AI being seen more as a "super 'cheat sheet' than a help," which implies a risk of diminishing students' efforts and skills development.

These insights paint a nuanced picture of the challenges and complexities involved in integrating generative AI into educational settings.

Important for students to learn

Understanding and Utilizing Generative AI

One of the most emphasized points in the data is the necessity for learners to comprehend the purpose and application of generative AI. The respondents stress the importance of knowing "how to use it, what for, and what are the pros and cons", as well as "what it is, what you can do with it."

The Potential of Generative AI

There's a shared sentiment that generative AI holds endless possibilities, with statements like "The possibilities are endless...creativity is endless". They also suggest that generative AI should not be seen as an endpoint, but rather as a tool that provides new opportunities - "Generative AI can be used as support in a learning process, not as an end result."

Critical Thinking and Truth Discernment

It's evident that there's a significant emphasis on being able to critically assess the outputs of generative AI.

Quotes like "Being able to distinguish between true and not true" and "Check the credibility / the sources. Don't believe everything you read" underscore this point.

The Role of Generative AI in Society

Respondents recognize that generative AI will have an increasing role in society, which warrants an understanding of both its advantages and limitations. They note "Because this will have a role in society in the future/already has" and call for a comprehensive view of the positive and negative aspects of the technology.

Generative AI as a Tool, not a Shortcut

There's a clear consensus among respondents that while generative AI can be highly beneficial, it's essential not to view it as a shortcut or a source of definitive truth. This sentiment is embodied in quotes like "it's a good tool, but not a source" and "It's a tool, not a shortcut".

Impact of the workshop

Appreciation of Hands-on Learning

Participants seem to highly value direct interaction with AI. The most impactful part for one attendee was "entering a question into ChatGPT and seeing the result," echoing a sense of active involvement and direct experience with AI. Another participant further emphasized this sentiment by expressing that the part of the workshop which had the biggest impact on her was "Just have fun in the program together with another participant"

The Expanding Horizon of AI's Capabilities

The workshop appeared to broaden participants' understanding of AI's capabilities. One participant was struck by "the many possibilities of AI," a sentiment also reflected in another participant's revelation that the "introduced AI can do much more than I thought." These comments indicate a newfound appreciation of AI's potential.

Surprising how the AI works

One participant noted the challenge of fact-checking in the absence of source references, stating it seems "bizarre that there are no sources so fact-checking seems impossible." This participant, however, also highlighted "how detailed ChatGPT can answer and how good that answer seems to be," indicating a nuanced understanding of AI's capabilities balanced with an awareness of its limitations. Other feedback from participants suggests that they were surprised by the capabilities and limitations of AI. As one person noted, "AI is not creative! You have to say very precisely what you want to get it." Whereas another participant observed "how detailed ChatGPT can answer," underlining in which ways AI can be surprising when interacting with it.

The Benefit of Collaborative Learning and Shared Experiences

Shared learning experiences emerged as a valuable component of the workshop. One participant remarked on the value of "the exchange of experience with a colleague in the country (from another discipline)." Another participant found resonance in realizing that a "colleague with the same interests had the same concerns and saw the same opportunities," indicating the shared insights and understanding that arose from collaborative learning.

Evaluation of workshop

"Allow more time for discussion. You see that the participants prefer to apply it as quickly as possible and discuss about their own field. Give more space to let them discuss those ideas and possibilities. There is a lot of room for fun discoveries, but less time to share those discoveries with the group."

A participants' reply in the post-workshop questionnaire to the question: Do you have feedback about the workshop to improve future sessions?

In the workshop, several attendees found no issues and had a seamless experience: A significant number of responses stated that there were no feedback points for future improvement, or they replied that they experienced "no problems." This indicates that a majority of the participants found the workshop well-structured, meeting their expectations and requirements.

Suggestions for Enhancement

Despite the generally positive feedback, participants pointed out several areas that could enhance their learning experience. One concern was a lack of clarity in the workshop's materials and task instructions. For instance, one participant had trouble understanding what was expected in the accompanying document and task requirements, suggesting a need for more explicit and clearer instruction methods.

A frequently mentioned area for improvement was time management. Some attendees felt there wasn't ample time allocated for practical exercises and group discussions. This feedback indicates a necessity for a better balance between theoretical learning and hands-on experience, perhaps through stricter time management or extending the workshop duration.

Lastly, attendees felt the need for the workshop content to be more tailored to individual knowledge levels and professional fields. Some participants found the pace of the workshop too fast, especially those who were new to the subject matter. This highlights the need to account for varied prior knowledge among the participants in future sessions.

