Master's thesis

NTNU
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AI Literacy at The Norwegian University of Technology and Science

A Mixed Methods Approach Measuring AI Literacy Among Technology Students

Master's thesis in Electronics Systems Design and Innovation
Supervisor: Torstein Bolstad
June 2024

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Acknowledgements

Re-use of Project Thesis

Some parts of this thesis have been based on our previously submitted project thesis (Cubas & Ersdal, 2023). The "Introduction" and "Method" are structurally similar to the project thesis, but have been rewritten and expanded to fit our current research. Parts of the "Background", specifically "Chatbots and ChatGPT", "AI Literacy" and "Education and AI Literacy", as well as "Limitations" and "Sustainability", share some similarities to the project thesis, as they have been modified, but not entirely rewritten.

Use of AI tools

This project uses OpenAI's ChatGPT to assist in the initial drafting of certain chapters. The AI-generated content served as a source of inspiration, providing initial ideas and language formulations. The final content was extensively reviewed and modified by the authors to ensure accuracy, coherence, and alignment with the objectives of this study. The authors maintained full control over the final narrative and conclusion presented in the project.

Abstract

The rise of Artificial Intelligence (AI) across all sectors of society has made the need for comprehensive AI literacy more crucial than ever. This study investigates the current level of AI literacy among technology students at the Norwegian University of Technology and Science (NTNU). Utilizing a mixed methods approach, we analyse quantitative data from a self-reporting questionnaire with qualitative insights from in-depth interviews. This approach highlights potential discrepancies between perceived and actual AI competencies. Findings reveal that while students are confident in their practical use of AI tools and aware of its implications, they exhibit gaps in their theoretical knowledge and understanding of AI's broader societal impacts. Additionally, the research uncovers a substantial shortfall in formal AI education and guidance from NTNU, leading students to rely on unstructured self-learning. The study underscores a strong student demand for more structured AI education, emphasizing the need for educational initiatives that bridge practical skills with theoretical knowledge. This investigation contributes to the ongoing discussion on AI literacy education, suggesting that enhancing understanding of AI among students is crucial for preparing informed, capable, and ethical participants in the digital world.

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Abbreviations

List of all abbreviations:

- **AI** Artificial Intelligence
- **NTNU** The Norwegian University of Technology and Science
- **genAI** Generative Artificial Intelligence
- **LLMs** Large Language Models

Chapter 1

Introduction

Artificial Intelligence (AI) is undeniably coming into our daily lives. Interaction with AI and AI systems is more common than ever, both in private and in industry. As of late 2023, about 42% of enterprise-scale organizations actively use AI within their operations [1]. The European Central Bank reports that 25% of European jobs are now exposed to AI automation, positively affecting the sector-occupation employment share [2]. Similarly in Norway, 25% of companies have adopted AI, up 5-10 percentage points since 2022 [3]. In the Norwegian technology sector, this figure rises to two-thirds of companies. Over half of the companies not adopting AI state that their greatest barrier is the lack of competencies in the field [4]. This highlights a growing need for skilled AI professionals, a need recognized by the Norwegian government through its push for AI use, research, and education to maintain competitiveness in the global AI industry [5]. The rise of AI presents opportunities for innovation and development across multiple fields. It is therefore important that the average user understands what AI is, and how it will affect their life in the future [6]. This new era mirrors the early 2000s' demand for basic computer skills, where AI skills is the new focus point. This skill set includes using, applying, and interacting with AI and is defined as "AI literacy" (AIL) [7].

As generative AI (genAI) tools like ChatGPT and Copilot have become easily accessible, it is imperative that educational institutions prepare and guide students on how to use these technologies. Learning about AI should begin in educational settings, and prepare students for their professional careers. For instance, the University of Florida has implemented "AI Across the Curriculum" to enhance AI literacy among its students [8]. Before adopting such comprehensive programs, assessing the current level of AI literacy is necessary. Because of the high use of AI in the tech industry, measuring the AI literacy of technology students is especially important. Therefore, this research aims to measure the level of AI literacy among technology students at the Norwegian University of Technology and Science (NTNU). To achieve this, a mixed-methods approach is employed, combining quantitative data from a self-reporting questionnaire with qualitative insights from follow-up in-depth interviews. Through these approaches, a more nuanced picture of AI literacy among students is captured, identifying gaps between their self-assessment and their actual skill. Additionally, it is necessary to investigate the student's experiences of current teaching standards in regard to AI, further broadening our insight on how AI education should be implemented.

To understand the competencies underlying the term AI literacy, Chapter 2.1 presents its many dimensions and definition. Chapter 2.2 explores how AI literacy is measured, while Chapter 2.3 provides background on how AI is used in education today. To understand the rapid growth of generative AI and its impact on the educational landscape, Chapter 2.4 will provide background on the rise of genAI, especially focusing on chatbots (Chapter 2.4.1) and ChatGPT (Chapter 2.4.2).

This thesis explores the research question **"What is the current level of AI literacy among technology students at the Norwegian University of Technology and Science?"**. To answer this question, a multifaceted approach is required. Both students' self-assessments and objective evaluation of their AI literacy should be considered. Additionally, how students perceive the delivery of AI education from the university must be examined. This approach is divided into three research sub-questions:

1. How do students perceive their own competency in AI according to the AI literacy framework?

2. What AI literacy competencies do students display in in-depth interviews, and how does this compare to their self-perceived AI literacy?

3. How do students experience guidance from NTNU regarding the use of AI, and in what ways do they perceive the need for AI education?

The mixed method approach applied for answering these research questions consists of a self-assessing questionnaire analysed with descriptive statistics, and semi-structured in-depth interviews with students, with thematic analysis of the transcriptions. Additionally, the literature explored on AI literacy and the measurement of its competencies will supplement the findings. The mixed methods approach is described in Chapter 3. The results can be found in Chapter 4, which presents both the quantitative data of the questionnaire, as well as the thematic analysis of the interviews. The results are discussed in the context of the research questions and background in Chapter 5. Lastly, the project conclusion is in Chapter 6.

Chapter 2

Background

The term "literacy" has traditionally referred to the ability to read and write in a language on a level adequate for communication. However, over the years, the term has broadened significantly. Literacy now encompasses a variety of competencies, skills and knowledge that enable individuals to effectively participate in a given area of society. The emergence of new types of literacy is closely linked to the rise of the internet, as well as other communication technologies (eg. digital literacy, media literacy, information literacy, technology literacy, and social media literacy [9]).

As AI is a ubiquitous concept and tool already found across a plethora of fields, higher educational institutions are in a position where the necessity has arisen to address and expand student competencies in, and awareness of AI [8]. Despite generative AI tools' rapid development in the last few years, there is still a diffusion of AI across the curriculum. AI Literacy has therefore emerged as a new competency in the era of intelligence [10].

2.1 AI Literacy

There are numerous definitions of AI literacy, differentiating in target groups and technicality, as well as configurations of core competencies. Cetindamar et al. (2024) [11] defines AI literacy in the context of work through a search of existing AI literature. Their findings highlight a set of four core capabilities related to AI literacy, namely technology-related, work-related, human-machine-related, and learning-related capabilities. It is also emphasized that AI literacy should be accessible to non-AI professionals, thereby excluding in-depth programming skills from the core competencies of AI literacy. Laupichler et al. (2023) [12] developed a scale for assessing the AI literacy of non-experts. Their definition of AIL "describes competencies that include basic knowledge and analytical evaluation of AI, as well as critical use of AI applications by non-experts". The paper explicitly excludes programming skills from their definition, and argues that it represents a separate set of competencies that go beyond their definition of AIL. Kong & Zhang (2021) [13] define AI literacy to include three components: AI concepts, using AI concepts for evaluation, and using AI concepts for understanding the real world through problem-solving.

The definitions above build on the AIL definition by Long & Magerko (2020) [7], and tailor it to their context. AI literacy, as defined by Long & Magerko, refers to an individual's ability to understand and critically assess AI technologies; communicate and collaborate effectively with AI; and use AI as a tool at home, online, or in the workplace. The paper presents an extensive framework consisting of 15 design considerations, and 17 core competencies in AI literacy to support AI developers and educators in creating learner-centered AI.

Although there exist many definitions of AI literacy, few of the studies provide a comprehensive explanation of how to conceptualize it [14]. Ng and colleagues, in their review on educational conceptualizations of AI literacy, state that an individual is AI literate if they know the basic functions of AI, can apply AI knowledge in different settings, evaluate, predict, and design, as well as make ethical considerations concerning AI [14]. The paper constructs a conceptualization framework consisting of four main competencies. The core competencies are as follows:

1. **Know & Understand AI:** Distinguish between technological artefacts that use, and don't use AI. Know the basic functions of AI and how to use AI applications, as well as strengths and weaknesses of AI, and critical thinking surrounding AI.

2. **Use & Apply AI:** Applying AI knowledge, concepts and applications in different scenarios. Ability to communicate and collaborate effectively with AI technologies.

3. **Evaluate and Create AI:** Higher-order thinking skills. Evaluate, appraise, predict and design with AI applications.

4. **AI Ethics:** Human centered considerations. Identify key ethical issues surrounding AI, such as privacy, employment, misinformation, ethical decision-making, diversity, bias and transparency.

As pointed out by Ng. et al (2021) [14], the novelty of AI literacy means that no classification of cognitive processes has been developed in the context of AI learning. Therefore, Ng and colleagues chose to adopt the Bloom architecture to map the competencies of AI literacy on [15]. In fact, most conceptualizations parallel Bloom's taxonomy in the hierarchical configuration of skills. The configuration of AI literacy skills on Bloom's Taxonomy can be observed in figure 2.1.1. The bottom two levels correspond to "Know & Understand AI", "Use & Apply AI" fits in the "Apply" level, "AI Ethics" corresponds to "Analyse", while "Evaluate and Create AI" fits the top two levels.

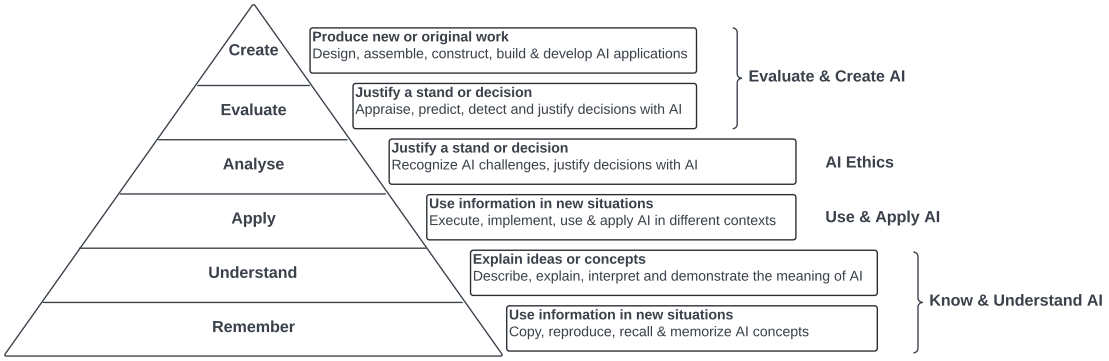

Figure 2.1.1: Bloom's Taxonomy and AIL, adapted from Ng et al. (2021) [14].

Even though the definitions of AI literacy differ, they mostly consider an individual to be AI literate even though they do not possess the in-depth technical knowledge or the ability to create AI applications [7][16][13]. This consideration conflicts the conceptualizations by Ng et al. (2021) [14]. However, Carolus et al. (2023) [17], in their development of the meta-AI literacy scale, found through a factor analysis of their questionnaire that "Create AI" did not show a strong alignment with the core construct of AI literacy. This result suggests that "Create AI" should be considered as a separate skill, related to, but distinct from AI literacy.

2.2 Measuring AI Literacy

Multiple scales have been developed to measure AI literacy. As noted by Carolus et al. (2023) [17], AI literacy is often thought of in the context of education, where the tools for evaluation are designed for a specific intervention. These AI literacy scales are often times measured with single choice or open-ended knowledge tests: Ali et al. (2019) [18] developed a K12 AI education curriculum, and tested the students prior to, and after receiving three 45-minute sessions with an open-ended test. On the university level, Kandlhofer et al. (2016) [19] created an AI education concept aiming at fostering AI literacy across all levels of education, evaluating students through questionnaires, hands-on exercises, and interviews. Williams et al. (2019) [20] developed an AI platform for children (e.g. K12), *PopBots*, and evaluated the children using multiple-choice tests. Rodríguez-García and colleagues developed the educational platform `LearningML`, aiming to provide learners and educators a platform for the creation of hands-on AI projects [21], where an open-ended knowledge test was given to the students participating in the research.

The supposed benefit of using these tests is the higher quality of measurement. This is debatable, as open-ended questions, for instance, are susceptible to personal opinion and social desirability bias [22]. A disadvantage of these tests is also that they are close to the content of the intervention, meaning that the test primarily assesses knowledge directly related to what was taught in the specific lesson, rather than evaluating the student's broader understanding of AI concepts.

To tackle the disadvantages of open-ended assessment, some researchers also resort to self-assessments [23]. These are easier to carry out, being more objective and

leaving no room for interpretation of answers. To investigate students' AI learning readiness, Dai and colleagues deployed a 4-point Likert scale questionnaire where students self-reported AI readiness, confidence in AI, AI anxiety, AI literacy, and AI relevance [16]. However, as pointed out by Carolus and colleagues, assessment instruments used in schools all have in common that their factorial structure was not examined in large samples [17]. Additionally large proportion of these studies do not separate between different competencies of AI literacy. This should be an important aspect of their evaluation, leading to a comprehensive assessment with better flexibility for cross-disciplinary investigations.

Recently, more researchers have published generalized scales for the measurement of AI literacy. Karaca and colleagues developed a scale to measure the AI readiness of medical students, MAIRS-MS [24]. However, the scale appears to be easily adaptable to other professional fields. The 27-item scale showed validity through the exploratory and confirmatory factor analysis, measuring AI literacy over the four domains "Cognition", "Ability", "Vision" and "Ethics". Wang et al. (2022) [25] also developed and validated a scale called the "artificial intelligence literacy scale". The scale consists of 12 items on four domains: "Awareness", "Usage", "Evaluation" and "Ethics". To develop this scale, Wang and colleagues draw clear lines of inspiration to existing theory on digital literacy, and do not consider the conceptualization of AIL by Ng et al. (2021) [14]. Pinski & Benlian (2023) [26] recently developed a measuring instrument for general AI literacy through a systematic literature review, and five expert interviews. Through these interviews, they derive their own conceptualization of AI literacy, and a scale that differentiates between experience-based knowledge, and explicit knowledge. Laupichler and colleagues developed the "scale for the assessment of non-experts' AI literacy" (SNAIL) [12]. An initial set of items was generated and refined by experts in the field of AI education, following the Delphi method. The scale consists of 38 items, only loosely connected to the AI literacy framework by Long & Magerko (2020) [7]. The authors did not conduct a factor analysis to validate the scale.

It becomes evident that measuring AI literacy has no conformed standards yet. Albeit, the number of scales already developed shows that AI literacy is an important topic, researched in many different and specialized ways. As pointed out by Carolus and colleagues, established competence taxonomies like Bloom (1956) [15] and Ng et al. (2021) [14] are not used consistently as a theoretical basis when formulating items [17]. With this in mind, Carolus and colleagues developed the Meta AI literacy scale (MAILS), aiming to create a measurement instrument that is applicable over multiple contexts, and modular (i.e. components of instruments can be used separately from one another). To confirm the factorial structure of the scale, 300 German-speaking adults answered the developed questionnaire consisting of 34 items. Their findings provide a scale with the facets "Use & Apply AI", "Understand AI", "Detect AI", "AI Ethics" and "Create AI" as a separate construct, and, "AI Self-efficacy" in learning and problem-solving, and "AI Self-management" [17].

2.3 Education and AI Literacy

In the light of education, Southworth et al. (2023) [8] at The University of Florida (UF), proposes a model called "AI Across the Curriculum", to address potential gaps in AI education, and integrate AI across the curriculum at the university level through AI literacy. They reason the need for AI education by expressing the importance of AI as a cross-disciplinary field, essential for future societal development. In addition, this is a push for educational systems to adapt and include AI across all disciplines, preparing students for the future demands in their careers. The UF model drives for a structured integration of AI literacy through curriculum development, academic programs, practical engagement and career preparation. The solution is built on the AI literacy framework by Ng et al., with specific student learning outcomes for each competency, and various amounts of AI-related course content across the university. Assessment of the model will be done annually by UF.

AI literacy is not only in the spotlight at higher levels of education. Zhang et al. (2022) [27] designed and implemented the "Developing AI Literacy" (DAILy) workshop, aiming at helping middle school students understand three fundamental domains of AI: "AI concepts" focuses on factual knowledge of AI concepts and technical details. "Ethical and societal implications" is designed to help students understand the implications and consequences of using AI for society, while "AI career future" concerns what impact AI can have on future careers. The outcomes of the workshop were promising. Students gained a basic understanding of AI operations like supervised learning, strong and weak AI, as well as recognizing bias and methods to mitigate it. Furthermore, the study found that the discussions on ethics and career opportunities effectively broadened students understanding of how AI will affect their lives personally, their careers, and society.

As discovered in the qualitative study by Chan & Louisa (2023) [28], some educators perceive generative AI technologies will work against them if they fail to provide proper guidelines and training in order for students to use the tools properly. Teachers emphasized the lack of AI literacy as detrimental, and suggested AI literacy for both educators and students [29]. Some teachers also raised concerns about the ethical challenges of generative AI, where students potentially violate academic integrity, leading to a loss of trust between teacher and student. Once again, this underscores the importance of heightening AIL among users, and raising awareness of ethical concerns and implications of using AI tools.

In the authors' project thesis, Cubas & Ersdal (2023) [30], we investigated how genAI can be used as a tool for improved learning in engineering education through interviews with four educators in different technological fields. By interviewing four educators in the field of engineering, the findings suggest that educators see the potential of AI in personalizing and enhancing learning. However, they caution against an over-reliance of the tools available to students, which might compromise the essential human elements of both teaching and learning. Additionally, they advocate for better education in AI, leading to better AI literacy across the educational landscape.

Until now, many researches on AI in education focus on the development of course material and assessment from an educator's point of view, as well as how educators think AI will affect education. However, student views seem to be somewhat underrepresented in this field, as stated by Brew et al. (2023) [31]. In their article, a guided open discussion about AI in education was held with students from the University of Leeds and University College London. Three provocations were presented and discussed, and shone light on the importance of AI literacy as a core competency of digital literacy. Shoufan (2023) [32], explored computer science students' perspectives of ChatGPT through a learning activity, thematic analysis of an open question, and follow-up survey. The results revealed that even though students admire the capabilities of ChatGPT and find it interesting, they observe many inaccuracies in its answers. When it came to the impacts ChatGPT had on learning, careers and society, students were generally more divided or diffuse in their opinion, suggesting a lack of knowledge of the core principles behind AI. As ChatGPT is already used widely among students [33], it is important that students also learn how to use it correctly. This emphasizes the importance of educating students on the concepts of AI, its' strengths and weaknesses, thereby, fostering AI literacy.