Positive Experience and Ideal Introduction

The workshop received positive feedback from participants, many of whom would recommend it to colleagues. It was praised as a suitable and enjoyable introduction for those new to the subject, providing an ideal first step for individuals with limited prior knowledge but interest in the subject.

Bad timing

While the workshop was generally well-received, one issue that did come up was its scheduling. A participant noted that the workshops coincided with the Central Examinations. This made it challenging to attend due to high workload. This highlights the importance of careful timing and scheduling when planning such educational opportunities.

Another teacher mentioned something similar, noting that the moment for workshops and planning workshops in is generally at the beginning of the school year and that the agendas were already very full at the end of the school year.

In summary, while the majority of participants had a positive and trouble-free experience during the workshop, reflecting its successful organization and adherence to the needs of most attendees, there are areas for improvement. Enhancements in the clarity of instructions, time management, and tailoring content according to participant's knowledge levels could enhance the overall learning experience in future workshops.

"The build-up of the workshop was good, too bad there was not enough time. But it shouldn't have lasted any longer... due to lack of time I couldn't participate in the discussion, that was a pity."
A participants' reply in the post-workshop questionnaire to the question: Do you have feedback about the workshop to improve future sessions?

"Yes

no: chosen moment, because it is in the middle of Central Exams and there is still 50 hours of work ready for me (Wednesday had just been the Central Exam. Monday was not an option due to class)"
A participants' reply in the post-workshop questionnaire to the question: Would you recommend this workshop to your colleagues? Why or why not?

Conclusions of teacher workshops

The analysis of the pre-workshop questionnaire responses suggests a widespread interest in generative AI among teachers from various educational levels and disciplines.

While many teachers expressed limited experience with AI, they were curious about its potential applications in education.

Views on AI in education varied, with some teachers seeing it as a promising tool and others expressing concerns about potential misuse.

The integration of AI in education was seen as requiring clear guidelines and effective supervision, and it may prompt a shift in educational objectives.

The high participation of high school teachers might suggest that the need for teacher development is highest in high schools. Overall, the workshops aim to empower teachers to integrate generative AI into their teaching practice effectively and ethically.

Based on the post-workshop questionnaire results, it can be concluded that the workshop on generative AI had a positive impact on the participants' understanding and perception of AI in education. The participants expressed a positively enhanced perspective towards generative AI in education. They also developed a deeper understanding of the diverse applications of generative AI beyond mere text generation. Furthermore, they acknowledged its significance in different areas of teaching and learning.

There was also an awareness of the challenges and obstacles in implementing generative AI in schools, including policy restrictions, concerns about student learning efficacy, and the need for teacher proficiency. Participants emphasized the importance of critical thinking, information validity, and AI literacy in the education system.

The workshop was appreciated for its hands-on learning approach, allowing participants to directly interact with AI tools and experience its capabilities. Collaborative learning and shared experiences were also highlighted as valuable components of the workshop.

Feedback from participants provided suggestions for improvement, such as clearer instructions, better time management, and tailored content to individual knowledge levels and professional fields.

Overall, the workshop was seen as a valuable introduction to generative AI in education, and many participants would recommend it to their colleagues. However, the timing of the workshop was mentioned as a potential issue, as it coincided with the central exams.

These findings highlight the potential of generative AI in education, but also emphasize the need for thoughtful implementation, teacher training, and critical thinking skills for students.

18. APPENDIX H: ORIGINAL APPROVED PROJECT BRIEF

DESIGN FOR our future

TUDelft

IDE Master Graduation
Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

(!) USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT
Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser.

STUDENT DATA & MASTER PROGRAMME
Save this form according to the format "IDE Master Graduation Project Brief_familyname_firstname_studentnumber_dd-mm-yyyy".
Complete all blue parts of the form and include the approved Project Brief in your Graduation Report as Appendix 1 ! (!)

family name	Visser	6197
initials	TML	given name	Titus
student number	4297636	
street & no.		
zipcode & city		
country		
phone		
email		

Your master programme (only select the options that apply to you):

IDE master(s): ★ IPD   ☐ DfI   ☐ SPD

2nd non-IDE master:

individual programme: ___ - ___ - ___ (give date of approval)

honours programme: ☐ Honours Programme Master

specialisation / annotation: ☐ Medisign
☐ Tech. in Sustainable Design
☐ Entrepeneurship

SUPERVISORY TEAM **
Fill in the required data for the supervisory team members. Please check the instructions on the right !

** chair	Derek Lomas	dept. / section:	DA
** mentor	Mathieu Gielen	dept. / section:	DCC
2nd mentor			

organisation:

city: country:

comments (optional)

(!) Chair should request the IDE Board of Examiners for approval of a non-IDE mentor, including a motivation letter and c.v..

(!) Second mentor only applies in case the assignment is hosted by an external organisation.

(!) Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30

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APPROVAL PROJECT BRIEF
To be filled in by the chair of the supervisory team.

chair   Derek Lomas   date 27 - 10 - 2022   signature

James Derek Lomas
Digitally signed by James Derek Lomas
Date: 2022.10.27 11:38:07 +02'00'

CHECK STUDY PROGRESS
To be filled in by the SSC E&SA (Shared Service Center, Education & Student Affairs), after approval of the project brief by the Chair.
The study progress will be checked for a 2nd time just before the green light meeting.

Master electives no. of EC accumulated in total: 32 EC

Of which, taking the conditional requirements into account, can be part of the exam programme 30 EC

List of electives obtained before the third semester without approval of the BoE

YES all 1st year master courses passed

★ NO missing 1st year master courses are:

ID4070 IDE Academy

name   Robin den Braber   date 30 - 01 - 2023   signature

Robin den Braber
Digitaal ondertekend door Robin den Braber
Datum: 2023.01.30 14:26:42 +01'00'

FORMAL APPROVAL GRADUATION PROJECT
To be filled in by the Board of Examiners of IDE TU Delft. Please check the supervisory team and study the parts of the brief marked **. Next, please assess, (dis)approve and sign this Project Brief, by using the criteria below.

- Does the project fit within the (MSc)-programme of the student (taking into account, if described, the activities done next to the obligatory MSc specific courses)?
- Is the level of the project challenging enough for a MSc IDE graduating student?
- Is the project expected to be doable within 100 working days/20 weeks ?
- Does the composition of the supervisory team comply with the regulations and fit the assignment ?

Content: ★ APPROVED   NOT APPROVED

Procedure: APPROVED   ★ NOT APPROVED

- the missing course ID4070 should be finished before the green light meeting

comments

name   Monique von Morgen   date 07 - 02 - 2023   signature

Using AI image generation to stimulate play and creativity in children　project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date　17 - 10 - 2022　　　　　19 - 05 - 2023　end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

In a fast changing digital society different skills are important to develop. According to a report from SLO, the Dutch agency for school curriculum development (2014), 21st century skills are important to develop in basic education. Some of the skills which are important for children to develop include: creative thinking, media wisdom, computational thinking, communication and ICT basic skills. In 2009 IBM interviewed 1500 CEO's about the biggest challenges they're facing. Complexity in the world came up often as one of the biggest challenge. The question is how to deal with that complexity. The most important finding is that the single most important leadership quality for dealing with complexity is creativity (Tomasco S. IBM 2010 Global CEO Study). For children's development, play is an important part and has many benefits. Play helps children develop executive functioning skills, such as cognitive flexibility, inhibitory control, and working memory. Play also helps children develop social skills, such as cooperation and empathy. Play is fundamentally important for learning 21st century skills, such as problem solving, collaboration, and creativity (Yogman M, Garner A, Hutchinson J, et al, 2018).

AI has seen rapid advancements in the past years. Specifically, AI image generation has gained massive momentum recently, since the AI image generation model stable diffusion has been released as open source software. AI image generation has the potential to change the world and could increase the complexity and accelerate the pace at which the world changes. AI image generation is expected to change the creative sector as a whole. This new technology also is a powerful and inspiring tool. For children it is now possible to create (photo realistic) art and design by typing in a few words. Some people who first get access to the tool feel like they have been given a wizard wand. Others even feel that the tool is addictive in some ways. Therefore, it is important to educate the future generations on AI so they can have a healthy relationship towards AI and enjoy the opportunities it provides.

According to Van Deursen (2020), digital proficiency is the extent to which someone is able to benefit from the Internet (technology) and to mitigate the risks now and in the future. He also mentions that it is not only necessary to use AI applications, but also to recognize when AI is used and understand how AI makes certain decisions for the user and for society. This way people will be able to obtain favorable results with AI and Internet (technology) and avoid negative results. In regards to AI, transparency and explainability and the impact of AI on education were prioritized by children participating in the JRC study, Artificial Intelligence and the Rights of the Child (2022). According to the JRC report Artificial Intelligence and the Rights of the Child (2022), one of the priority knowledge gaps is: "Children's cognition, development and play: Designers and researchers should systematically study the impact of the use of AI technology on children's cognitive and socio-emotional capacities in different contexts and in an inclusive way."