2.4 Chatbots and ChatGPT

The term chatbot refers to a computer program that provides services through dialogue [34]. With the advancement of AI technology over the recent years, especially in generative AI (GAI) and large language models (LLMs), chatbots have become extremely powerful tools for chatting, asking questions, and executing tasks in a human-like manner [35]. Particularly noteworthy is ChatGPT, an advanced model that serves as a prominent example of AI technologies actively used by students [36][37]. Therefore, it is necessary to review this technology in the context of education.

2.4.1 Chatbots in Educational Contexts

From the literature review of Hwang & Chang [38], many chatbots have been used and researched in education over the last decade, as scholars have found that interacting with chatbots could potentially increase students' learning interests. Kerly and Bull used a chatbot to train university students how to negotiate with people [39]. Tegos et al. used a chatbot to promote academically productive talk in a multimedia course, and found it effective in terms of improving students' performance [40]. Recently, Shorey et al. used a chatbot as a virtual patient to train nursing students' communication skills [41]. On the other hand, studies also report the limitations of chatbots. Fryer et al. conducted a study in a language course to compare the performance of students using chatbots for practice, and students practicing via peer interactions [42]. They found that after 3 weeks, students' interest in using chatbots for practice decreased, while peer practice was the same. It becomes clear that there is a big potential for using chatbots in education, but at the same time, the challenges and limitations of these tools must be considered.

2.4.2 ChatGPT

A landmark in the evolution of chatbots was the release of ChatGPT by OpenAI on November 30, 2022 [43]. As Atlas notes, this release marked a substantial advancement in language models technology [44]. ChatGPT extends the capabilities of chatbots by integrating deep learning and language models based on the Generative Pre-training Transformer (GPT) architecture by Radford et al. [45]. This architecture uses unsupervised pre-training, and supervised fine-tuning to produce responses that closely mimic human interactions on levels of an expert in the topic of choice. With a vast training database, consisting of web pages, books, articles and social media content, ChatGPT shows proficiency in a plethora of tasks; software development, essays, poetry, business letters and contracts [46][47]. However, it has also raised concerns relating to the difficulty of detecting AI versus human authorship within the academic and educational landscape, leading to scholars raising the alarm because of the possible compromise of academic integrity [48]. In response to these challenges, there is a growing need to establish clear guidelines and frameworks for the responsible use of generative AI in an educational setting. In addition, the need for students and other users to learn about and understand AI tools (i. e. AI Literacy) is essential, bringing to light the potential pitfalls one could stumble upon when using them.

Chapter 3

Methods

In this chapter, the methodology of the thesis is presented. With our general research question "What is the current level of AI literacy among technology students (at NTNU)?" as a starting point, research methods were chosen. To measure the AI competencies of students, we employ a mixed method approach. An overview of the methods, and how they each contribute to the research- and research sub-questions can be viewed in figure 3.0.1. Firstly, data is gathered through a questionnaire, followed by an in-depth interview with a random sample of participants who answered the questionnaire. The data from the questionnaire is analysed using descriptive statistics, and interesting findings are brought to the interview for further investigation. The interviews are transcribed and thematically analysed using a deductive approach.

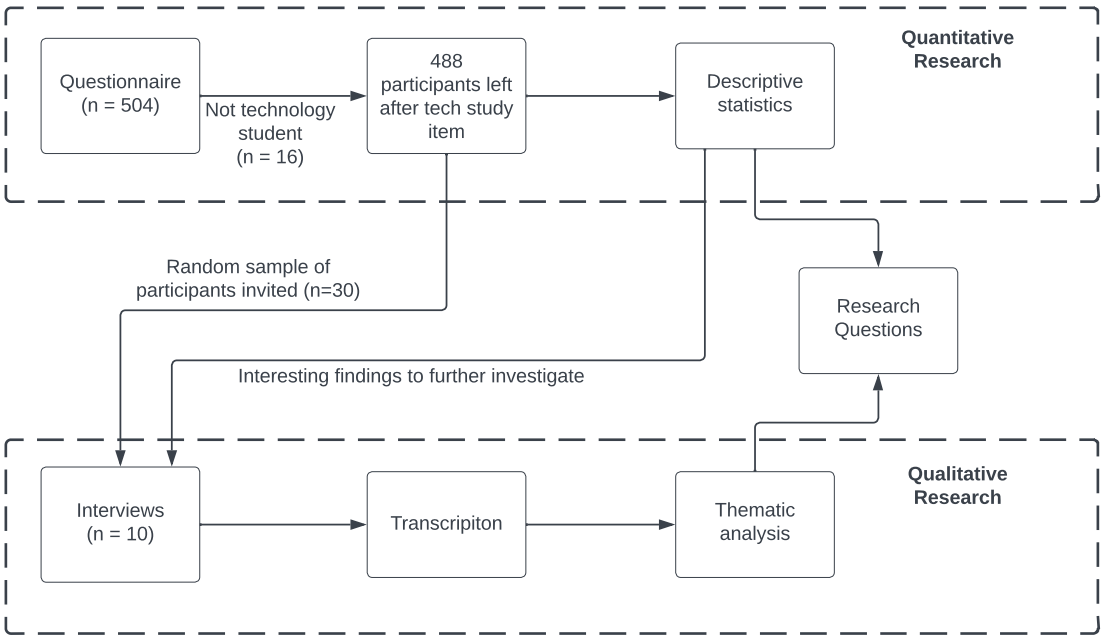

Figure 3.0.1: Overview of the research method.

Choosing a questionnaire for data gathering is effective for assessing the level of AI literacy of students across various technology fields. This method is especially suitable because it can handle large sample sizes, which is essential for detailed

insight [49]. From Chapter 2.2, measuring AIL is a field with many different approaches. We have chosen items in line with the competencies by Long & Magerko (2020) [7], in categories corresponding to the AIL conceptualization presented by Ng et al. (2021) [14], influenced by the items on the AIL measurement scale by Carolus and colleagues [17]. Some items are added regarding students' experiences with guidance from the university regarding AI, giving insight into how NTNU currently guides students on the use of AI.

The basis for the quantitative approach will be a questionnaire on students' self-perceived knowledge and understanding of AI, a qualitative approach will allow for a more nuanced, and deeper understanding of the student's competencies. Not only does it add more detailed explanations and reasons on items from the questionnaire, but it also underlines and ensures that the quantitative data is reliable. A random sample of participants is therefore picked from the questionnaire participant list. The interview format is semi-structured [50]. This allows students' perspectives and own ideas to emerge, and gives them the chance to provide meaningful insight into their knowledge and understanding of AI tools. In addition, it gives the interviewer the possibility to ask follow-up questions. The interviews are transcribed and then analyzed using a thematic analysis approach to identify and deduce themes and patterns [51]. The interview is also designed based on the AIL model by Ng et al. This creates some clear lines between the questionnaire and the interview, giving us a meaningful way to analyse each theme in correspondence with the AIL competencies.

The mixed method approach allows for a nuanced insight into the use and understanding of AI among technology students. Since these research methods derive theoretical assumptions from practical observation (i.e., participants' answers to questionnaire items, and semi-open interviews), we refrain from formulating hypotheses.

3.1 Questionnaire Design

The approach to developing the questionnaire for technology students in higher education started by examining the AIL competencies of Long & Magerko [7]. The developed items were then categorized according to the AIL conceptualization framework by Ng et al. (2021) [14], sorting items into the four competencies "Know & Understand AI", "Use & Apply AI", "Evaluate AI" and "AI Ethics". Our questionnaire items are comparable to the the meta AI literacy scale by Carolus et al. [17]. However, we have excluded facets like AI Self-Efficacy and AI Self-Competency, solely basing our items on AI literacy competencies. As pointed out in Chapter 2.1, the competency of creating AI is considered a separate construct, and is therefore not included. Additionally, we have constructed a separate section unrelated to AI literacy competencies, called AI in Education (AIED). Here, we wish to investigate the experiences students have in receiving guidance or information about the use of AI tools from the university. An overview of each item and their answer types of the questionnaire can be seen in table 3.1.1.

3.1.1 Questionnaire Items

The questionnaire had 38 items, where 28 items were related to a competency of AI literacy. An overview of which items relate to which competency can be observed in table 3.1.2. Each item required students to answer a statement based on 5- and 4-point Likert scales, either answered in frequency (i.e., never, a little, sometimes, a lot, always), or agreement (i.e., disagree, somewhat disagree, neither agree nor disagree, somewhat agree, agree). This enables a quantitative assessment of students' perceptions of their knowledge and use of AI. Two user tests were conducted when designing the questionnaire. In this process, we actively discussed with the test participants how they understood each item, and what scale seemed reasonable to use. A 4-point scale is used for items UA1-UA5 and AIED1. This forces the participant to take a non-neutral stance, giving more nuanced insight into the general opinions and perceptions on AI use, and what experience students have regarding guidance from educators on AI. Most other items use a 5-point scale, including the option to stay neutral, as the items are formulated in a way that neutral is meaningful to the results. Noteworthy, four items in the category "AI in Education", AIED2-AIED5 use a 5-point scale, with an additional "don't know" option. This option is excluded from the data when the results are analysed.

Item	Question	Answer type
INTRO1	Are you an engineering student, or a student of a similar study of technology?	Y/N
INTRO2	What year are you in?	Single choice 1-5
KU1	I know about areas where AI is and can be used	5-point Likert scale (Agreement)
KU2	I know about the limitations of AI	
KU3	I am interested in AI technology and its areas of use	
KU4*	I don't know how to use AI	
KU5	I can imagine future usage areas for AI	
UA1	I often use AI tools in my studies	4-point Likert scale (Agreement)
UA2	I am always able to use AI in a way that gives me a satisfactory answer	
UA3*	I always get a satisfactory answer on the first attempt	
UA4	I always take my time writing a good prompt to get a satisfactory answer	
UA5	When I use AI, I think of it as a collaborator, not as a tool	
S1	How much do you use AI tools in the scenario: Programming	5-point Likert scale (Frequency)
S2	How much do you use AI tools in the scenario: Writing reports	
S3	How much do you use AI tools in the scenario: Mathematics	
S4	How much do you use AI tools in the scenario: Grammar and spelling	
S5	How much do you use AI tools in the scenario: Learning curriculum	
S6	How much do you use AI tools in the scenario: Writing academic English	
EV1*	I always trust the answers I get from AI	5-point Likert scale (Agreement)
EV2	I am confident in my ability to evaluate the correctness of answers from AI	
EV3	I am aware there are disadvantages of using AI in my schoolwork	
EV4*	AI is always precise enough to copy the answer if I want to	
EV5	I always compare answers from AI with other sources	
ETH1	I am aware there are ethical challenges related to AI technology	
ETH2	I am aware of this ethical challenge related to AI: Plagiarism	4-point Likert scale (Knowledge)
ETH3	I am aware of this ethical challenge related to AI: Privacy	
ETH4	I am aware of this ethical challenge related to AI: Bias	
ETH5	I am aware of this ethical challenge related to AI: Equality	
ETH6	I am aware of this ethical challenge related to AI: Misinformation	
ETH7	I am aware of this ethical challenge related to AI: Sustainability and environmental changes	
AIED1	How much guidance have you received from the university when it comes to responsible use of AI tools?	4-point Likert scale (Frequency)
AIED2	I wish the university would give us more guidance on how to use AI	5-point Likert scale (Agreement) + Don't know
AIED3	I am afraid I won't learn the course if I use AI tools as assistance	
AIED4	I am not worried about my future work opportunities when looking at AI development	
AIED5	I am not dependent on using AI tools when doing schoolwork	
AIED6	I think it's important to learn about AI because: Preparation for work life	5-point Likert scale (Agreement)
AIED7	I think it's important to learn about AI because: Making schoolwork more efficient	
AIED8	I think it's important to learn about AI because: Understanding ethical challenges	

Table 3.1.1: Overview of the questionnaire items, their code and answer type. Items marked with * indicate an inverse scale.

AI literacy categories	Definitions	Competencies	Questionnaire items
Know & Understand AI	Know and understand the basic concepts and how to use AI applications.	Identify, recognize, describe and explain characteristics of AI.	**KU1, KU2, KU3, KU4, KU5**
Use & Apply AI	Applying AI knowledge, concepts and applications in different scenarios.	Utilize AI tools and techniques appropriate to specific contexts and applications.	**UA1, UA2, UA3, UA4, UA5, S1, S2, S3, S4, S5, S6**
Evaluate AI	Higher-order thinking skills (e.g., evaluate, appraise) AI outputs.	Assess and evaluate the quality and correctnes of the output of AI tools.	**EV1, EV2, EV3, EV4, EV5**
AI ethics	Human-centered considerations (e.g., ethics, bias, misinformation, privacy, sustainability).	Identify, consider and be aware of ethical considerations and challenges when using AI tools.	**ETH1, ETH2, ETH3, ETH4, ETH5, ETH6, ETH7**

Table 3.1.2: Descriptions of four AIL categories, competencies and related questionnaire items. The categories are based on the conceptualizations of Ng et al. and competencies by Long & Magerko.

3.1.2 Data Analysis

Student responses were analysed with descriptive statistics, where each item is measured in mean, median, and mode. To analyse the data, IBM SPSS is used. To visually represent data, a python script using the library `pandas` is used.

3.1.3 Distribution

The questionnaire was distributed targeting students in studies of technology and engineering at NTNU. It was distributed through different channels, such as student email lists, posters, and word of mouth to fellow students. Multiple emails were sent to faculty staff members of the Faculty of Information Technology and Electrical Engineering (IE), the Faculty of Engineering (IV), and the Faculty of Natural Sciences (NV), asking them to distribute the questionnaire to their students. With varying success, the questionnaire was distributed to 9 study programmes within the three faculties through email. This amounts to approximately 3000 technology students. The questionnaire does not ask which study programme the participant enrolls in, which is irrelevant to the study. Students are generally uninterested in answering questionnaires, so a 500NOK gift card was used as bait to reel in participants.

To ensure the questionnaire was answered by eligible participants, additional screening was employed through the questionnaire distributor Nettskjema, where a Norwegian student account (Feide) was required to answer the questionnaire. To reinforce the stringency and restriction to technology students only, a simple "Yes" or "No" question asking if the participant enrolled in a technological study was asked at the beginning. The questionnaire was open from the 19^{th} of February until the 15^{th} of March. A total of 504 students answered the questionnaire, where a student was limited to answering once, due to the login method of the questionnaire provider. The Norwegian Agency for Shared Services in Education and Research, Sikt, requires an approved application in order to conduct a research survey. This was obtained before distribution began. The questionnaire was anonymous, and the sole purpose of gathering e-mail addresses was to hand out the gift card. Privacy and data security were also provided through Nettskjema.

3.2 Interview with Students

3.2.1 Interview Structure

The interview is divided into six parts, as shown in figure 3.2.1. All parts are contained within the semi-structured interview, and work as topics and talking points connected to the AIL competencies. This allows students time to develop their thoughts in a guided manner. The first part consists of simple introductory overview questions. The second part focuses on the AIL competency "Know & Understand AI". The third part investigates the student's use and application of AI tools in their schoolwork. The fourth part investigates students' abilities and approaches to evaluating AI. The fifth segment explores the knowledge students have regarding ethics in AI. Lastly, part six explores what guidance students have received from their educators regarding AI technologies.

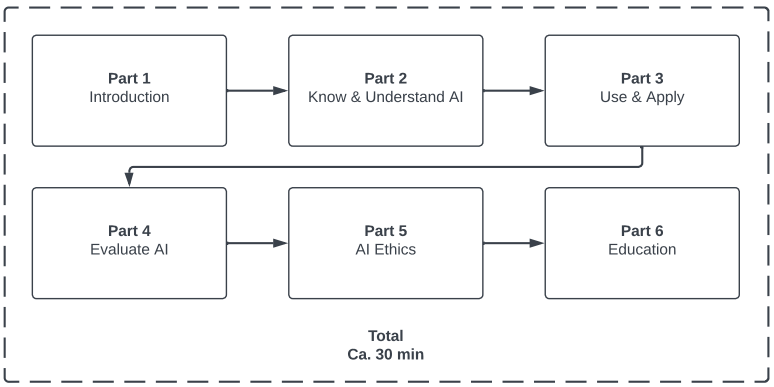

Figure 3.2.1: Overview of the interview structure.

The interviews are recorded with permission from the participants, which is clearly stated as voluntary in the participation invite prior to the interview. The Norwegian Agency for Shared Services in Education and Research, Sikt, requires an approved application in order to record interviews. This was obtained before starting the interview process. Participants also receive a consent form before the interview starts, maintaining the integrity of privacy and rights.

The semi-structured nature of the interviews allows the opportunity for follow-up questions, as well as altering questions to align with what type of AI tools the students use, and how they use them. This adaptability is crucial in ensuring that each question is somewhat answerable by all participants, resulting in a consistent data set capturing nuanced elements between study years, and study programmes. Semi-structured interviews create an encouraging environment for the students to reflect and give in-depth insight beyond the questionnaire. This approach facilitates a comprehensive understanding of the competency level in AIL across technological study programmes at NTNU.

3.2.2 Interview Questions

The interview questions are developed based on the research question "What is the current level of AIL among students at NTNU?". The questions are closely linked to the questionnaire in its distribution of categories corresponding to the AIL conceptualization by Ng et al, as previously observed in table 3.1.2 and figure 3.2.1.

The first category, "Introduction" gathers basic but crucial information about the participant's academic background and their initial exposure to AI tools. This contextualizes their subsequent responses by linking their AI usage and competency level to their stage of education.

The second category, "Know & Understand AI", dives into the cognitive aspect of AI literacy. In this part, students are prompted to define AI in their own words and discuss the distinctions between human and artificial intelligence. This section also explores their awareness of AI's capabilities and limitations, which is important for understanding students' conceptual grasp of AI tools as a whole.

The third category, "Use & Apply AI", focuses on the practical application of AI tools in the student's academic lives. It investigates how actively they use these tools and in which contexts, looking for specific examples that illustrate their approach to integrating AI into their daily tasks. This part is key for assessing how well AI tools are embedded in students' academic practices, and how they enhance or hold back their educational experiences.

The fourth category, "Evaluate AI", probes into the evaluation process (if any exists) students engage in when using AI outputs. It examines the trust they place in AI-generated solutions and their strategies, thoughts and reflections for verifying and utilizing these outputs. This reflects their ability to think critically when interacting with AI technologies. This section also addresses the perceived drawbacks of using AI in academia, providing insights into potential barriers to effective AI integration.

The fifth category, "AI Ethics", explores how well students know the ethical challenges of AI. This section seeks to uncover their understanding of, and attitudes towards the ethical implications of AI. This includes issues of plagiarism, privacy, and bias, but also gauges their awareness of less-discussed concerns like sustainability and equality, offering a rounded view of the ethical considerations students have knowledge of.