For teachers it is important to prepare children for the future by teaching about all facets of society. For parents it is important that their children are safe and enjoy their lives. All this in the context of a complex and fast paced world taking into account boundaries like a lack of digital skills both functional and critical (Van Deursen, 2020)), ethical limitations of bias and discrimination in the data sets of the AI image generation as well as difficulties surrounding copyright of the training data and resulting images. Another thing to take into account is play theory and barriers to play. Some people are drawn to the image generator where others seem to stop playing with it quite soon.

space available for images / figures on next page

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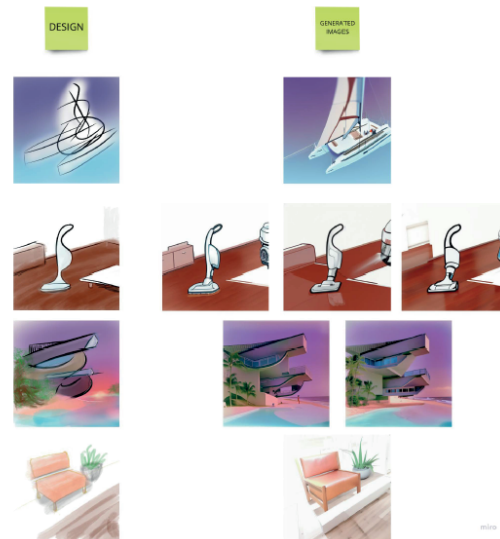introduction (continued): space for images

image / figure 1:   Image generation using an image as base prompt

image / figure 2:   image generation with artist, architect or designer as prompt text combined with something else

PROBLEM DEFINITION **
Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

The opportunity is in using AI to help children explore their creativity. AI can help children learn about different styles of painting, photography and illustration. It can help children find new ways to think about problems, become more flexible in their thinking, and develop their own ideas. Next to this AI image generation can be used to support and accelerate divergent thinking.

Creativity and play are important for children because they are enjoyable and can help children develop new skills. When children are engaged in activities that they enjoy, they are more likely to be motivated to continue doing them. This approach is based on play theory: the idea that children learn best through play. This theory has been around for centuries, and was first mentioned by Plato in his book Laws (Brooker et al., 2014). Play theory is based on the idea that children are natural explorers and that they learn best when they are allowed to explore their environment and try new things. When children are intrinsically motivated to play with AI because they enjoy playing with it they will learn about different aspects of it in a playful, healthy and non-forcing way. Healthy play can be described as a type of play that is beneficial to the physical, mental, and emotional well-being of a child. It is typically characterized by physical activity, social interaction, and creative exploration.

Children playing with AI image generation tools may develop certain intuitions about the technology. For example, they may become aware of the fact that the technology can create images that look realistic, but are not actually real. Additionally, they may develop an understanding of how the technology works and how it can be used. Children may also use it to explore gross, weird and outrageous things. This should be taken into account during development. In short, I see a potential use for AI image generation to foster the development of design skills and creative problem solving in a playful way while at the same time enlarging the understanding of AI image generation and AI as a whole. All this while taking into account ethical, educational and societal boundaries.

ASSIGNMENT **
State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

I will research play and creativity and how these two can be stimulated with AI image generation. Using my research insights I aim to develop a product service system to facilitate children in being creative with AI image generation so they can develop design skills and a healthy relationship towards AI in a self-motivated, playful way. The goal is to develop the basis for a startup using the design concept of my graduation.

I aim to research play and creativity and how these two can be stimulated with AI image generation. By using Co-design and workshops I aim to develop a thorough understanding of children's concerns, values and preferences in regards to AI and AI image generation. This way I expect to be able to develop a way to allow children to play with AI and learn about it through self-motivated learning. Next to this I aim for the children to have a healthy relationship towards AI.

I expect to develop a strategy to roll out a product service combination in an entrepreneurial way. My aim is therefore to have a minimal viable product at the end of my graduation. One of the highest accomplishments would be if I actually have a paying customer at the end of my project.

Since this goal might be too ambitious I aim to at least have a plan for market implementation, a validated value proposition and a plan for how to scale. This should all be included in a pitch video explaining how my product service will be of added value and how it could create a sustainable income flow.