The sixth and last category, "AI in Education", is not directly connected to AIL, but rather captures students' perceptions on the role of AI in education, specifically focusing on the institutional support and guidance they receive. This final section discusses their views on how AI tools should be taught and used at the university level. The interview questions can be found below.

Part 1: Introduction

1. What is your study programme?
    (a) What year are you in?
2. Have you used AI tools in your education?
    (a) Which AI tools have you used?
3. How would you describe your own competency in AI?

Part 2: Know & Understand AI

1. With your own words, can you provide a definition of artificial intelligence?
2. What do you think divides human intelligence from AI?
3. Can you give examples of tasks where AI tools do not work well?
4. Can you give any examples of tasks where AI tools do work well?
5. Can you imagine any future areas of use for AI?

Part 3: Use & Apply AI

1. Do you use AI tools actively in your everyday schoolwork?
2. How do you use AI tools in your schoolwork?
    (a) Give us an example where you have used AI tools for a task, and talk us through how you did it
3. Of the areas you use AI tools, where do you find them most useful?
4. Do you make conscious choices to optimize the answers you get from AI tools?

Part 4: Evaluate AI

1. How do you normally approach evaluating outputs from an AI tool?
    (a) What do you think about when you read the output, and how do you decide what to use the output for?
    (b) Does your strategy change if you use AI tools for different tasks?
2. Do you trust the answers given by AI tools?
    (a) Why?
    (b) When do you trust, and when do you not trust the answers?
3. How do you think one should "deal with" answers from AI tools?
4. From the questionnaire, we found that many agreed there exist disadvantages of using AI tools in their schoolwork. Do you agree, and can you elaborate?

Part 5: AI Ethics

1. Can you describe some ethical challenges related to AI?
   (a) Why are these ethical challenges?
2. In the questionnaire, plagiarism, privacy, bias, equality, misinformation, sustainability and environmental changes were listed as ethical challenges. Do you know any of these, and can you explain them?
3. Do you think students should learn about ethics related to AI?
   (a) Why/why not?
   (b) How do you think ethics should be learned about by students?
4. From the questionnaire, the least known ethical concerns were sustainability and environmental changes, and equality.
   (a) Why do you think these two items scored low?
   (b) Can you explain these ethical concerns?

Part 6: AI in Education

1. Have you received any form of guidance from the university on the use of AI tools in your education?
   (a) If so, what type of guidance have you received?
2. Do you think the university should teach students how to use AI tools?
   (a) Why/why not?
3. How do you think AI tools should be used by students at university level?

3.2.3 Transcription Style

All recordings of the interviews are transcribed and anonymized, unlocking the possibility for a detailed analysis of each interview. Transcriptions are written in Norwegian, as all interviews were held in Norwegian. The chosen transcription style is intelligent verbatim, which makes for an easily readable transcript that captures the participants' intended meanings [52]. This approach involves the removal of filler words, repetitions, and other noise unless they contribute to some context or significance of dialogue. Furthermore, long pauses and extended irrelevant sentences are included, ensuring the authentic nature of the participants' expressions. This selection is subjective, but aims to preserve the richness of the conversation, as well as streamlining the transcript for clarity and coherence.

All transcriptions are marked by **Q** and **A**, representing the dialogue contribution from the interviewers (Q) and participants' (A). Given the semi-open nature of the interview, a noteworthy dimension is the inclusion of follow-up questions, an aspect not explicitly outlined in the prepared question sheet. However, they

are transcribed as any other question asked.

3.2.4 Thematic Analysis

In this study, a thematic analysis is employed. This is a methodological approach that allows for a systematic and in-depth exploration of the qualitative data collected through the interview process. Thematic analysis is a good approach when trying to gauge the competencies of students in AIL. The thematic analysis is deployed using a deductive approach, where the themes are developed from preexisting theory and conceptualization of AIL, as well as connecting themes directly to the questionnaire. This approach allows for flexibility in terms of uncovering patterns and key insights into the dataset, facilitating meaningful comparisons between questionnaire and interview findings. The subtext underlying the qualitative data is important in order to fully understand students' level of AIL in the context of this study. Therefore, a latent approach is used when trying to understand the data [51]. Unlike a semantic approach, the latent approach focuses on the underlying meaning of the data, in order to deduce the competencies underlying the semantic content [53].

The thematic analysis approach is based on a step-by-step guide from Braun & Clarke [54]. The process is described as the following:

1. Familiarization - Transcribe, read, reread, and make observations.
2. Generate Initial Codes - Pick out relevant quotes with an inductive approach, organize them.
3. Search for Themes - Gather all data into chosen themes.
4. Review Themes - Deductive approach, find connections between themes, review relevancy, remove or add, read through transcriptions again.
5. Define and Name Themes - Iterative process of going over analysis, provide concise and meaningful descriptions of the themes.
6. Write Results - Present the findings of the thematic analysis.

3.2.5 Distribution

The questionnaire contained a preliminary question, asking if participants were interested in doing a follow-up interview, and receiving a cinema gift card as a thank-you for participating.

In total, 28 participants of the questionnaire were invited to the follow-up interview, and contacted via e-mail. As expected, many did not answer or declined. In the end, 10 participants were interviewed.

Chapter 4

Results

4.1 Questionnaire

In this chapter, the results for the questionnaire are presented for each of the sections "Know & Understand AI", "Use & Apply AI", "Evaluate AI", "AI Ethics" and "AI in Education". A short overview of the participant demographic is also presented.

4.1.1 Participation

In total, 504 answers were collected from the questionnaire. Of these, 16 participants answered they were not part of a technological or engineering program and were thus omitted from the analysis. A further distribution of the responses based on the year level of the respondent can be seen in table 4.1.1.

Table 4.1.1: Distribution of responses.

Study year	**# of participants**	**% of total**
1st year	96	19.0%
2nd year	86	17.0%
3rd year	78	15.5%
4th year	90	17.0%
5th year	138	27.4%
No technical studies	16	3.2%
Total responses	504	100%

4.1.2 Questionnaire Results

4.1.2.1 Know & Understand AI

For the "Know & Understand AI" section of the questionnaire, the respondents were confident in their own knowledge on AI and there were an overall high score on every question. As can be seen in table 4.1.2, every question was ranked as 4 or higher with the exception of KU4. KU4 was worded opposite of the other questions in the section and the score is therefore reversed. The results indicate that the respondents feel they are knowledgeable in current areas of use for AI

(KU1), as well as future uses (KU5). This knowledge is closely linked to being aware of the limitations of AI (KU3) and knowing how to use AI (KU4), which both also have high scores. Finally, given the reported high level of knowledge, it is no surprise that the respondents are highly interested in AI technology and its areas of use (KU3).

Table 4.1.2: Mean, median and mode of the "Know & Understand AI" section. Items marked with * indicate an inverse scale.

Question	Mean	Median	Mode
KU1	4.41	4.0	5
KU2	4.06	4.0	4
KU3	4.44	5.0	5
KU4*	1.76	2.0	2
KU5	4.30	4.0	4

4.1.2.2 Use & Apply AI

The results from the "Use & Apply AI" section can be seen in table 4.1.3 together with the six scenarios in table 4.1.4. From the mode of UA1 one can see that the majority of the respondents regularly use AI tools in their studies. The rest of the items concerns how proficient the respondents feel they are at using said tools, with always getting a satisfactory answer (UA2), getting a satisfactory answer on the first attempt (UA3), and putting in time and effort into achieving a satisfactory answer (UA4). The last item asks to what degree the respondents use AI tools as a collaborator or simply as a tool (UA5). In this section, UA3 is worded opposite of the other questions and the score is therefore reversed. Considering the high mean of UA1 (3.27), UA2-UA5 score lower. This suggests that although students use AI tools, they might not use them critically or in the most efficient way possible.

Further, the AI use is more or less evenly spread across the different scenarios with the exception of S1 programming being the most popular area of use. The rest are writing reports (S2), mathematics (S3), grammar and spelling (S4), learning curriculum (S5) ans writing academic English (S6).

Figure 4.1.1 shows the distribution between years of study for item S4, using AI for spelling checks. The figure reveals a stark difference in use between years of study, where fifth graders utilise AI tools to a far greater extent than lower years.

Table 4.1.3: Mean, median and mode of the "Use & Apply AI" section on a 4-point Likert scale. Items marked with * indicate an inverse scale.

Question	Mean	Median	Mode
UA1	3.27	3.0	4
UA2	2.79	3.0	3
UA3*	1.79	2.0	1
UA4	2.61	3.0	3
UA5	2.24	2.0	2

Table 4.1.4: Mean, median and mode of the scenarios in the "Use & Apply AI" section.

Question	Mean	Median	Mode
S1	3.61	4.0	4
S2	2.69	3.0	3
S3	2.17	2.0	2
S4	2.51	2.0	1
S5	2.72	3.0	3
S6	2.35	2.0	1

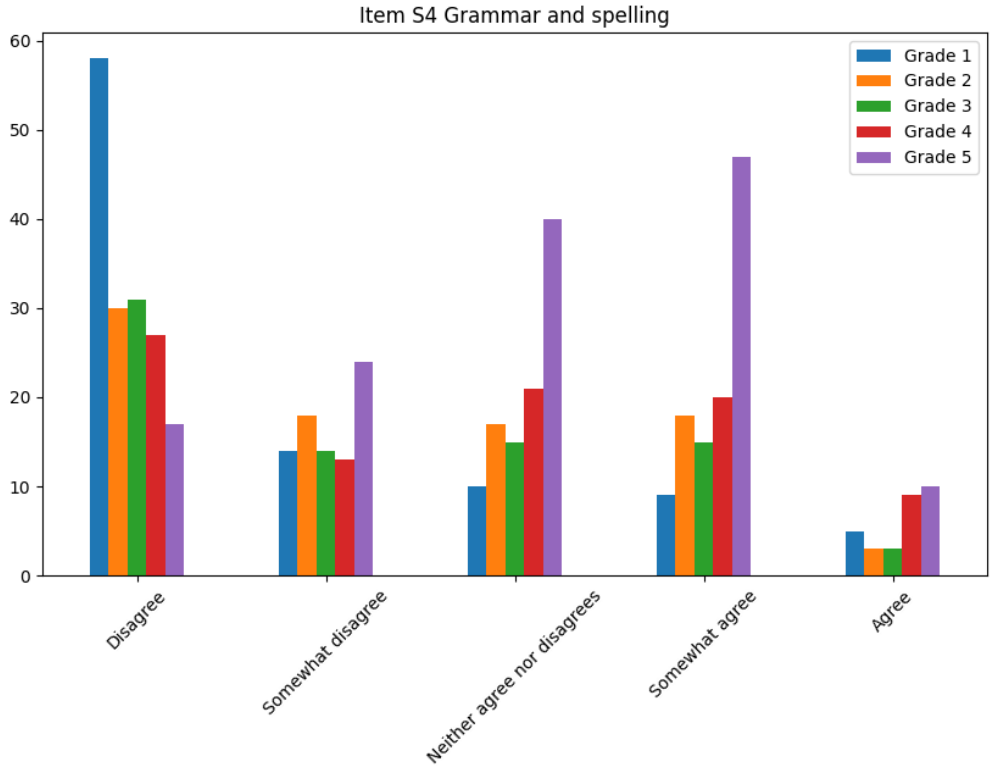

Figure 4.1.1: Distribution between years of study for item S4, the number 1-5 on the x-axis corresponds to the questionnaire options "Never", "Little", "Sometimes", "A lot" and "Always" respectively.

4.1.2.3 Evaluate AI

The scores for the "Evaluate AI" section is shown in table 4.1.5. EV3, being aware that using AI tools at school can have issues, has the highest mean, mode and median, while while the other items also are quite high. The rest of the items concerns the respondents' evaluation of answers from AI tools. Here, there are low scores on always trusting the answer (EV1), and on the answers being precise enough to copy directly (EV4), while confidence in their own evaluation (EV2) and always comparing with other sources (EV5) have high scores. This is indicative of a good critical view of answers from AI tools. Items EV1 and EV4 are worded the opposite of the others and their score are thus reversed.

Table 4.1.5: Mean, median and mode for the "Evaluate AI" section on a 5-point Likert scale. Items marked with * indicate an inverse scale.

Question	Mean	Median	Mode
EV1*	1.91	2.0	1
EV2	3.87	4.0	4
EV3	4.51	5.0	5
EV4*	1.56	1.0	1
EV5	3.45	4.0	4

4.1.2.4 AI Ethics

The results for the "AI Ethics" section can be seen in table 4.1.6 as well as for the ethical issues in table 4.1.7. Table 4.1.6 shows that the vast majority of respondents are aware of ethical issues being present with the use and development of AI. When it comes to the example issues presented, the median shows that every issue was somewhat known by the majority of respondents with the exception of equality (ETH5) and sustainability (ETH7). The other issues are plagiarism (ETH1), privacy (ETH2), bias (ETH4) and misinformation (ETH6).

Table 4.1.6: Mean, median and mode for the "AI Ethics" section.

Question	Mean	Median	Mode
ETH1	4.29	5.0	5

Table 4.1.7: Mean, median and mode for the ethical issues.

Question	Mean	Median	Mode
ETH2	3.65	4.0	4
ETH3	2.93	3.0	4
ETH4	3.05	3.0	4
ETH5	2.42	2.0	2
ETH6	3.70	4.0	4
ETH7	2.30	2.0	2

4.1.2.5 AI in Education

The results for the "AI in Education" section can be seen in the tables below. Table 4.1.8 shows the result for item AIED1, how much guidance repondents have recieved from their univeristy, as this is the only item on a 4-point likert scale.

Furthermore, table 4.1.9 contains the results for the statements regarding attitudes toward AI in education. These items had six options, where the last was "Don't know/Don't care" which was not included in the calculation for the mean, median and mode values. The final option is instead included in the table indicating how many selected it. There is a clear discrepancy between the results for AIED1 and the respondents wish for more guidance (AIED2) given this items high score. The rest of the items shows that respondents are not worried about decreased learning from using AI tools for a course (AIED3), future work opportunities being threatened by AI development (AIED4), or their dependency on AI tools for school work (AIED5).

Finally, table 4.1.10 show the results for the three educational scenarios the students were asked to take a stand on. Here, the scores indicate that the respondents feel it is important to learn about AI to prepare for their future career (AIED6) and to enhance school work (AIED7). Interestingly, the respondents did not see as much value in understanding ethical issues surrounding AI (AIED8).

Table 4.1.8: Mean, median and mode for the "AI in Education" section.

Question	**Mean**	**Median**	**Mode**
AIED1	1.64	2.0	1

Table 4.1.9: Mean, median and mode for the educational scenarios.

Question	**Mean**	**Median**	**Mode**	**Dont know/care**
AIED2	4.02	4.0	4	49
AIED3	2.84	3.0	4	18
AIED4	3.80	4.0	5	16
AIED5	3.93	4.0	6	2

Table 4.1.10: Mean, median and mode for the educational scenarios.

Question	**Mean**	**Median**	**Mode**
AIED6	4.22	4.0	5
AIED7	4.17	4.0	5
AIED8	3.62	4.0	5

4.2 Interviews

In this chapter, the findings from the in-depth interviews are presented. Chapter 4.2.1 also presents a short overview of the participants for the interviews.

4.2.1 Participation

A total of ten students were interviewed in order to gain deeper insight into the findings from Chapter 4.1. These were randomly picked from students who reported that they were willing to also participate in a later interview. The picked students were selected randomly from the entire pool of available participants, and there were no measures taken to ensure diversity. In the end, five of the selected students were in the fifth and final year of their education, two were in their fourth year, and one student each in their third, second and first year.

4.2.2 Thematic Analysis of Interviews

As we use a deductive approach to the thematic analysis, the themes are preconceived in line with Ng and colleagues AIL conceptualization [14], with the addition of the theme "AI in Education". The codes however, appear inductively from the analysis of the transcriptions, consisting of approximately 30000 words. An overview of the themes and codes is shown in figure 4.2.1. The themes are described in detail in Chapter 3.2.2.

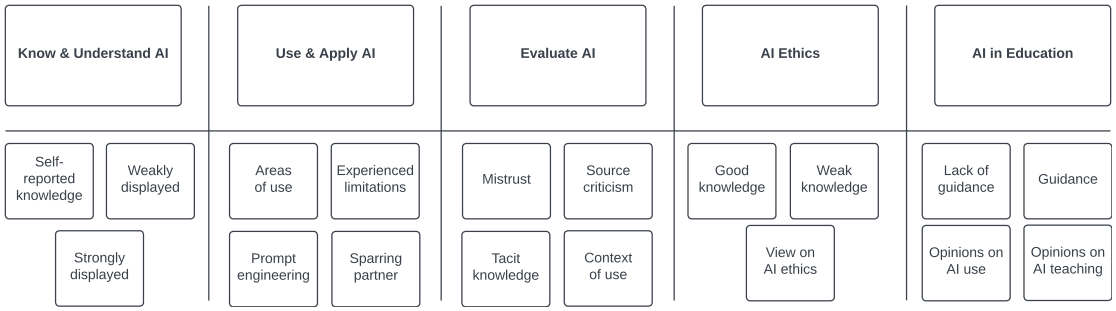

Figure 4.2.1: Overview of the themes and codes emerging from the thematic analysis.

4.2.3 Know & Understand AI

The theme "Know & Understand AI" attempts to uncover students' knowledge and understanding of AI technology, in accordance to the AI literacy framework. The analysis is based around three codes: "Self-reported knowledge", "Weakly displayed" and "Strongly displayed".

Self-reported Knowledge

In general, students self-report having good knowledge of AI. When they are asked to self-report their competency in AI, only two students reported limited knowledge. A clear divide emerge looking at the students self-reporting proficient knowledge. Some students perceive good knowledge as theoretical knowledge, while the

majority perceive it as practical knowledge, and the ability to use AI tools effectively. Student 5 felt they were proficient in using AI without knowing its concepts on a theoretical level.

> I don't understand the concept of AI, but I feel like I'm utilizing it quite effectively. It automates many of the tasks that I wouldn't otherwise do efficiently. So, I'd say I'm using it intelligently.
>
> – S5

In contrast, student 1 ranked their theoretical knowledge of AI as high, crediting it to them taking courses in machine learning.

> I would say it's [AI knowledge] higher than most others in society, because i have taken basic machine learning courses.
>
> – S1

Student 6 further displayed the two perceptions of proficiency in AI by both reporting proficient use, and a sufficient knowledge of AI structurally.

> When it comes to usage, I feel confident in finding answers to my questions. Regarding the structure, I might know more than the average person, but not as much as someone who has studied AI.
>
> – S6

Student 2 felt that what proficiency they had came from personal experiences and by trial and error.

> It's more of an experiential understanding. It's gradually becoming clearer to me how to use it effectively to obtain the answers you're looking for.
>
> – S2

Displayed knowledge

The subsequent questions for this theme aimed at allowing the students to display their knowledge of AI, mapping out either the discrepancy or accuracy of their self-reported knowledge level. Only two out of ten students gave more wrong than correct responses. Both of them ranked their theoretical knowledge as low. For the remainder of the students, the share of correct to incorrect responses corresponded with the stated confidence in their own knowledge.

Weakly displayed

When students were asked to explain the difference between human and artificial intelligence, many found it difficult to answer. Some students were completely unable to explain what the difference was, or attempted to explain in broad strokes, such as students 7 and 5.

> Human intelligence is probably still a bit better. But artificial intelligence catches up quickly.
>
> – S7

> I don't know, really.
>
> – S5

Others had more technical explanations, directly comparing distinct human abilities to current AI capabilities. Student 9 explained that humans are able to better understand emotions and facial expressions than AI.

> Understanding emotions, for example, I would say that competent individuals are better at understanding emotions or facial expressions than AI, well, perhaps that [...]
>
> – S9

However, there is a wide range of facial emotion recognition models using AI to accurately predict emotion from a persons facial expressions [55].

Further, when asked what AI is, several shortfalls on students knowledge of how AI works are revealed. Here, student 4 was unable to articulate a meaningful explanation, explaining that AI is humans tricking computers to "think".

> Artificial intelligence is tricking your computer into thinking for itself.
>
> – S4

Others used their most familiar AI model, ChatGPT, as a basis when forming their answer. Here, student 10 displayed a lack of understanding of how ChatGPT generates its responses, believing that it is a computer that finds answers on the internet.

> When I use ChatGPT, I understand that it's a computer searching the internet to find answers to what I'm asking.
>
> – S10

When asked if they could see any future applications for AI, some students were unable to come up with any distinct use cases. Student 2 claimed AI would be used for programming, but based it on the wrong understanding.

> It essentially consists of code itself, so I think [ChatGPT] will increasingly be used for coding, I believe.
>
> – S2

Student 4 were only able to come up with the fact that AI is all encompassing and will be used everywhere.

> No, it could be anything. I actually envision that the advancement in AI will be so significant that it will touch upon most areas.
>
> – S4

Other students answered similarly, but were able to provide more specific examples for different areas of future use, students 10 and 5 came up with areas such as medicine or personal assistance, without any reasoning.

> Everywhere. Perhaps in medicine, it could become quite relevant, I imagine.
>
> – S10

> It will probably be most things, I imagine. With the use of personal assistants, that can do things for you beyond just answering questions.
>
> – S5

Strongly displayed

The majority of the students showed a strong grasp of concepts surrounding AI and its capabilities. When asked to explain what AI is, the students answers ranged from short but precise, to more in-depth explanations. Especially student 1, who stated they had taken courses in AI, displayed a deeper understanding of concepts within the AI field.

> Much of what we call AI is actually just machine learning. So, I perhaps differentiate a bit in that with machine learning, I think more about needing significant computational power to perform complex tasks. With that computational power, one can solve new problems that are seen as artificial intelligence.
>
> – S1

Furthermore, when asked to compare human intelligence to AI, several students noted the the limits of current AI models. Student 3 explained how AI is more akin to highly specialized tools made for one specific task, while human intelligence is broader and capable of more varied tasks.

> We humans tend to have a bit more... What should I say? Have a bit more general intelligence [...] Often, AI tools are more specialized in certain areas. We humans are much better at reflecting and arguing than AI tools.
>
> – S3

Despite human intelligence being broader, student 7 shared the understanding of student 3, that for its given task, an AI model easily outperforms a human.

> Currently, AI is very narrow. It can excel at one thing very well. Often better than humans, but it can still only do that one thing.
>
> – S7

Additionally, student 6 pointed out humans' ability to reflect and defend their reasoning. Further underlining the narrowness of many AI applications.

> For now, I believe human intelligence is better at reflecting and not arriving at a specific solution. I think we are better at seeing multiple sides of an issue. But AI, for now, is more direct.
>
> – S6

Student 9 used chess as an example of how, and why, human intelligence differs from AI. The student pointed out intuition as a key difference. They compared how a beginner human and AI would play chess by explaining that the human can use the ruleset together with their own intuition to easily spot moves that would garner no gain, and immediately exclude those. An AI on the other hand, would need to actually try out all the moves in order to determine if a move was beneficial or not.

> We are beings capable of reflection, finding simpler ways to everything with intuition, which AI lacks [...] In chess positions, we can start with [...] We, with our intuition on how a position should be, can quickly exclude areas where we say, 'okay, there's no point in exploring that,' while perhaps an artificial intelligence that is iterative...
>
> – S9

To summarize this theme, most students self-report a good understanding of AI, regarding good knowledge as either technical understanding, or the ability to use AI tools well for their own purposes. Only two students report a limited theoretical knowledge, which is evident in their inability to provide meaningful responses in explaining AI. A number of students also struggle to explain the difference between human and artificial intelligence, often answering in vague or incorrect ways. On the other side, both students with and without prior educational experience in AI show a robust understanding of core AI concepts, explaining limitations, and recognizing its strengths.

4.2.4 Use & Apply AI

The theme "Use & Apply AI" investigates how students use AI technologies, and aims to uncover their abilities when interacting with AI. The analysis is based around four codes: "Areas of use", "Experienced limitations", "Prompt engineering" and "Sparring partner".

Areas of use

When students were asked to elaborate on the areas they utilized AI tools, they generally use ChatGPT and GitHub Copilot more than other technologies, using them mostly for programming and help with theory in courses. When it comes to programming, the students explained different ways to utilize the AI tools. Student 1 mentioned getting help with discovering errors in the code, or understanding error messages.

> So, it's more like I try to build the structure of the code on my own. Usually, it might not work perfectly right away. Then I can go back and ask [ChatGPT] about specific error messages in the code.
>
> – S1

Further, student 2 emphasised ChatGPT's strength in explaining coding concepts, asking the tool how a certain data type or method is structured.

> But sometimes it's a bit more difficult, in a way, and then, you prompt [ChatGPT] and then you get something out and then you see, 'oh, that's how you structure a class,' for example. I think [ChatGPT] works very well for that.
>
> – S2

Similarly, student 3 pointed out how ChatGPT could be used in place of the popular help forum Stack Overflow, as it is easier and faster to get answers to your specific situation.

> Especially in the code, I haven't always found a direct answer on Stack Overflow, for example.
>
> – S3

Student 4 also described how they utilize the AI tools in order to work more effectively, skipping boring or repetitive tasks and focusing more on what they find interesting in the course.

> If it's something I find enjoyable to solve myself, problems, for instance, I find that I use AI tools less. [...] If it's dull, repetitive tasks, I'm happy to hand it over to ChatGPT.
>
> – S4

Additionally, student 6 underlined how they can save time by letting AI tools handle more tedious and simple tasks that they do not want to handle themselves.

> Not necessarily creating entire things, but also creating small parts that I don't feel like making myself. [...] 'Can you create this function that sorts this and this, in this or that way,' you know. And [ChatGPT] fixes it perfectly well. Mostly to avoid the boring work.
>
> – S6

Student 7 also pointed out that even though they often know how to perform a given task, they choose to let ChatGPT do it instead, because it is faster.

> Mostly, it's to get help with plotting things in Python. So, kind of stuff I could have figured out myself, but it just takes a bit of time. So, I just get [ChatGPT] to do it.
>
> – S7

Conversely, student 2 reported that they preferred to not rely too much on ChatGPT for subjects other than programming, and rather favored discussing problems with fellow students.

> Yeah, that's not what I use it for the most, definitely not. I prefer going to tutorials, talking to other students, doing those kinds of things [...] I use it quite actively for coding.
>
> – S2

Experienced limitations

Some of the students pointed out ways they felt AI tools struggled within their school work. Student 2 reported that they felt they could not use ChatGPT to help with their courses as it was unable to give useful answers, hence, identifying limitations of the tool through experimenting.

> I'm taking the course 'materials technology' now, and I feel like it's something [ChatGPT] almost doesn't know at all.
>
> – S2

Student 10 also experienced limitations in a course where images and figures are a central part of educational activities. As the free version (i.e. GPT 3.5) of ChatGPT is unable to process images, the student refrains from using it for the given course.

> I'm taking Mechanics 1, and many of the problems there involve images and drawings on how to find forces. That's something [GPT] 3.5 just can't understand. So, I never use it there.
>
> – S10

Prompt engineering

When students were asked how they approach prompting ChatGPT, the general angle of attack is to act out of experience on what works or not. However, only a few students seemed to put more thought into why a certain prompting methods worked better. Despite this, the students displayed both skill and awareness when prompting. Student 2 displays this by emphasizing the need of a context in their prompts.

> "I have this class, I have these functions, programming in this language, and now I want to create a function that does this. Can you show me some suggestions?"
>
> – S2

Student 4 noted how their wording affects the answers they get, discovering the need to be more specific when prompting ChatGPT.

> I feel like I've understood that you have to be a bit specific in the description of what you want, to actually get what you want out of, for example, ChatGPT. Otherwise you often get a general answer that I can't really utilize.
>
> – S4

Further, some students employed different methods of prompting to get the most out of the answers. One such approach, underlined by student 1, was explaining to the AI that they had a certain degree of knowledge on a subject, and that it should take this into account when formulating its answer.

> Even though I find it much more specified, you can prompt a bit from the fact that you can say that you are a student at that level, so you can get a somewhat tailored response as opposed to just very generic.
>
> – S1

Another method, as displayed by student 5, involved requesting more information by asking for both sides of an issue.

> I feel it contradicts itself a lot. Maybe partly because people also tend to just say yes to everything. So, I usually have to ask things 'for and against' in order for it not to... for it to give a correct answer.
>
> – S5

Sparring partner

Some students explicitly mentions their use of ChatGPT as a sparring partner, using back and forth communication as a way to extract more useful information from the AI tool. Student 2 explained how they appreciated the method as an option when they worked with a subject alone.

> But then I tend to have it sort of like if I'm at home and have read through that part of the book I'm working on and don't have any tutors or fellow students to talk to, I try to use it more as a sparring partner rather than just asking it.
>
> – S2

Student 9 included ChatGPT in both their own work, as well as in discussions among fellow group members concerning a subject. For personal use, they saw ChatGPT as their private tutor, providing insight or additions to their ideas.

> I use it like my own professor, who doesn't always have the correct information, but can always give you a hint or ideas. Say I have an idea, then I just ask in addition to explore other possible ideas...
>
> – S9

Student 9 further explained a similar approach when planning a group project.

> When we read a problem, we have a sort of way we like to approach it, so you write the entire problem text, paste it in, and then ask the question based on," I'm thinking this, do you have any other methods or ways to think about it?", and then you get a sparring partner, which makes us reflect on what we're thinking...
>
> – S9

To sum up this theme, students find various use cases for AI tools, predominantly using ChatGPT and Copilot for assistance in programming and understanding theoretical concepts. Through using these AI tools, students also discover limitations like image processing and lack of relevant information when doing tasks in specific course contexts. Through prompt engineering, students also show that they are able to tailor their AI interaction to facilitate more precise and useful responses, utilizing ChatGPT as a sparring partner to simulate interactive learning environments both alone and in groups.

4.2.5 Evaluate AI

The theme "Evaluate AI" aims to uncover students' ability to evaluate and reflect around the weaknesses of AI, as well as their ability to think critically about AI outputs. The analysis is based around the four codes "Mistrust", "Source criticism", "Tacit knowledge" and "Context of use".

Mistrust

When asked, the students unanimously agreed that one should not blindly trust outputs from AI tools. Student 9 emphasized this view when reflecting on how ChatGPT gains information.

> It's not like I go around actively seeking information I can find myself to ask ChatGPT, that would be silly in my opinion, because it's not verified information at all.
>
> – S9

When asking for the reason of this mistrust, it became clear that it stemmed from students own experiences with receiving wrong answers, as pointed out by student 3.

> No, it's based on experience. I've encountered situations where it gives me an answer that it's 100% sure about. So, in a way, it's like, 'Do it like this.' And then I try it out, and it doesn't work.
>
> – S3

Student 2 also relates the use of AI tools to how they were taught to use Wikipedia, and that much of the information you find on the internet should be double checked.

> Then it's like 'don't use Wikipedia, anyone can write whatever they want on Wikipedia' [...] I don't check all possible sources on something, but still, I have like 2-3, and if they point me in the same direction, you can kind of vouch for it.
>
> – S2

Source criticism

The above sentiment carries over into source criticism, as students generally do not blindly trust the information they get from ChatGPT. Consequently, most of the students reported being diligent in self-checking facts they received from the AI tool. Through experience, student 5 has learned to always check a fact or theory with other sources.

> If I ask for examples of theories or facts, I always have to check it up. Like, completely, completely factual, I sometimes feel that it gets wrong.
>
> – S5

Interestingly, several students said they were able to detect when ChatGPT would start manufacturing information. Student 6 points this out through both intuition and experience, leading to them double-checking facts.

> I've used it quite a bit, so I notice after a while when ChatGPT starts to guess a bit. So if I see something that I'm a bit skeptical about, I might have to double-check and Google it.
>
> – S6

Student 6 was not alone in believing in their innate ability to detect faults. Student 9 had a similar view, trusting their intuition when the output seemed questionable.

> The other thing is, you know, we always have an intuition about what's true and what's not, right? If there's some outrageous information that seems completely, like, invalid, then it's probably invalid, right? So, there's something to that, you know.
>
> – S9

Tacit knowledge

A consistent observation across students reflections on evaluating AI is their preference for prompting AI tools on subjects they already possess some level of understanding. The students found it much easier to evaluate the correctness of AI responses when they had some preconception about what the answer should include. This observation underscores the importance of preexisting knowledge, and is illustrated explicitly by student 1.

> Very often, you know, one asks about topics one knows something about, I was about to say. So you can sort of assess a bit from that. Okay, it aligns with what I've heard either in previous courses, or what I've read beforehand. So, you just have to be a bit observant yourself.
>
> – S1

Student 7 further underlines the point by explaining their thought process when assessing an answer from AI tools.

> But if I've asked something with a theoretical question, I should really just think through if it makes sense, if it's something I already know about the topics. And if it sounds right, then I just think it's correct. But if it sounds wrong, then I might look a bit more.
>
> – S7

Context of use

As a follow-up question, students were asked to explain which scenarios they would be less inclined to fact check responses from AI tools. Student 4 reported that they used less time fact checking in less important situations, presumably outside of school.

> Yes, in less important contexts. If it's just something I'm just curious about, something I could easily Google, I'll type it into ChatGPT, and then I get an answer, and I think it's good enough.
>
> – S4

However, other students stated that this could be the case within a school context as well. When it comes to programming inquires, the evaluation process is a bit different. Many agree with the evaluation approach of student 4, simply verifying that the AI generated code works, as a sufficient quality check.

> With coding or something like that, it's more that I try to practically use what it has given me, and then I see if it works or not. So then that's the evaluation.
>
> – S4

Despite this, student 9 seemed to have a much more methodical approach to generated code, going further than the others to ensure that it is what they expected.

> And then comes the testing afterwards, you shouldn't just accept a solution for what it is. It quickly becomes about checking, running the code, creating tests, seeing if it actually works the way I want it to work. Lots of debugging here and there. Trying to understand the code.
>
> – S9

To summarize this theme, students are unanimous in their belief that AI outputs not always can be trusted blindly. This opinion is largely driven by the students' experiences getting misleading or incorrect responses from AI tools. They engage in source criticism, often validating the output of ChatGPT with additional googling or research in books. The students rely on their tacit knowledge, preferring to ask questions on topics they already possess a certain level of understanding. This approach helps them detect errors done by the AI tool. Lastly, their evaluation methods differ depending on what they use the AI tool for. Programming, for instance, is often evaluated straightforward through testing the code.

4.2.6 AI Ethics

The theme "AI Ethics" aims to uncover what knowledge students have in the realm of ethics concerning AI technologies. The codes for this theme are "Good knowledge", "Weak knowledge" and "View on AI ethics".

Good knowledge

The questions about AI and ethics gave the students the opportunity to show how much they knew about ethical issues surrounding AI tools. There were two issues that a clear majority knew well, plagiarism and bias. With plagiarism, the students mostly had superficial but correct answers. An example is student 2, noting that you cannot acquire ownership over work that is not your own.

> But it's like the classic thing that it doesn't become your own work, you don't get any ownership of what you do.
>
> – S2

Similarly, most of the students knew about the issue surrounding bias in training data, and were able to use more examples and in-depth explanations compared to their knowledge on plagiarism. Student 4 explains the potential bias reflected by the developer of the model.

> Yes, there has been a lot of talk, for example, about discrimination in AI models. Because, for example, most developers working on these models are men. And the biases they have can be reflected in the model they create.
>
> – S4

Student 1 explicitly explains the training process of AI models, and reflects on the importance of a diverse dataset.

> I think the biggest and most important thing is the data the models will train on. There is no artificial intelligence without the data, and then there is a very big responsibility for those who create these datasets, that they should be diverse datasets.
>
> – S1

Student 6 further underlines student 1's sentiment, pointing out the inherent bias in human data.

> Yes, all the AI we have doesn't get information from nothing. It's trained on data that is ultimately human. And there are biases in humans. So I feel it's almost impossible to avoid.
>
> – S6

Student 8 goes on to point out the dangers of biased datasets, and how misinformation is also reflected in AI models.

> And who chooses the data is also an ethical issue, if you go in with some prejudice and just give it data that supports your background and your thought about how things work. From certain websites, or certain databases and such things that don't embrace the truth, then that could be... bad.
>
> – S8

Further, some students were able to explain two least known issues from the questionnaire, sustainability and inequality. Student 6 was able to both explain sustainability, and reason around why it was such an unknown subject.

> It's perhaps that people don't consider what goes into training an AI model and such things. That it uses an enormous amount of power. And you need cooling for it and often use water. So it's really just a lack of knowledge in that area. That people don't think of AI tools as a sustainability problem.
>
> – S6

Student 9 also displayed a good grasp of an ethical issue connected to inequality, socioeconomic inequality.

> So people who don't have access [to AI] will then fall even further behind than those who do have access. And that's really unfortunate, but that's how development will proceed.
>
> – S9

No knowledge

Most of the students were not able to explain the two issues of inequality and sustainability. Their reasoning for both their and others' illiteracy were that these are obscure issues that are not talked about as much as other things.

> The other points you mentioned haven't been discussed as much.
>
> – S3

Student 5 mentioned that they had touched upon sustainability, but that their familiarity with the issue stopped there.

> If AI uses a lot of data power, for example, if it consumes a lot of electricity. Takes a lot of energy. Does it do more than anything else? I don't know. There are probably many who don't know. It's something people don't think about at all.
>
> – S5

Other students attempted to explain or reason the two issues without success. Student 10 touched in on the subject of AI gender bias, but were imprecise in their understanding of how such biases is introduced into an AI.

> Ethical issues with equality, in relation to AI robots. If they are developed by men, they might give good answers to men and not to women.
>
> – S10

Student 9 was unable to reason why sustainability presents a pressing issue within AI. They struggled to see why using an already existing tool would contribute much to pollution.