Setting up a company is seldom a solitary activity, so this might mean that I have to establish collaborations with partners to develop my business. At the end of my project I want to either continue with the venue or at least end my partnerships in a professional way and hand over my valuable results to my partners.

start date   17 - 10 - 2022   19 - 5 - 2023   end date

Project week	1	2	3	4	5	6	7	8	9	10		11	12	13	14	15	Visit brother in Colombia	16	17	18	19	20	21	22	23	24	25
Calendar week	42	43	44	45	46	47	48	49	50	51	52	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 17 18 19 20
Date	17-10	24-10	31-10	7-11	14-11	21-11	28-11	5-12	12-12	19-12	26-12	2-1	9-1	16-1	23-1	30-1	6-2	13-2	20-2	27-2	6-3	13-3	20-3	27-3	3-4	10-4	17-4 24-4 1-5 8-5 15-5
Working days	3	4	4	3	3	4	4	4	4	2	2	4	4	4	4	0	0	0	0	4	4	4	4	4	4	4	4 4 4 4 4
Deadline	kick off												Mid-term												Green light		

Research
- Analysis: Finalizing design brief; Finalizing research questions; Context analysis; Desktop research
- Explore: Prototype workshop for adults; Prepare and send sensitizing materials; Teacher interviews; Expert interviews; Parent interviews; Market research; Co-design research session (with kids)
- Define: Definition of design direction

Design
- Ideating: Co-design ideation session (with kids); Co-design ideation session (with experts/ adults); Developing and choosing most promising ideas
- Prototyping: Co-design Prototype ideas session (with kids); Develop Prototype further

Validate
- Validating with target users: Co-design test prototypes (with kids)
- Video: Make design/ pitch video
- Validating with target buyers: Choose prototype and improve into MVP; Try to get first customer

Documenting: Writing report

The practical context of my project will be the international school in Delft. The main focus will be on children almost finishing elementary school or just starting high school. Using Co-design and inclusive and human centered approach can be used to design with AI image generation. Next to Co-design I will do expert, parent and teacher interviews to get a graps of the full context I'm operating in. I will have two classes in which I will be able to do Co-design workshops and other research activities. The cultural mix of international children can provide interesting insight in how children from different nationalities and backgrounds react to my research and design.

The school follows their own curriculum, which is inquiry based learning. This includes design education. The school children have access to computers and Ipads if needed. According to design teacher Miros, most children are using discord. This is currently also the medium through which the research group positive A.I. generates images. This would provide an opportunity to let the children play on their own if this is found to be responsible enough. Important stakeholders in this project are the children themselves, the parents, the teachers of the school and the school board. The school board should be enthusiastic enough about the project to let me do multiple sessions of Co-design. So far the teachers seem very interested in the project and are curious how we can implement it. No parent has been contacted as of this moment. The children have also not yet been informed about the exact goal and subject of my project. It is important to actively put effort into shaping the workshops in such a way that everybody feels safe and that the children can enjoy the new tool. Informed consent for the video is also of great importance.

At the end of the project a solid base for a startup should be there with a validated value proposition and a business plan. Potentially made partnerships during my project could be maintained if decided to follow through, or should be professionally terminated and handled. Handing over any valuable results to the partners.

MOTIVATION AND PERSONAL AMBITIONS
Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

Since I have access to A.I. image generation I have been amazed by the capabilities this software has. This new technology brings with it a lot of unanswered questions which I am eager to find an answer to. This technology has the potential to disrupt the creative business as a whole and will impact the world in many different ways. I think we should guide this technology into the right paths so we can enjoy the possibilities it provides.

Another motivation for me to do this project because I really enjoyed doing my bachelor final project designing a construction toy for children using co-design. I want to deepen my knowledge of co-design techniques and maybe even combine them with context mapping.

I always like to be in the fuzzy front end of the design process, therefore my final product will be more of a demonstrator concept than a production ready concept with a higher technology readiness level.

I want to prove my concept generation and development skills. I want to prove I'm a human centered designer.

Next to this I want to prove my video skills. I want to use my entrepreneurial and (visual) communication skills.

The best outcome would be to have a startup come out of this project!

I want to learn how to design from a technology perspective: "The amazing technology is here, what can we do with it?"

I am also very interested in AI as a whole and want to learn more about this amazing technology and what possibilities it brings.

I also want to learn how to host creative sessions in such a way that it is a reciprocal experience. Where I learn from the participants and the participants learn from me.

FINAL COMMENTS
In case your project brief needs final comments, please add any information you think is relevant.

I still have to finish the reflection assignment for IDE academy (has been approved) and I still have to send the signed graduation brief to the initiate to graduate course coordinators to receive the necessary ECTS. Next to this my brothers first child will be born at the end of January 2023 and I want to visit him in Colombia to see my niece for the first time :) This holiday does make a hole in my project, however I am convinced this will only have minimal effect on my work and the project as a whole.