> Because I don't understand, since one spends time on the screen regardless. It's like those who say our calculators make us, what should we say, pollute more because we produce calculators.
>
> – S9

Notably, student 7 pointed out that inequality and sustainability are wide terms, and therefore, not easily explainable without some context. The authors see this as a possible limitation to the questionnaire.

> But those are wide terms, both of them. [...] when i think about sustainability, i think about, can something work for a long time without destroying for everything around it.
>
> – S7

View on AI ethics

Regardless of their understanding of ethical issues surrounding AI, there was an almost unanimous agreement that the users of AI tools should know as much as possible about the ethical challenges, as pointed out by student 4.

> But it's important that as a user of a tool, you are aware of these ethical issues. So that you can again be a bit more critical or a bit more careful when using tools.
>
> – S4

Student 9 expressed that knowing about ethical issues especially applies to those who are going to create AI models.

> I would say that if you're working on something, you should be an expert in it, but not an expert in the sense that you should have a PhD in it, but in the sense that you understand all the issues surrounding it.

– S9

This sentiment is further underlined by student 7.

> And it's almost regardless of what kind of technology studies you're studying now, you're going to use some AI. But it's perhaps most relevant to those who are developing AI now.
>
> – S7

To sum up this theme, students are aware of key ethical issues like bias and plagiarism, understanding that using AI can threaten the originality of their work and reflect inherent biases from training data. However, their understanding of broader ethical concerns like sustainability and inequality is notably weaker, where only a few students could articulate meaningful reflections on the matter. Lastly, there is a wide agreement among that understanding AI ethics is crucial in order to ensure responsible use and development of AI.

4.2.7 AI in Education

The last theme, "AI in Education" is constructed separately from the AI literacy framework. It aims to answer the research question "How do students experience guidance from the university regarding AI use, and what do they consider important for AI education?". The codes for this theme are "Lack of guidance", "Guidance", "Opinions on AI use" and "Opinions on AI teaching".

Lack of guidance

When students were asked if they had received any formal guidance from the university regarding the use of AI tools in education, nearly all stated that it was minimal. It appears that what guidance they have received is either related to writing their master thesis, or less structured tips and tricks from teaching assistants and professors. Student 1 and 7 had only received an email regarding their master thesis, informing the student that they have to document AI use.

> Regarding the master's thesis, that's the only thing, and it's just an email about documenting the use of it, not how we should use it.
>
> – S1

Student 2 had the same experience, only getting a little guidance from teaching assistants on the option to use ChatGPT in programming.

> No, very little [guidance]. The most concrete thing i can think of is some teaching assistants in programming subjects saying 'try Googling, and if you don't find anything, then try chat[GPT].
>
> – S2

Student 8 also reported this lack of guidance, but stated that the university had sent emails with information on their stance on AI tools, telling students that the tools are accessible, but that they should use them with care.

> No, I haven't received any guidance. I've received some stern instructions by email. And they mentioned that, "yes, AI is here to stay, but you are still students who must write your own work, so use it in moderation".
>
> – S8

Guidance

Although the students heavily emphasize the lack of guidance from the university, one still report having received a small guided intervention. Prior to writing an article last fall, student 5 took part in a lecture regarding AI tools, structured as an open discussion by the educator.

> When we wrote an article last fall, we had a whole lecture that was about, "AI is here, what do we think about this?"
>
> – S5

Opinions on AI use

A common opinion among students is that you become better at using AI tools if you learn more about them. This is emphasized by student 3, acknowledging the fact that students are unaware of the technical aspects of AI, and that this knowledge could help in using AI tools more correctly.

> For many students, AI tools are essentially a black box. You don't really know what's behind it. If you learn more about it and use it properly, I think people will use it more correctly.
>
> – S3

When asked how students should use AI in education, student 8 responded by addressing AI tools ability to assist, and help students. However, they also think it is important to do work on your own.

> [...] it's about AI bringing out the best in you, and helping you, not just polishing up what AI has written or done for you and pretending it's somewhat your own.
>
> – S8

Student 2 draws historical lines to the introduction of the calculator, believing that AI tools will follow its path of acceptance. They too, emphasize the importance of learning the limitations of AI.

> I think it could become a tool just like the calculator, but then you have to learn the limitations of the tool and how to use it effectively.
>
> – S2

Opinions on AI teaching

Building on the student opinions of AI use above, students all believe that the university should teach them how to use it. During this discussion, interesting and precise ideas on how AI can be taught emerged. Student 3 sees all students eventually using AI in some way, and takes inspiration from the mandatory HSE course for engineering students at NTNU, proposing the idea of a similar AI course.

> Over the last few years, as it [AI use] has become more prevalent, I see all students eventually using AI tools. I think it's important to already have a lesson about it in the first year. We had a HSE course in the first year, so it's possible to have an AI course.
>
> – S3

Student 4 agreed that the university should teach how to use AI tools to students. They stated that a mandatory AI course, and explicit guidelines in practical courses could be a potential solution.

> Yes, I think so. Some form of training or guidance. [...] Maybe having a mandatory course that you go through. Then, set up clear guidelines in the subjects that have practical exercises.
>
> – S4

Student 6 looked back at the early days of ChatGPT, and wished they had gotten clearer instructions on how to use AI tools through a do's and dont's list.

> When it [ChatGPT] came out, it would have been cool if there was something like an overview of things it is good at and things it is bad at. Kind of a list of do's and dont's.
>
> – S6

Lastly, student 7 reflected on the consequences of AI use at the university. Using the positive effect knowing AI has on ones ability to use AI tools, the student incentivizes NTNU to teach AI to students.

> It [work] can be much more efficient if you manage to use AI tools effectively. Then you get a lot more done, so more work comes out of NTNU, which is a good goal for NTNU.
>
> – S7

To summarize the theme, students express a significant lack of formal, structured guidance from the university on using AI tools in education. The advice they do get, however, is often within a specific context like writing a thesis, or for programming assistance. Students have received emails from the university, cautioning them on AI use without any detailed explanations on how to actually use it. The consensus among students is that greater understanding will help them use AI tools in more effective, meaningful ways. Similarly to mandatory safety courses, students believe an AI course could be a possible solution to teaching AI, ultimately leading to better knowledge, and therefore better usage.

Chapter 5

Discussion

The goal of this research has been to explore the research question "What is the current level of AI literacy among technology students at the Norwegian University of Technology and Science?" by answering the three sub-questions: "How do students perceive their own competency in AI according to the AI literacy framework?", "What AI literacy competencies do students display in in-depth interviews, and how does this compare to their self-perceived AI literacy?" and "How do students experience guidance from NTNU regarding the use of AI, and in what ways do they perceive the need for AI education?".

5.1 Self-perceived AI Literacy

This chapter dives into the self-reported AI literacy among students, as assessed through their responses to the questionnaire. This self-assessment serves as a preliminary evaluation of AI literacy, providing insight into students' confidence in four facets of the AI literacy framework: "Know & Understand AI", "Use & Apply AI", "Evaluate AI" and "AI Ethics". These observations will be further investigated and substantiated through in-depth interviews, where students will have the opportunity to demonstrate their knowledge of AI.

5.1.1 Know & Understand AI

The measured scores of items KU1-KU5 immediately reveal that the participants rate their knowledge of AI tools being high. Every item having a mean above 4.0 is indicative of the students having considerable confidence in their own comprehension. At face value, these results indicate that the students report having a high level of AI literacy within this competency.

Being the most agreed upon statement with both a median and mode of 5, KU3 shows that the vast majority of respondents are to some degree interested in AI technology. It is not possible to tell how this interest unfolds for anyone, but it seems clear that most students care about the subject. This is reflected in the results for the other values, KU1, KU2, KU4 and KU5. It is also natural to assume that someone with a strong interest in AI technology would have some level of knowledge about it as well, as is evident in the results for the other items.

As mentioned, the values for the other items are very high as well, but KU1 stands out. Knowing about areas of use for AI has a mean of 4.41 and a mode of 5, which means that almost everyone agreed to some extent. These results seem almost fantastical in the context of measuring AI literacy, and one should therefore proceed with some caution. Given the self-reporting nature of the questionnaire and the phrasing of the questions, it is difficult for the participants to prove their knowledge, and difficult for us to disprove it. Therefore, the results should be seen in the context of other sections and items as well.

5.1.2 Use & Apply AI

For this section, it is worth noting that while there may not necessarily be any strong correlation between knowledge of AI and proficiency of use, it could be interesting to examine given the strong confidence expressed in the "Know & Understand AI" competency. As expected after the high scores in both KU1 and KU3, item UA1 has both a high mean value of 3.27 as well as a mode of 4, meaning students use AI tools frequently. What is not clear from the questionnaire results is if the high frequency of use comes as a result of the students being knowledgeable about AI tools or vice versa.

The rest of the items UA2 through UA5 concern the student's ability to effectively communicate and collaborate with AI tools. These should have a stronger correlation to understanding, as knowledge about strengths and weaknesses allows for better utilization of the tools. While the resulting values do not display a low proficiency, they are lower than one would expect. Notably, UA2 and UA4, always getting satisfactory answers, and using time to write a good prompt. While the majority of students partially agree, the mean values of 2.79 and 2.61 respectively tell us that a notable portion of the participants disagree to some extent. Being able to use AI tools in a way that gives satisfactory results is a key ability of this AI literacy competency, and requires some degree of knowledge about the tools. The same applies to investing time in curating a prompt that gives a satisfactory response. Further underlining this is the mode of UA3 being 1, meaning that a plurality of the participants are unable to get the response they want on their first try. At face value, these results indicate a lower level of understanding than what was reported by the participants in the previous section. Further, UA5 represents one way of communicating with AI that displays a high level of AI literacy. The low mean of 2.24 does however not imply a low level of AI literacy, but rather that students might use AI tools in a straightforward manner, instead of communicating with it back and forth. A potential reason for this could be what type of scenarios the students choose to use AI for.

When it comes to usage in the different scenarios that were given, programming stands out as the most prominent use case with a mean of 3.61. Programming was the only scenario where the majority of respondents used AI tools regularly. For the rest of the scenarios, the use was far more restricted with mean values below 3.0. Programming being the front runner is not surprising, and there could be several reasons for this. The current curriculum for technology students contains a wide range of programming applications across most fields of study. Widely used

AI tools such as ChatGPT or Github CoPilot excel at programming in most languages, and it is natural that students should employ them. Additionally, unlike the other scenarios, the solutions to programming tasks are less ambiguous. It is easy to evaluate if a solution is correct or not, meaning that students can use a tool with more confidence in the final result.

Another interesting observation regards items S3 and S4, the use cases of mathematics and spelling checks. While S3 has the lower mean value of 2.17, S4 has the lower mode of 1. This suggests that while the mode indicates that many never use AI for spelling, of those who do, a higher proportion utilizes it actively. This could be explained by a difference in usage patterns across different year levels. Most students in their first and second years of study write fewer reports and papers than students in their third and fourth years. Additionally, fifth-year students stand out as those who use AI tools for spelling checks, which can be reasoned by their work on project reports and master thesis.

Finally, scenarios S2 through S6 all have a mean value below 3, meaning that there is more seldom AI use across the board. This challenges the findings of UA1, which indicated more widespread use. From the questionnaire results alone, it is not possible to deduct what the cause of this discrepancy is. However, a possible explanation is that the participants are unable to assess their own frequency- or area of use. Another reason could simply be that we as the authors of the questionnaire provided a poor selection of scenarios.

5.1.3 Evaluate AI

The items for this section are divided into two parts, agreeable statements that embody desirable behaviors, and disagreeable statements which does the opposite. Across these, the responses display an attitude that indicates a high degree of AI literacy. For the disagreeable items EV1 and EV4, "always trusting AI" and "AI is always sufficiently precise", the results show a healthy level of skepticism towards responses from AI tools. Furthermore, although the two items may seem to cover similar themes, the resulting values paint another picture. The slightly higher mean (1.91) and median (2.0) values for EV1 indicate that some students do not always distrust the answers. Whether or not this means they are bad at evaluating responses from AI, or are more selective about what to trust and not, is not possible to discern from the questionnaire alone. Item EV4 on the other hand (mean: 1.56, median: 1.0), revolves around a different kind of trust, namely, that AI is precise enough that the answer can be copied directly. According to the questionnaire results, even though a student is confident in the correctness of an answer, almost no one feels it is precise enough to be used as is. This is not surprising behavior, as a model such as ChatGPT famously tends to become "wordy" in its answers [56].

Moreover, of the agreeable statements, the result values for EV2 (mean: 3.87) and EV5 (mean: 3.45) further suggest a high level of AI literacy among the participants. It shows that the students themselves feel they are capable of discerning how correct an answer is. It does not, however, tell us anything about how they

do it. Yet, the values for EV5 may indicate that they simply always double-check their responses with other sources.

Lastly, EV3 stands out with both a median and mode of 5, and a high mean value of 4.51. This shows that the students are well aware of the potential drawbacks of using AI tools for school work. But, also here is it impossible to discern what the students think of as disadvantages, how many they know of, or if what they are referring to is a drawback at all. However, we are beginning to see a clearer picture of the student's use and attitudes towards AI tools. From the previous sections, it is evident that the majority are enlightened when it comes to potential pitfalls or disadvantages of the use of AI tools in their education. The results further suggest that most students are careful and take measures in order to maintain the quality of their work.

Although, when the results are clear cut and in favor of AI literacy, one should exercise some caution. There is a possibility that the questionnaire items are formulated in a suggestive way, influencing the participant's answers. In this way, we as the authors could influence the students to choose what seems "correct". This further underscores the advantages of evaluating the questionnaire results together with the in-depth interviews.

5.1.4 AI Ethics

In the questionnaire, the competency "AI Ethics" starts with item ETH1, which is similar to EV3 in asking the students to rate the degree to which they know of a concept. Here as well, with a median and mode of 5, the results show that a vast majority of the respondents feel they know of ethical challenges related to AI. Similarly, this does not tell us about how many or which challenges they know of, or if what they are thinking about actually is an ethical issue. These concerns are therefore also addressed in the in-depth interviews. Nevertheless, ETH1 represents a cornerstone skill within AI ethics, and the students overwhelmingly report that they are aware of ethical issues, indicating a high level of AI literacy.

Moving on to the student's knowledge of specific ethical issues, it is clear that ETH2, plagiarism, and ETH6, misinformation, are most known among the students, both having a mean of 4. Considering the participants in this questionnaire, it is not surprising given that these are issues that are highly relevant to them. As students, finding information on the internet means having to be careful to either not copy directly or cite proper sources in order to avoid plagiarism. With chatbot AIs such as ChatGPT reciting information from the internet without being able to give sources to its claims, it is natural to believe that most students put thought and effort into avoiding excessive use and copying. Similarly, ETH6 is also closely tied to the everyday study life of the participants. If a student employs an AI tool when working on an educational activity, or in helping them learn a subject, they are vulnerable to misinformation. This is underlined by the findings of the "Evaluate AI" competency. The respondents need to be careful that the information they get from AI tools is correct in order not to build their understanding of a course on the wrong basis. Thus, it is natural that ETH6 has the highest mean

with a value of 3.70.

When looking at ETH4, bias, and ETH3, privacy, are next in line with mean values of 3.05 and 2.93 respectively, meaning students are somewhat aware of these ethical issues. With the world becoming increasingly data-driven [57], personal privacy and autonomy over your own data is important. With the many new AI chatbots, it can be difficult to know what happens to any of the information you write to them. Despite these issues, few people are actively thinking about their personal data online [58], which is somewhat reflected through students' knowledge of privacy. Additionally, bias is currently one of the main challenges AI is facing [59]. Given the reported high level of interest in AI technology in KU3, it would be natural to expect a higher mean value. It has to be mentioned, however, that while these values are lower than expected, given the student's interest in AI, they are not low. Both issues having a mode of 4 shows that the plurality is very familiar with these challenges.

Items ETH5, equality, and ETH7, sustainability and environmental changes, are by far the least known ethical concerns with median and mode being 2 for both. This is more expected as these are quite wide terms that seem disconnected from AI. It is likely not easy for most people to imagine how a simple website can contribute to pollution, or how an online chatbot could be environmentally unsustainable. However, AI tools such as ChatGPT use extreme amounts of power and water to sustain its big user base. This is a concept that is naturally hard to understand from the point of the user, who only sees their own part of the service. Likewise, issues related to equality often concern more tangible societal subjects, and it is natural for people to overlook digital services as culprits.

In conclusion, Chapter 5.1 examined the self-perceived proficiency in AI literacy of students from their questionnaire responses. The students responded in a way that indicates a high degree of AI literacy across the four competencies. "Know & Understand AI" saw the highest levels of agreeableness across the items, where it was clear that the respondents were interested in AI technology and had a good grasp of its strengths and weaknesses. This was further substantiated in the section for usage, where the majority reported regularly using AI tools for their school work. One should expect a fair amount of usage from someone who is fairly interested. Despite this, the remaining statements display a small discrepancy, some students seem more interested in theory and concept than thoughtful application. Reporting on their ability to evaluate AI, the students' answers correspond better with the knowledge they reported earlier. For this competency, it is evident that the students have an awareness of pitfalls and weaknesses surrounding responses from AI tools that match what one would expect based on their knowledge. This is also the case in the section on AI ethics, where the students report being well aware of ethical issues. When asked about actual issues, however, the participants reported less familiarity with several concepts that it would be natural to know of given their knowledge and interest in the subject. So, despite some discrepancies, the students overall seem to exhibit a high degree of AI literacy based on their

responses. However, it is prudent to not draw too strong conclusions based on these results, as there is no way to prove or disprove any claims made through the answers. This underlines the necessity for students to display their knowledge, not only self-reporting it.

5.2 Demonstrated AI Literacy

The quantitative data gives a good picture of the AI literacy level among technology students. However, these competencies are so far only self-reported. Through the in-depth interviews, students had the chance to display their actual knowledge. Comparing their display with the quantitative data will hence reveal discrepancies, similarities, and a more detailed picture of technology students' AI literacy competencies.

5.2.1 Know & Understand AI

Initially, we start by asking the question "How would you describe your own competency in AI?" This question is self-reporting, and many students claim a good overarching knowledge of AI concepts. However, there is a key difference between how they perceive "good knowledge" in the context of AI. This reveals gaps in both understanding and theoretical knowledge of concepts surrounding AI.

On one side, students see "good knowledge" as excelling in practical usage of genAI like ChatGPT. They believe their knowledge is good because they have built up a solid foundation on experiences, exposing both the strengths and weaknesses of AI tools. However, these students generally lack in-depth theoretical knowledge of AI. This discrepancy explains the observation in Chapter 5.1, where students self-report good knowledge, but do not apply this theory when using AI tools. For instance, some are unable to identify the fact that AI models are trained on vast datasets. Student 2 shows this by wrongly claiming that because AI is made of code, it is also good at programming. Additionally, as the knowledge these students display is experience-based, it is also narrow. When reflecting on key strengths and weaknesses of AI tools, these students struggle to see past the boundaries of their usage area. In terms of AI literacy, one can argue that the students' practical, experience-based knowledge reflects a partial fulfillment of the "Know & Understand AI" competency. In particular, they are able to understand how to operate AI applications, and recognize- to some extent, the practical strengths and weaknesses of AI tools.

On the other side, a minority of students associate "good knowledge" with a strong theoretical knowledge of AI. These individuals have typically engaged in AI courses, which is not reflective of the majority. Their ability to explain how genAI models are trained marks a significant distinction in AI literacy, displaying an understanding of the underlying data processes that many of their peers lack. This awareness of data and model training represents one of the clearest divides between superficial and in-depth AI knowledge, clearly displayed by Student 1. These students are not only familiar with the basic functions of AI, but can also

apply this knowledge when reflecting on future applications of AI. These capabilities are important components of the competency "Know & Understand AI". The small group's proficiency does point to a potential gap in educational opportunities for technology students at NTNU, showing a need to address and elevate the overall AI competency across the university.

The questionnaire results revealed that students have high confidence in their knowledge about AI use (KU1). The perception that being able to use AI tools proficiently equals "good knowledge" is likely a substantial contributor to self-reported confidence. However, this self-assessment overlooks the theoretical aspects of AI knowledge. The absence of an item regarding theoretical knowledge in the questionnaire is a notable limitation, as it could have provided more insight into the depth of students' knowledge. The questionnaire items KU1-KU5 were designed to capture the essence of knowing and understanding AI. Yet, the lack of a direct item on theoretical knowledge means that these items may only capture the surface of the competency. Even though students self-report proficiency, the interviews reveal that this confidence might not reflect a solid understanding of AI tools. This difference reveals the potential for students to overestimate their own abilities only based on practical tool usage. This mismatch underscores the need for educational strategies that specifically target broadening the theoretical knowledge base of students. In doing so, the gap between being able to use AI tools effectively and understanding the core principles of AI functionality might be closed, giving students a more holistic view of AI.

5.2.2 Use & Apply AI

The AI literacy competency "Use & Apply AI" assesses how students integrate AI tools into their educational activities. Both interview and questionnaire data provide useful insights into the different contexts students utilize AI technologies, and help highlight both their capabilities, as well as grasp of understanding.

Generally, the interviews reveal that students use AI tools mostly for programming, understanding theoretical concepts, and automating tedious or time-consuming tasks. According to the questionnaire results S1-S6, programming emerges as the most popular application of AI tools, aligning with the interview findings. A small discrepancy is found in the usage of AI tools when understanding concepts. Over half of the students interviewed described using the tools for this purpose, while S5, using AI tools to learn curriculum, averaged at "sometimes". A reason for this could be a slight disconnect between the usage areas, as learning curriculum and understanding concepts are not entirely the same thing. Nonetheless, students display the ability to apply AI technologies in different contexts, fitting well within the "Use & Apply" competency.

The interviews also revealed that students are good at recognizing when and where AI tools are most effective, and where they fall short. Student 2 notes specific weaknesses like figure interpretation and mathematics, but struggle to explain why the tools fail in these certain scenarios. They simply remember the weakness, and never try to apply it the same way again. While students have gained sig-

nificant understanding through experience, this observation suggests that they do not fully understand the concepts that limit the usage areas of AI technologies. From item UA2, students partially agree that they are able to use AI tools in a way that gives them satisfactory answers. This seems to reflect well on the above insight gained through the interviews.

Some students demonstrate strategic prompting, commonly known to students as prompt engineering. The general strategy they apply mainly revolves around building a solid context prior to giving a problem. Student 4 notes that they often receive higher quality answers with this approach, instead of inputting the question right off the bat. This prompting technique aligns well with the findings of Nikolic and colleagues, who noted that providing context leads to more complete answers when prompting genAI [60]. The strategic approach displayed by some students shows a high level of competency in utilizing AI effectively. In comparison with the questionnaire, students are divided between partially agreeing and disagreeing to taking enough time to write a good prompt (UA4). Students using strategic prompts can be assumed to answer "Agree" to this item, suggesting a slight misalignment between interviews and questionnaire.

A key competency within "Use & Apply AI" is the ability to communicate and collaborate efficiently with AI technologies [14]. A commonly used expression for this is using AI as a sparring partner, which some students mention explicitly. Students 2 and 9 point out that they use AI tools in this way especially when human assistance is unavailable. Student 9 also mentioned using ChatGPT as a collaborator in a group setting. The authors discussed this as a potential way of implementing AI tools in an educational setting [30]. Using AI tools as collaborators can teach with a hands-on approach how to effectively communicate with it. As only a few students mention this approach, it aligns well with the item UA5, as students slightly disagree to using AI as collaborative partners in a back and forth manner.

5.2.3 Evaluate AI

The competency "Evaluate AI" involves the ability to critically evaluate and appraise the reliability and validity of information provided by AI tools. The interviews revealed a clear trend where students have developed a cautious approach to accepting AI-generated outputs, particularly from ChatGPT. This skepticism seems rooted in personal experiences of AI-generated misinformation, as noted by student 3. This observation aligns well with the questionnaire, as EV1 shows that students generally disagree to always trusting answers generated by AI. It also shows that students are aware of the limitations of AI tools and are able to reflect critically on their outputs, key aspects of the "Evaluate AI" competency.

Student 6 also claims to have the ability to detect when ChatGPT-generated content may be fabricated or incorrect. However, most students disregard this claim, and rather depend on verifying the information through external sources, as noted by student 5 and others. However, while students are good at evaluating through source criticism, few are able to articulate specific reasons for their dis-

trust. This indicates a gap between practical skepticism and a deep understanding of AI limitations, raising questions about critical thinking skills among students.

A significant number of students rely on their existing knowledge to evaluate the correctness of AI responses. In the interviews, they report greater confidence in their judgment when prompting about a subject of familiarity. This is emphasized by student 1. The questionnaire item EV2 reveals an overall agreement that students are confident in their ability to evaluate the validity of AI outputs. It becomes clear that through both source criticism and tacit knowledge, students' abilities to evaluate AI outputs in themselves are high. However, it does not completely cover the competency of evaluating AI, as the criticism they show is mainly linked to their context of use and not the bigger picture of AI.

Interestingly, the level of skepticism applied by students seems to vary depending on what tasks and context they use AI tools in. For instance, for programming tasks, students tend to trust the AI outputs in a straightforward manner as long as the code functions correctly, as mentioned by student 4. Additionally, when students perceive their task to have no impact on their learning, they are also less critical. This suggests that the importance of the task influences the degree of critical evaluation applied, which might be connected to the high number of students stating that they "sometimes" use other sources to evaluate AI outputs in item EV5.

5.2.4 AI Ethics

Human-centered considerations are important in educating the general public to become socially responsible and ethical users of AI technologies. Students show from the questionnaire that they are aware there exist ethical issues regarding AI. However, the interviews reveal a broad spectrum of actual knowledge under this awareness, ranging from well-informed to superficial.

Students commonly recognize widely discussed ethical issues such as misinformation, plagiarism and bias. This recognition is consistent with the questionnaire results. One could argue that these three are understood easily from their names. However, there is a noticeable variation in how deeply the students understand these issues. The difference again, lies in the ability to understand that AI is trained on vast datasets. One example shows student 10 touching on bias, but misses in their explanation of the relation between men developing AI, and how this leads to gender inequality in the AI tool. In contrast, students with a robust understanding of AI ethics can articulate the implications of ethical issues, drawing lines back to human decisions and their consequences on society. Student 6 displays this competency clearly by being aware that AI is trained on data that is ultimately human, and that there exists bias in humans. This observation is not reflected in the questionnaire, but indicates an area that could be improved through AI education.

Issues like equality and sustainability are less understood and not often addressed by students. These topics require deep reflection and a thorough understanding of

human-centered ethics, areas where the gap in ethical competency among students becomes most apparent. As these two ethical issues are also the least known from the questionnaire, the level of ethical knowledge seems to be reflected well. On another note, student 7 pointed out that equality and sustainability are difficult and wide terms, and that they would have been able to explain it given a bit more context. This is a potential weakness of the questionnaire, potentially leading to more participants indicating a low knowledge of these topics.

Despite the difference in competency regarding AI ethics, students almost unanimously agree that it is something everyone should know. For instance, student 10 acknowledges that AI tools will be integrated into their everyday lives, and that one should therefore know how to use them in the right way. This reflection is also a key sentiment used by Ng and colleagues when arguing for ethical considerations to be part of the AI literacy framework [14]. Even though the interviews suggest this unanimous agreement, it does not completely align with item AIED8. Although students tend to agree that AI should be taught to build awareness of ethical considerations, a quarter of the participants disagree. A reason could be, as student 9 pointed out, that one should know about ethical considerations if you are to engage with them on an expert level.

In summary, Chapter 5.2 explored the discrepancies and alignments between students' displayed AI literacy competencies and their self-perceived competencies. Students demonstrated a wide range of knowledge and understanding. Many students associate practical skills in using AI with good understanding. This suggests a trend of students being proficient in using AI, but a lack of underlying theoretical knowledge. The absence of a direct question about understanding AI concepts could have made this observation clear in the questionnaire as well. A developed skepticism was evident in how students interacted with AI outputs, which reflects the result of item EV1, showing general distrust in AI's reliability. Though students were cautious, their depth of critical evaluation varied. Some students were unable to articulate specific reasons for their distrust beyond immediate experiences, pointing to a gap in critical thinking skills. Ethical issues were broadly recognized, with issues like plagiarism, misinformation and bias widely understood. However, more complex issues like equality and sustainability were less comprehended. Despite this, all interviewed students agreed that ethics was an important part of AI education, which somewhat reflects the questionnaire item AIED8. A divide between competency levels in all facets of AI literacy is the ability to recognize that AI is trained on vast datasets, which seems to unlock a great deal of reflection and display of competency from the students. These findings underscore the need to broaden AI education beyond practical skills, but also deepen the theoretical and ethical understanding of AI technologies, leading to a more complete form of AI literacy.

5.3 AI in Education

Although students' thoughts and experiences regarding AI in education are not part of the AI literacy framework in itself, it is essential to understand the dynamic between the university and the students when it comes to teaching and learning about AI technologies. It is especially important to investigate because the university is responsible for equipping students to competently and ethically use AI, preparing them for a future where AI is prevalent in a wide variety of sectors.

The findings from both the questionnaire (AIED1) and the interviews indicate a clear lack of formal guidance on the use of AI tools to the students. Students 1 and 7, for instance, mentioned that the only information they had ever gotten regarding AI was an email about the documentation of using AI tools in their master thesis. Student 8 had also gotten an email, but rather than guiding, it contained more of a warning. In other words, the only apparent measures taken by NTNU, are warnings and regulations on the use of AI in specific contexts. Student 5 does however mention having a lecture openly discussing AI, but so far, this is not common practice, only an individual educator's approach. Hence, what AI knowledge students possess has mostly been acquired independently, without structural educational strategies fostering genuine AI literacy. Item KU3 underscores the students' initiative to explore generative AI, as students are curious, and see the potential to enhance their academic efficiency. The arisen informal hands-on approach used by students is understandable, but as revealed in Chapter 5.2, it might not lead to a comprehensive and accurate understanding of AI capabilities.

NTNU's approach to AI education appears to lag behind that of other institutions which have more systematically implemented educational measures on how to use AI, or to foster AI literacy. Notable examples include the University of Florida's *AI Across the Curriculum* [8], and the University of Oslo's GPT UiO [61]. As mentioned in Chapter 2.3, the University of Florida's approach is comprehensive, with measurements to integrate AI education across disciplines. Conversely, the University of Oslo (UiO) has created a privacy-friendly version of ChatGPT, and a web page on how to use AI as a student. Here, they cover important concepts of AI in order to understand the technology, provide useful resources on AI literature, and suggest ways of using AI tools as learning support for students [62]. While NTNU may not immediately implement an initiative as extensive as UF, adopting smaller, feasible steps similar to UiO's could be a step in the right direction to enhance AI literacy.

Responses from questionnaire item AIED2 and interviews indicate a strong desire among students for more structured AI education. As student 3 points out, many students perceive genAI as a black box, and that with better AI education, more students will learn how to use the tools correctly and effectively. When ChatGPT was released, students were more or less left on their own in learning how to use it. Student 6 would have preferred to receive some formal guidance on the dos and don'ts of ChatGPT from the university, but this never happened.

The students recognize AI as a technology that will affect their lives going forward. This is also reflected through items AIED6 and AIED7, as the majority agree that it is important to learn about AI in preparation for work life, and to make schoolwork more effective. Student 2, for instance, compares the rise of genAI to the integration of the calculator, and emphasized the need to learn and understand the limitations of AI tools in order to use them effectively.

In addition to the strong wish for more AI education, students also come up with ideas of how to teach it. Student 3 notes that having a course already in the first year of study is necessary. They suggest building on the already mandatory HSE course, creating a similar mandatory AI course. This idea is further substantiated by student 4, expressing a wish for some form of training or guidance through a course, with clear guidelines in subjects that have practical exercises where AI tools can be exploited. Interestingly, student 7 is also able to see how the university would benefit from teaching AI. They argue that better knowledge leads to more effective usage, and hence, the university can produce more work. However, as discovered in the authors' project report, educators are overall skeptical to the integration of AI tools into education, believing it would disrupt experiential learning [30]. This disconnect between educators and students underscores the need for initiatives that bridge understanding and application of AI technologies.

In summary, the investigation into how technology students at NTNU experience guidance regarding AI use, and their opinions on the importance of AI education, reveals a significant gap in formal AI guidance. Students have so far only received sparse information, typically not extending outside of basic documentation requirements, and warnings on the usage of generative AI. Such an approach sharply contrasts the educational initiatives seen other places in Norway and in the world. Students at NTNU have shown that they are curious about exploring AI technologies, and acknowledge the impact AI could have on their lives. However, the self-directed learning approach often leads to shortcomings in the understanding of core AI concepts. The students' desire for more structured AI education is apparent, and suggest a dedicated AI course in order to ensure the correct and ethical use of AI tools, and foster AI literacy. The disconnect between the students' enthusiasm for AI integration, and the educators' skepticism about its impact on traditional learning models highlights a need for initiatives that bridge these differing perspectives. By investing in AI education and providing clear, structured guidance, NTNU can better prepare its students for the inevitable integration of AI in various sectors, thus fulfilling its responsibility as an educational institution in an AI-driven world.

5.4 Limitations

This research, while providing valuable insights into AI literacy among technology students at NTNU, is subject to certain limitations that must be considered when interpreting the findings. These limitations arise from various aspects of the study design and methodology, including the sampling strategy, the instruments used for data collection, and the inherent biases associated with these methods.

5.4.1 Questionnaire Limitations

Firstly, the sample of the questionnaire was collected online, and only consists of native Norwegian-speaking students of technology at NTNU, which limits the scope of the research significantly, only covering the portion of citizens that are most likely to know about and interact with AI technologies.

The layout and design of the questionnaire itself can influence how participants answer. There are two opposing effects. The *primacy effect* is when participants tend to choose questionnaire options that are closer to the beginning of a list [63], while the *recency effect* states that when presented with a list of items, you are more likely to remember the last ones [64]. In the case of the designed questionnaire, every list of the Likert response options was ordered from the most negative on the left, to the most positive on the right. Optimally, for a questionnaire such as the one used, one would have two versions, each with a reversed order of response options to the other. The two different versions would then be randomly distributed among the participants in order to ensure more reliable data. Despite this, the results from the questionnaire seem to be evenly distributed at both the beginning of the order and the end, with several sections favoring the end almost entirely.

Additionally, the questionnaire might also be exposed to *confirmatory bias*, meaning that the respondents tend to agree with a statement in the question. A common way to work around this is to mix up some questions by using negative statements. Additionally, this is an effective tool for detecting respondents who simply answer the same for all the questions in order to get through the questionnaire quickly.

Lastly, no factor analysis of the questionnaire items was conducted, and hence, we are unable to assess whether the designed items statistically represent their designated competencies. As there is no golden standard for measuring AI literacy yet, our questionnaire design can therefore only be described as exploratory.

5.4.2 Interview Limitations

As the interview format is semi-structured with open-ended questions, it may be susceptible to selection and response bias [65][66].

A potential limitation arises from the study's exclusive focus on technology students, thereby, only interviewing students from technology studies. This may introduce selection bias. The insight gained from technology students is poten-

tially skewed from the general population, because they are rather well-versed in the world of technology. The resulting data may therefore not be transferable to other fields of study. Future research will benefit from a more diverse sample, including not only students of technology. Many of the invited students chose not to participate in the interviews, or were non-responsive. This could potentially lead to self-selection bias [65]. Students with more interest, and consequently, more knowledge of AI, are more likely to participate in the interviews, which

Additionally, response bias is a potential limitation of this study. This refers to the systematic error introduced when participants provide answers that may not accurately reflect their true thoughts, feelings, or experiences [66]. Although this bias may not manifest in the student's displayed knowledge of AI technologies, it can certainly affect their opinions on ethical challenges, as well as opinions on how to use and critically evaluate AI tools. Here, the students may conform to social norms, in order to answer "correctly". However, it is still important to let subjective answers be acknowledged in the discussion of a relatively new and rapidly evolving technology such as generative AI.

5.5 Sustainability and AI Literacy

Understanding the impact of AI on different levels of society is not just about recognizing its capabilities, but also its sustainability implications. As AI technology advances rapidly, its integration spans multiple industries, making it important to consider its ethical, social, and environmental impacts. A crucial component in meeting these impacts is knowledge and education on the subject. This chapter discusses the impact an AI-literate society can have in working towards the UN Sustainable Development Goals (SDGs) [67].

It is easy to argue that AI technology can directly or indirectly influence the progress of all 17 SDGs, as there is virtually no limit to how it can be applied. One could argue that AI could revolutionize agriculture or optimize economic models, but these are end-goal achievements. It is more likely that such improvements begin with better optimization of supply chains and logistics, ensuring more abundance which can be distributed where it is needed. Further, one can imagine that AI will help make small improvements that help in their own isolated areas. Together, these changes could lift society as a whole and accelerate the development towards the SDGs. This does however demand a certain level of AI literacy across the population and in almost all sectors.

Goal 3, which focuses on health and well-being, demonstrates areas where AI literacy is crucial. The potential of using AI technology for vaccine design or disease prevention is profound [68]. Furthermore, overworked hospital staff could be alleviated with the help of AI assistants managing patient journals or speeding up clinical decisions [69]. An important factor in implementing these improvements is identifying the problems, and realizing a fitting AI solution. This requires the actual people encountering the challenges to have an understanding of AI technology and how it can be utilized, underlining the impact AI literacy can have on the goal.

Similarly, goal 9 aiming at industry, innovation and infrastructure is the goal where AI tools have made their biggest entrance as of today. Also here, an AI-literate workforce enables tailored solutions to problems that are unknown to the traditional AI experts with no domain knowledge. This effect will increase with time, seeing as more and more industries implement AI solutions [70]. However, this development poses a risk to the goal of promoting inclusive and sustainable industrialization. An increased reliance on AI technology can lead to bigger socio-economic differences. Certain groups in society can fall behind because when they are not as proficient with AI due to limited access to the internet, creating a digital divide [71]. This shows the importance of ensuring that AI literacy is provided to all. Similarly, the divide presents a challenge for goal 4, which aims at ensuring inclusive, equitable, and quality education for all. Ensuring that all students achieve AI literacy could help lessen this problem, as well as help with providing quality education to more students.

Furthermore, goal 8 aims at achieving decent work and economic growth. Findings from the World Economic Forum estimate that 44% of workers' skills will be disrupted by AI in the next five years [72]. While the arguments made in the previous section can help mitigate this, one could also look to the other side of the issue. Understanding AI can help policymakers and businesses implement AI responsibly, ensuring that economic progress does not come at the cost of job security. This emphasizes the benefits of AI literacy in as many levels of society as possible.

Finally, 12 stands as a challenge for further development of large GAI models such as LLMs, as these use enormous amounts of energy [73] and water [74] to operate. With a bigger portion of the population being AI literate and more aware of such issues paves the way for more constructive discussions, as well as opening for more public pressure on developers to find more sustainable solutions. This subject stands as a final hurdle before AI can be fully utilized to achieve the other goals.

In conclusion, encouraging AI literacy is not only about enabling more effective use of AI technologies, it is about ensuring that their deployment advances sustainable development in a manner that is informed, equitable, and ethical. As society continues to make use of AI to achieve the SDGs, the role of AI literacy becomes increasingly critical in guiding these efforts in a responsible and sustainable way.

5.6 Future Work

The findings of this thesis open many paths for future research into both AI literacy, and the implementation of AI in education. Investigating both student knowledge levels, and their experiences with guidance regarding the use of AI tools at NTNU, provides a solid foundation for understanding what areas require further investigation.

One area of future research should be to extend the scope of measuring AI literacy to include non-technology students at NTNU. This will help build a more comprehensive picture of the level of AI literacy across all disciplines, and address how AI literacy requirements may differ between disciplines.

Another area of future research should explore different ways of employing AI education aimed at improving AI literacy. The educational approaches should then be tested to identify which methods are most effective at enhancing understanding and practical skills in AI. Further, research should employ longitudinal studies, aiming at measuring AI literacy over time in response to the different educational approaches.

As mentioned in Chapter 5.4.1, there is no golden standard to measuring AI literacy yet. Conducting a comprehensive factor analysis of the questionnaire items is therefore crucial in future work, to confirm that they accurately measure the intended competencies of AI literacy. This would refine the questionnaire based on empirical evidence, ensuring that it reliably assesses the different dimensions of AI literacy.

Finally, future work should consider the ethical considerations of implementing AI in education. This research should help develop guidelines for the ethical and fair use of AI tools in academic settings, and explore how AI literacy influences ethical decision-making among students.

Chapter 6

Conclusions

The aim of this research was to investigate the current level of AI literacy among technology students at the Norwegian University of Technology and Science. Based on the descriptive analysis of students self-reported knowledge and understanding in the questionnaire, and the thematic analysis of their displayed proficiency through in-depth interviews, it can be concluded that the level of AI literacy varies. The questionnaire revealed that students had good confidence in their own ability to use AI tools, know its strengths ans weaknesses, critically evaluate its answers, and see future areas where AI can be utilized. Additionally, students reported being aware there exists ethical issues concerning AI like plagiarism and misinformation, but reported less knowledge of ethical considerations more connected to society, including bias, equality and sustainability. Through the students' displayed competencies in in-depth interviews, discrepancies from their self-reported knowledge arose. Students generally showed a flipped understanding of what it means to have good knowledge of AI, often perceiving this as the ability to use AI tools effectively, instead of theoretical understanding of AI concepts. This divide in theoretical understanding was most clearly displayed through the students' knowledge of how AI is trained on vast datasets, and a lack of reflection on future applications for AI. Nonetheless, students showed that they had an experience based proficiency in using AI tools, and displayed a healthy level of skepticism towards AI outputs. Additionally, when evaluating AI responses, students relied on their preexisting knowledge of the queried subject. Similarly to the questionnaire, students showed an awareness of ethical challenges regarding AI such as plagiarism and misinformation, but less knowledge of the human-based considerations. Both questionnaire and interviews revealed a severe lack of AI guidance from NTNU. Hence, the knowledge and shortfalls displayed by students are a result of unstructured self-teaching. The students show a great desire for more structured AI education, emphasizing the need for educational initiatives that bridge the gap between practical skills that students already display, and theoretical knowledge of AI technologies. This will ensure students are proficient users, but also informed, reflective, and ethical participants in the digital world.

Recommendations for future research are to expand the scope of students examined to include non-technology studies, as this will help paint a fuller picture of cross-disciplinary AI literacy. We also recommend developing and testing curriculum dedicated to AI literacy in order to assess what measures are most effective

in raising competency among students. Finally, future research should test the factorial structure of the questionnaire items in order to ensure it fully reflects the competencies of AI literacy.

References

[1] IBM. *IBM Global AI Adoption Index 2023*. Tech. rep. IBM.

[2] S. Albanesi et al. "Reports of AI ending human labour may be greatly exaggerated". In: *European Central Bank* Research Bulletin No. 113 (2023). URL: https://www.ecb.europa.eu/press/research-publications/resbull/2023/html/ecb.rb231128~0a16e73d87.en.html.

[3] Samfunnsøkonomisk Analyse. *Kunstig Intelligens i Norge - nytte, muligheter og barrierer*. Tech. rep. NHO, Abelia, Finans Norge, Nelfo, 2023. URL: https://www.samfunnsokonomisk-analyse.no/nye-prosjekter/2024/1/8/kunstig-intelligens-nytte-muligheter-og-barrierer.

[4] "Kunstig intelligens i Norge - nytte, muligheter og barrierer (Sammendrag)". In: *Næringslivets Hovedorganisasjon* (Jan. 2024). URL: https://www.nho.no/tema/digitalisering/Kunstig_intelligens_i_Norge_Rapportsammendrag_SOA2023/#part2.

[5] Digitaliserings- og forvaltningsdepartementet. "Nasjonal stategi for kunstig intelligens". In: *Strategi* (2020). URL: https://www.regjeringen.no/no/tema/statlig-forvaltning/it-politikk/KI-strategi/id2639883/.

[6] T. H. Davenport and R. Ronanki. "Artificial Intelligence for the Real World". In: *Harvard Business Review*. Volume 96 (2018), pp. 108–116.

[7] D. Long and B. Magerko. "What is AI Literacy? Competencies and Design Considerations". In: *Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems* (2020). DOI: https://doi.org/10.1145/3313831.3376727.

[8] J. Southworth et al. "Developing a model for AI Across the curriculum: Transforming the higher education landscape via innovation in AI literacy". In: *Computers and Education: Artificial Intelligence* Volume 4 (2023). DOI: https://doi.org/10.1016/j.caeai.2023.100127.

[9] K. Polanco-Levicán and S. Salvo-Garrido. "Understanding Social Media Literacy: A Systematic Review of the Concept and Its Competences". In: *International journal of environmental research and public health* 19 (July 2022). DOI: https://doi.org/10.3390/ijerph19148807.

[10] S.-C. Kong, W. M.-Y Cheung, and G. Zhang. "Evaluating an Artificial Intelligence Literacy Programme for Developing University Students' Conceptual Understanding, Literacy, Empowerment and Ethical Awareness". In: *Educational Technology Society* (2023), pp. 16–30.

[11] D. Cetindamar et al. "Explicating AI Literacy of Employees at Digital Workplaces". In: *IEEE transactions on engineering management* 71 (2024), pp. 810–823. DOI: https://doi.org/10.1109/tem.2021.3138503.

[12] M. C. Laupichler et al. "Development of the "Scale for the assessment of non-experts' AI literacy" – An exploratory factor analysis". In: *Computers in Human Behaviour Reports* Volume 12 (2023). DOI: https://doi.org/10.1016/j.chbr.2023.100338.

[13] S.-C. Kong, W. M.-Y Cheung, and G. Zhang. "Evaluation of an artificial intelligence literacy course for university students with diverse study backgrounds". In: *Computers and education. Artificial intelligence* 2 (2021). DOI: https://doi.org/10.1016/j.caeai.2021.100026.

[14] D. T. K. Ng et al. "Conceptualizing AI literacy: An exploratory review". In: *Computers and Education: Artificial Intelligence* Volume 2 (2021). DOI: https://doi.org/10.1016/j.caeai.2021.100041.

[15] B. Bloom. *Taxonomy of Educational Objectives: The Classification of Educational Goals*. 1956. URL: https://web.archive.org/web/202012120725 20id_/https://www.uky.edu/~rsand1/china2018/texts/Bloom%20et%20al%20-Taxonomy%20of%20Educational%20Objectives.pdf.

[16] Y. Dai et al. "Promoting Students' Well-Being by Developing Their Readiness for the Artificial Intelligence Age". In: *Sustainability* 12.16 (2020). DOI: https://doi.org/10.3390/su12166597.

[17] A. Carolus et al. "MAILS - Meta AI literacy scale: Development and testing of an AI literacy questionnaire based on well-founded competency models and psychological change- and meta-competencies". In: *Computers in Human Behavior: Artificial Humans* Volume 1 (2023). DOI: https://doi.org/10.1016/j.chbah.2023.100014.

[18] S. Ali et al. *Constructionism, Ethics, and Creativity: Developing Primary and Middle School Artificial Intelligence Education*. 2019. URL: https://robots.media.mit.edu/wp-content/uploads/sites/7/2019/08/Constructionism__Ethics__and_Creativity.pdf.

[19] M. Kandlhofer et al. "Artificial intelligence and computer science in education: From kindergarten to university". In: *IEEE Frontiers in Education Conference* (2016). DOI: https://doi.org/10.1109/fie.2016.7757570.

[20] R. Williams, H. W. Park, and C. Breazeal. "A is for Artificial Intelligence". In: *Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems - CHI '19* (2019). DOI: https://doi.org/10.1145/3290605.3300677.

[21] J. Rodríguez-García et al. "Evaluation of an Online Intervention to Teach Artificial Intelligence with LearningML to 10-16-Year-Old Students". In: *Technical Symposium on Computer Science Education* (2021). DOI: https://doi.org/10.1145/3408877.3432393.

[22] K. Nikolopoulou. *What Is Social Desirability Bias? | Definition Examples*. June 2022. URL: https://www.scribbr.com/research-bias/social-desirability-bias/.

[23] C. S. Chai et al. “Perceptions of and Behavioral Intentions towards Learning Artificial Intelligence in Primary School Students”. In: *Educational Technology Society* 24.3 (2021), pp. 89–101. URL: https://www.jstor.org/stable/27032858.

[24] O. Karaca, S. Çalişkan, and K. Demir. “Medical artificial intelligence readiness scale for medical students (MAIRS-MS) – development, validity and reliability study”. In: *BMC Medical Education* 21.1 (2021). DOI: 10.1186/s12909-021-02546-6.

[25] B. Wang, P. Rau, and T. Yuan. “Measuring user competence in using artificial intelligence: validity and reliability of artificial intelligence literacy scale”. In: *Behaviour Information Technology* 42.9 (2022), pp. 1324–1337. DOI: 10.1080/0144929x.2022.2072768.

[26] M. Pinski and A. Benlian. “AI Literacy - Towards measuring human competency in artificial Intelligence”. In: *Proceedings of the Annual Hawaii International Conference on System Sciences* (2023). DOI: 10.24251/hicss.2023.021.

[27] H. Zhang et al. “Integrating Ethics and Career Futures with Technical Learning to Promote AI Literacy for Middle School Students: An Exploratory Study”. In: *International journal of artificial intelligence in education* 33.2 (2022), pp. 290–324. DOI: https://doi.org/10.1007/s40593-022-00293-3.

[28] C. K. Y. Chan and L. H. Y. Tsi. *The AI Revolution in Education: Will AI Replace or Assist Teachers in Higher Education?* 2023. URL: https://arxiv.org/abs/2305.01185.

[29] L. Wilton et al. “Where Is the AI? AI Literacy for Educators”. In: *Springer eBooks* (2022), pp. 180–188. DOI: https://doi.org/10.1007/978-3-031-11647-6_31.

[30] M. J. Cubas and B. H. Ersdal. *AI in Engineering Education: A Qualitative Study on Opportunities and Challenges of Generative AI in Engineering Education*. Norwegian University of Technology and Science, 2023.

[31] M. Brew et al. “Towards Developing AI Literacy: Three Student Provocations on AI in Higher Education”. In: *Asian Journal of Distance Education* Volume 18 (2023). URL: https://www.asianjde.com/ojs/index.php/AsianJDE/article/view/726.

[32] A. Shoufan. “Exploring Students’ Perceptions of ChatGPT: Thematic Analysis and Follow-up Survey”. In: *IEEE access* 11 (2023). DOI: https://doi.org/10.1109/access.2023.3268224.

[33] N. Črček and J. Patekar. “Writing with AI: University Students’ Use of ChatGPT”. In: *Journal of Language and Education* Volume 9 (2023). DOI: https://doi.org/10.17323/jle.2023.17379.

[34] K. Brennan. *The Managed Teacher: Emotional Labour, Education, and Technology*. 2006. URL: https://api.semanticscholar.org/CorpusID:17687424.

[35] F. Miao et al. *AI and Education, Guidance for Policy-Makers*. UNESCO, 2021. URL: https://unesdoc.unesco.org/ark:/48223/pf0000376709.

[36] C. T. Tiwari et al. “What drives students toward chatgpt? An investigation of the factors influencing adoption and usage of Chatgpt”. In: *Interactive Technology and Smart Education* (2023). DOI: 10.1108/ITSE-04-2023-0061.

[37] C. D. Duong, T. N. Vu, and T. Viet. “Applying a modified technology acceptance model to explain higher education students’ usage of ChatGPT: A serial multiple mediation model with knowledge sharing as a moderator”. In: *International journal of management education* 21.3 (2023). DOI: https://doi.org/10.1016/j.ijme.2023.100883.

[38] G-J. Hwang and C-Y. Chang. “A review of opportunities and challenges of chatbots in education”. In: *INTERACTIVE LEARNING ENVIRONMENTS* Volume 31, Number 7 (2020), pp. 4099–4112. DOI: https://doi.org/10.1080/10494820.2021.1952615.

[39] A. Kerly and S. Bull. “The Potential for Chatbots in Negotiated Learner Modelling: A Wizard-of-Oz Study”. In: *Intelligent Tutoring Systems: (ITS 2006)* (2006), pp. 443–452. URL: https://link.springer.com/chapter/10.1007/11774303_44.

[40] S. Tegos, S. Demetriadis, and A. Karakostas. “Promoting academically productive talk with conversational agent interventions in collaborative learning settings”. In: *Computers Education* Volume 87 (2015), pp. 309–325. DOI: https://doi.org/10.1016/j.compedu.2015.07.014.

[41] S. Shorey et al. “"A Virtual Counseling Application Using Artificial Intelligence for Communication Skills Training in Nursing Education: Development Study"”. In: *"Journal of Medical Internet Research"* Voume 21:10 (2019). DOI: https://doi.org/10.2196/14658.

[42] L. K. Fryer et al. “Stimulating and sustaining interest in a language course: An experimental comparison of Chatbot and Human task partners”. In: *Computers in Human Behavior* Volume 75 (2017), pp. 461–468. DOI: https://doi.org/10.1016/j.chb.2017.05.045.

[43] OpenAI. *ChatGPT*. URL: https://openai.com/chatgpt.

[44] S. Atlas. *ChatGPT for Higher Education and Professional Development: A Guide to Conversational AI*. 2023. URL: https://digitalcommons.uri.edu/cba_facpubs/548.

[45] A. Radford and K. Narasimhan. “Improving Language Understanding by Generative Pre-Training”. In: 2018. URL: https://api.semanticscholar.org/CorpusID:49313245.

[46] M. Scharth. “The ChatGPT chatbot is blowing people away with its writing skills”. In: *The University of Syndey* (2022). URL: https://www.sydney.edu.au/news-opinion/news/2022/12/08/the-chatgpt-chatbot-is-blowing-people-away-with-its-writing-skil.html.

[47] G. Cooper. “Examining Science Education in ChatGPT: An Exploratory Study of Generative Artificial Intelligence”. In: *Journal of Science Education and Technology* Volume 32 (2023), pp. 444–452. URL: https://doi.org/10.1007/s10956-023-10039-y.

[48] Y. K. Dwivedi et al. “Opinion Paper: “So what if ChatGPT wrote it?” Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for research, practice and policy”. In: *Computers and Education: Artificial Intelligence* Volume 71 (2023). DOI: https://doi.org/10.1016/j.ijinfomgt.2023.102642.

[49] P. Bhandari. *What Is Quantitative Research? | Definition, Uses Methods.* 2020. URL: https://www.scribbr.com/methodology/quantitative-research/.

[50] T. George. “Semi-Structured Interview | Definition, Guide Examples”. In: *Scribbr* (Jan. 2022). URL: https://www.scribbr.com/methodology/semi-structured-interview/.

[51] J. Caulfield. “How to Do Thematic Analysis | Step-by-Step Guide Examples”. In: *Scribbr* (Sept. 2019). URL: https://www.scribbr.com/methodology/thematic-analysis/.

[52] A. Brooks. “The 4 Types of Transcriptions, With examples”. In: *Upwork* (Mar. 2021). URL: https://www.upwork.com/resources/types-of-transcriptions.

[53] Dovetail Editorial Team. “How To Do Thematic Analysis”. In: *Dovetail* (Feb. 2023). URL: https://dovetail.com/research/thematic-analysis/.

[54] V. Braun and V. Clarke. “Using Thematic Analysis in Phsycology”. In: *Qualitative Research in Phsycology* 3 (2006), pp. 77–101. URL: https://www.tandfonline.com/doi/abs/10.1191/1478088706qp063oa.

[55] S. K. Khare et al. “Emotion recognition and artificial intelligence: A systematic review (2014–2023) and research recommendations”. In: *Information fusion* 102 (2024). DOI: https://doi.org/10.1016/j.inffus.2023.102019.

[56] T. George. *What Are the Limitations of ChatGPT?* Apr. 2023. URL: https://www.scribbr.com/ai-tools/chatgpt-limitations/.

[57] A. Esteve. “The business of personal data: Google, Facebook, and privacy issues in the EU and the USA”. In: *International data privacy law* 7 (2017). DOI: https://doi.org/10.1093/idpl/ipw026.

[58] S. C. Boerman, S. Kruikemeier, and F. J. Zuiderveen Borgesius. “Exploring Motivations for Online Privacy Protection Behavior: Insights From Panel Data”. In: *Communication Research* 48 (2018). DOI: https://doi.org/10.1177/0093650218800915.

[59] Dr. Varsha PS. “How can we manage biases in artificial intelligence systems – A systematic literature review”. In: *International journal of information management data insights* 3 (2023). DOI: https://doi.org/10.1016/j.jjimei.2023.100165.

[60] S. Nikolic et al. “ChatGPT versus engineering education assessment: amultidisciplinary and multi-institutional benchmarking andanalysis of this generative artificial intelligence tool to investigateassessment integrity”. In: *European Journal of Engineering Education* Volume 43 (2023), pp. 559–614. DOI: https://doi.org/10.1080/03043797.2023.2213169.

[61] The University of Oslo. *GPT UiO – UiOs privacy friendly GPT chat*. URL: https://www.uio.no/english/services/it/ai/gpt-uio/index.html.

[62] The University of Oslo. *How to Use AI as a Student*. URL: https://www.uio.no/english/services/ai/student/index.html.

[63] J. A. Krosnick and D. F. Alwin. "An Evaluation of a Cognitive Theory of Response-Order Effects in Survey Measurement". In: *Public Opinion Quarterly* 51.2 (Jan. 1987). DOI: https://doi.org/10.1086/269029.

[64] K. Schweitzer and N. Nuñez. "The effect of evidence order on jurors' verdicts: Primacy and recency effects with strongly and weakly probative evidence". In: *Applied Cognitive Psychology* 35.6 (Oct. 2021), pp. 1510–1522. DOI: https://doi.org/10.1002/acp.3884.

[65] K. Nikolopoulou. *What Is Selection Bias? | Definition Examples*. 2022. URL: https://www.scribbr.com/research-bias/selection-bias/.

[66] K. Nikolopoulou. *What Is Response Bias? | Definition Examples*. 2022. URL: https://www.scribbr.com/research-bias/response-bias/.

[67] *The Sustainable Development Goals Report 2023: Special Edition*. July 2023. URL: https://desapublications.un.org/publications/sustainable-development-goals-report-2023-special-edition.

[68] T. H. Davenport and R. Kalakota. "The potential for artificial intelligence in healthcare". In: *Future healthcare journal* 6.2 (June 2019), pp. 94–98. DOI: https://doi.org/10.7861/futurehosp.6-2-94.

[69] L. Raymond et al. "Nurse practitioners' involvement and experience with AI-based health technologies: A systematic review". In: *Applied nursing research* 66 (Aug. 2022), pp. 151604–151604. DOI: https://doi.org/10.1016/j.apnr.2022.151604. URL: https://www.sciencedirect.com/science/article/pii/S0897189722000465.

[70] M. Chui et al. *The state of AI in 2022—and a half decade in review*. Dec. 2022. URL: https://www.mckinsey.com/capabilities/quantumblack/our-insights/the-state-of-ai-in-2022-and-a-half-decade-in-review.

[71] R. Cullen. In: *Online Information Review* (2001). DOI: https://doi.org/10.1108/14684520110410517.

[72] World Economic Forum. *Future of Jobs Report 2023*. May 2023. URL: https://www3.weforum.org/docs/WEF_Future_of_Jobs_2023.pdf.

[73] S. McQuate. *QA: UW researcher discusses just how much energy ChatGPT uses*. 2023. URL: https://www.washington.edu/news/2023/07/27/how-much-energy-does-chatgpt-use/#:~:text=Overall%2C%20this%20can%20lead%20to,of%20over%201%2C000%20U.S.%20households..

[74] P. Li et al. *Making AI Less "Thirsty": Uncovering and Addressing the Secret Water Footprint of AI Models*. 2023. URL: https://arxiv.org/abs/2304.03271.

Appendices

A - Quotes in Norwegian

Når det kommer til bruk, så føler jeg at jeg er god på å få svar på det jeg lurer på. Når det kommer til oppbygging, så kan jeg mer enn mannen på gata, men ikke mer enn noen som har studert KI.

– S6

Mer sånn på en måte erfaringsbasert. Litt sånn skjønt på en måte mer og mer hvordan det er lurt å bruke det for å få de svarene du er ut etter liksom.

– S2

Jeg vil si at det er høyere enn de fleste andre i samfunnet. Fordi jeg har hatt de grunnleggende maskinlæringsfagene.

– S1

Menneskelig intelligens er vel enda litt bedre. Men den tar det igjen fort.

– S1

Jeg vet ikke, egentlig.

– S5

Forstå emosjoner, for eksempel, jeg vil jo si oppegående mennesker klarer å forstå emosjon eller ansiktsuttrykk bedre enn KI, ja, for så vidt kanskje det [...]

– S9

Kunstig intelligens er å lure pc'en sin til å tenke av egne trenger.

– S4

Når jeg bruker chatGPT, så skjønner jeg at det er en datamaskin som leter på nettet for å finne svar på det jeg spør om.

– S10

Den på en måte består jo av kode selv liksom så jeg tror [ChatGPT] kommer til å bli brukt mer og mer på koding det tror jeg nok.

– S2

Nei, det kan jo være hva som helst. Jeg ser jo egentlig for meg at utviklingen i AI blir såpass stor at det kommer innom de fleste områder.

– S4

Overalt. Kanskje i medisin kan det bli ganske aktuelt, vil jeg tro.

– S10

Det blir vel det meste egentlig, ser jeg for meg. Med bruk av personlig assistent. At den kan gjøre ting for deg utover å bare å svare på spørsmål.

– S5

Mye av det vi sier er KI, er jo egentlig bare maskinlæring. Så jeg skiller kanskje litt på det at med maskinlæring tenker jeg mer på at man trenger stor regnekraft for å utføre noen komplekse oppgaver. Med den store regnekraften klarer man å løse nye problemer som man ser på som kunstig intelligens.

– S1

Vi mennesker vil ha litt mer.. Hva skal jeg si? Har litt mer generell intelligens [...] Ofte er KI-verktøy litt mer spesialisert på enkelte områder. Vi mennesker er mye bedre på å reflektere og argumentere enn KI-verktøy.

– S3

Som AI nå er veldig snevert. Den kan en ting veldig bra. Gjerne bedre enn mennesker, men den kan fortsatt bare den ene tingen.

– S7

Forløpig tror jeg at menneskelig intelligens er bedre på å reflektere. Og ikke komme frem til en spesifik løsning. Jeg tror vi er bedre på å se flere sider av et spørsmål. Men KI forløpig er mer direkte.

– S6

Vi er jo skapninger som har mulighet til å reflektere, finne en enklere vei til alt med intuisjon, det har jo ikke KI [...] sjakkposisjoner kan vi begynne med [...] vi med vår intuisjon på hvordan en posisjon skal ligge, kan fort utelukke områder der vi sier, ok, det er jo ingen vits å utforske den, mens kanskje en kunstig intelligens som er iterativ

– S9

Så går det mer til at jeg prøver å bygge på egen hånd strukturen i koden. Som regel funker det kanskje ikke sykt bra med en gang. Så kan jeg gå tilbake igjen og spørre på konkrete feilmeldinger i koden.

– S1

Men noen ganger sitter det litt mer inne på en måte og da bare gir [ChatGPT] noen prompter og så får du den ut og så ser du at, åja, sånn strukturerer man en klasse, for eksempel. Det synes jeg [ChatGPT] fungerer veldig godt til.

– S2

Spesielt i koden så jeg har ikke alltid funnet et direkte svar på Stack Overflow for eksempel.

– S3

Hvis det er noe jeg synes er gøy selv å løse, problemstillinger, så opplever jeg at jeg bruker KI verktøy mindre. [...] Hvis det er kjedelige, repetitive oppgaver, så gir jeg det gjerne til ChatGPT.

– S4

Ikke nødvendigvis lage hele ting, men også lage små deler som jeg ikke orker å lage selv. [...] kan du lage denne funksjonen som sorterer dette og dette på denne eller denne måten, liksom. Og det fikser [ChatGPT] helt fint, Mest for å slippe det kjedelige arbeidet.

– S6

For det meste er det for å få hjelp med å plotte ting i python. Så litt sånn ting jeg kunne ha klart selv, men det bare tar litt tid. Så jeg bare får [ChatGPT] til å gjøre det.

– S7

Jeg har materialteknikk nå, det føler jeg han nesten ikke kan i det hele tatt.

– S2

Jeg har Mekanikk 1 og veldig mange av oppgavene der er jo bilder og tegninger og hvordan man skal finne krefter. Det klarer jo ikke 3,5 å skjønne noe av. Så der bruker jeg det jo aldri.

– S10

Ja, det er ikke det jeg bruker mest, det er det nok ikke. Jeg er mer glad i sånn gå på øvinger, snakker med studenter og gjør typ sånne ting [...] koding bruker han ganske aktivt.

– S2

Jeg har denne klassen, jeg har disse funksjonene, programmerer i det her språket liksom og nå vil jeg lage en funksjon som gjør dette. kan du vise meg noen forslag.

– S2

Føler jeg har skjønt at man må være litt spesifikk på beskrivelsen av det man vil ha, for å faktisk få det man vil ha ut av for eksempel ChatGPT, ellers så får man veldig ofte et overordnet svar som egentlig ikke jeg får utnyttet.

– S4

Selv om jeg synes det er mye mer spesifisert, så kan man jo prompte litt ut fra at man kan si at man er en student på det og det nivået, så kan man få litt tilpasset svar kontra bare sånn veldig generisk.

– S1

Jeg føler den motsier seg selv veldig mye. Kanskje litt fordi at mennesker også bare vil si ja til alt. Så jeg må spørre ting «for og imot» som regel for at den ikke skal... for at den skal gi et riktig svar.

– S5

Men da bruker jeg å ha han litt sånn på en måte hvis jeg sitter hjemme og har lest igjennom den delen av boka som jeg jobber med og ikke har noen studasser eller noen medstudenter å snakke med så prøver jeg å bruke han litt som en sparringspartner mer enn bare spørre han.

– S2

Jeg bruker det som min egen professor, som har tilgang til, ikke alltid riktig informasjon, men den kan alltid gi deg en pekepinne, eller ideer, skjønner du hva jeg mener [...] si jeg har en ide så bare spør jeg i tillegg for å utforske andre mulige ideer...

– S9

Når vi leser en oppgave, så har vi en sånn ish måte vi tenker vi liker å approache denne her da, så da skriver du hele oppgaveteksten, limer det inn, og så stiller spørsmålet ut ifra, jeg tenker dette her, har du noen andre metoder som måter man kan tenke sånn på, og så får du jo en sånn sparringspartner, som gjør at vi selv reflekterer rundt det vi tenker...

– S9

Det er ikke sånn at jeg går rundt og søker etter informasjon jeg aktivt kan finne selv til chatGPT, det blir for dumt synes jeg, for det er jo ikke verifisert informasjon i det hele tatt.

– S9

Nei, det er jo erfaringsbasert. At jeg har vært borte i at den gir meg et svar som den er 100% sikker på. På en måte, sånn gjør du det. Og så prøver jeg det ut, og så fungerer det ikke.

– S3

Da var det jo sånn "ikke bruke Wikipedia alle kan skrive hva de vil på Wikipedia" [...] jeg sjekker ikke alle mulige kilder på noe men likevel har jeg en sånn 2-3 og hvis de peker meg i samme retning så kan du på en måte gå god for det.

– S2

Hvis jeg ber om eksempler på teorier, eller fakta, så må jeg alltid sjekke det opp. Sånn helt, helt fakta føler jeg noen ganger at den tar feil på.

– S5

Jeg har brukt det ganske mye, så jeg merker litt etter hvert når ChatGPT begynner å tippe litt. Så hvis jeg ser noe som jeg er litt skeptisk til, så kan jeg hende jeg må dobbeltsjekke og google det.

– S6

Veldig ofte så spør en jo om noen temaer man kan noe om, holdt jeg på å si. Så man kan på en måte vurdere litt utifra. Ok, det stemmer med det jeg har hørt enten i tidligere fag, eller det man har lest på forhånd. Så da må man jo bare være litt obs selv.

– S1

For eksempel si injektivitet da, så er det jo for det første at man har på en måte litt kunnskap om det fra før for som forelesning så må du stemme litt overens med det du tror og tenker fra før av da.

– S2

For eksempel, jeg har spurt om å forklare et tema som jeg allerede kan noe om, og forklare det på tre-fire setninger.

– S3

Men hvis jeg har spurt noe med teoretisk spørsmål, så skal jeg egentlig bare tenke gjennom om det gir mening, om det er noe jeg allerede kan om temaene. Og hvis det høres riktig ut, så bare tenker jeg at det er riktig. Men hvis det høres feil ut, så kan jeg kikke litt mer.

– S7

Nei, som regel spør jeg om noe jeg kanskje kan litt fra før. Så man har en litt anelse om det er riktig eller ikke.

– S10

Med coding eller noe sånn, så er det vel mer det at jeg prøver å ta i bruk praktisk det den har gitt meg, og så ser jeg om det fungerer eller ikke. Så da blir det vurderingen.

– S4

Nå når jeg bruker mye til koding så er det jo liksom funker det eller funker det ikke liksom.

– S2

Ofte bruker jeg det til en plotting. Da er det bare å kjøre koden, og da ser man om det fungerer.

– S7

Og så blir det jo testing etterpå, da. Du skal ikke bare akseptere en løsning for det det er. Det blir jo fort å sjekke, kjøre den koden, lager tester, se om det faktisk fungerer som jeg vil ha det til å fungere. Masse debugging her og der. Prøver å forstå koden.

– S9

Men det er jo sånn klassiske ting som at det det blir jo ikke ditt eget verk liksom du får jo ikke noe eierskap til det du gjør.

– S2

Også litt det med ærlighet. Om du bruker KI verktøy og så bare copy-paste det over. Om du virkelig vil kalle det ditt eget arbeid.

– S3

Og da hermer du noe. Og det er jo etisk feil å herme, vil jeg tenke meg. Hva mer har vi da? Nei, jeg kommer ikke på noe on the spot med etiske problemstillinger bak det.

– S9

Så det er jo litt, det er lett å få plagiat hvis man bruker det aktivt. I hvert fall til å generere tekst også.

– S10

Ja, det er jo for eksempel diskriminering av KI-modeller har det vært mye snakk om. På grunn av for eksempel de fleste utviklere som jobber på disse modellene er for eksempel menn. Og den biasen de har kan reflekteres i den modellen de har.

– S4

Jeg tror det aller største og viktigste er jo dataen som modellene vil trene på. Det er jo ingen kunstig intelligens uten dataen, og da er det jo et veldig stort ansvar for de som lager disse datasettene, at det skal være mangfoldige datasett.

– S1

Ja, all AI vi har får jo ikke informasjon fra ingenting. Det er trent på data som til syvende og sist er menneskelig. Og det finnes bias hos mennesker. Så jeg føler det er nesten umulig å unngå.

– S6

Og hvem som velger dataen er jo også et etisk greie, hvis man går inn med en eller annen fordom og bare gir den data som støtter sin bakgrunn og sin tanke om hvordan ting går. Fra enkelte nettsider, eller enkelte databaser og sånne ting som ikke omfanger sannheten, så vil jo det kunne brukes... dårlig.

– S8

Det er vel kanskje at man ikke tenker over hva som går inn i å trene en AI-modell og sånne ting. At man bruker en enorm mengde strøm. Og man trenger kjøling til det og bruker ofte vann. Så det er egentlig bare mangel på kunnskap innenfor det området. At man ikke tenker på KI verktøy som et bærekraftsproblem.

– S6

Det er ikke snakket like mye om de andre punktene som dere nevnte.

– S3

Om AI bruker mye datakraft, for eksempel. Om det tar mye strøm. Tar det mye energi. Og gjør det mer det enn noen andre ting. Det vet ikke jeg. Det er vel mange som ikke vet. Det er noe man ikke tenker på i det heletatt.

– S5

Etiske problem med likstilling, i forhold til ki robotter. Hvis de er utviklet av menn, så ville de kanskje gi gode svar til menn og ikke til damer.

– S10

Men det er jo viktig at som bruker av et verktøy, at man er klar over disse etiske problemstillingene. Sånn at man kan igjen være litt mer kritisk eller litt mer forsiktig når man bruker verktøy.

– S4

Ja. Fordi det blir mer og mer brukt i skolehverdagen, og da er det viktig at vi vet hvordan vi skal bruke det, og at vi skal bruke det på riktig måte. At det ikke skal bli utnyttet.

– S10

Jeg vil jo si at hvis du holder på med noe så bør du være ekspert i det, men ikke ekspert i formen av at du skal ha en doktorgrad i det, men i form av at du skjønner alle problemstillingene rundt det.

– S9

Og det er jo nesten uansett hva slags teknologistudier du studerer nå, så kommer du til å bruke litt AI. Men det er kanskje aller mest relevant til de som lager AI nå.

– S7

I forhold til masteroppgaven. Det er vel det eneste, og det er vel en mail. Og det er vel mer at vi skal dokumentere bruken av det, ikke hvordan vi skal bruke det.

– S1

Nei, veldig lite. Det mest konkrete som man kan tenke på er noen studasser i programmeringsfag som sier prøv å google og hvis du ikke får noe så kan du prøve chat.

– S2

Nei, jeg har ikke fått noen veiledning. Jeg har fått noen strenge beskjeder på mail. Og de sa noe om at, ja, AI er her for å bli, men dere er fortsatt studenter som skal skrive eget, så da bruk det med måte.

– S8

Da vi skulle skrive artikkel i høst, så hadde vi en hel forelesning som var sånn "nå er det AI her. Hva tenker vi om dette?"

– S5

For mange studenter er jo egentlig KI-verktøy en sånn black box. Du vet ikke egentlig hva som står bak. Hvis du lærer mer om det og bruker det på riktig måte, så tror jeg folk bruker det mer riktig.

– S3

[...] AI skal spille deg god, og hjelpe deg, du skal ikke bare pusse opp det AI har skrevet eller gjort for deg, og late som det er litt eget.

– S8

Jeg tror nok at det kan bli et verktøy på like linje med en kalkulator liksom, men da må du på en måte lære begrensningen til det verktøyet og hvordan du bruker det på en god måte liksom.

– S2

De siste par årene når det har blitt mer og mer av det, så kommer jo alle studentene til å bruke KI verktøy ser jeg for meg. Da synes jeg det er viktig allerede på første året å bare ha en leksjon om det. Vi hadde jo HMS-kurs første året. Det går an å ha AI-kurs.

– S3

Ja, det synes jeg. En eller annen form for trening eller veiledning. [...] Kanskje hatt et obligatorisk kurs som man går gjennom. Så har man satt opp klare retningslinjer i fagene som har øvingsopplegg.

– S4

Men da det kom, så hadde det vært kult om det var noe sånn... altså oversikt over ting den er god på og ting den er dårlig på. Så det er på en måte litt do's and dont's.

– S6

Det kan være mye mer effektivt hvis du klarer å bruke KI-verktøy effektivt. Da får du gjort mye mer, så det blir jo mye mer effektivt arbeid når det kommer ut av NTNU. Og det er jo et bra mål, for NTNU. Det er et bra mål.

– S7

Men det er jo brede begreper, begge to. [...] når jeg tenker på bærekraft i hvert fall, så tenker jeg bare på, kan noe gå i lang tid uten å ødelegge for alt annet rundt seg

– S7

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