Digital Tools in the Thesis Process: A Case Study from Sweden

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Abstract: The emergence of autonomous learning has revolutionized educational systems, offering new pathways to enhance higher education. Across most Swedish universities, Bachelor's and Master's theses (final projects) represent an important part of students' academic journey. Embracing technology as a tool, rather than an end in itself, has become imperative in contemporary higher education and thesis processes. Departing from traditional instructional methods, the focus has shifted towards interactive and autonomous learning, propelled or supported by digitalization. Despite the growing emphasis on autonomous learning and the benefits of technology-enhanced learning (TEL), there are concerns about the misuse of digital tools such as Generative Artificial Intelligence (GAI) in educational contexts. The scarcity of knowledge to properly use available tools would potentially affect students' academic performance and future employment prospects, which has recently caused significant concern for educational authorities, educators, and even policymakers. This study reflects on students' perceptions of using digitalization and GAI to facilitate autonomous and interactive learning to support the thesis writing process. The focus is to understand how digital natives (predominantly Gen Z) view the integration of new digital tools in autonomous learning. A case-based approach in the form of an open survey conducted during the spring semester of 2024 gathered 52 responses from students within the informatics discipline at bachelor's and master's levels in a Swedish university. Results indicate that most students used digital tools such as GAI interactively, in the thesis process, mainly for constructive learning. They indicated that learning about digital tools as part of their formal learning leads them towards effective and more structured use of the tools for brainstorming, drawing inspiration, and developing interactive learning, which simulates real-world peer interactions or teacher-student dynamics. This instructional approach equips students with the skills to responsibly use tools as academic support rather than for any other inappropriate purposes. Effective utilization of digital tools promotes autonomous learning, leading to improved quality of bachelor's and master's theses and overall academic performance in higher education. Conversely, inadequate knowledge and improper use of these tools can negatively impact students' educational outcomes.

Keywords: Thesis, Autonomous learning, Digital tool, Generative AI, ChatGPT

1. Introduction

A thesis course is typically a core course of the final year in many undergraduate and graduate programs (Aghaee, 2015a; Hashim & Hashim, 2010). The terminology of “thesis” carries a common understanding of documents mandatory for partial fulfilment of degrees in higher education (Evans, Gruba, & Zobel, 2011; Eco, Farina, Farina & Erspamer, 2015). A thesis project integrates students’ academic knowledge with future career prospects and research (Hashim & Hashim, 2010), and hence a thesis course adds significant value to the student’s transcripts. Peer collaboration in the thesis process involves students working together to share ideas, develop the thesis work together, share resources in the same thesis group, and even in some phases, provide some constructive feedback for other groups (Aghaee & Hansson, 2013). This cooperative effort enhances understanding, critical thinking, and overall quality of the thesis (Aghaee, 2015a).

Technology-enhanced autonomous learning potentially opens new opportunities and challenges to thesis courses at universities (Rosli & Saleh, 2023, Hashim, Tlemsani & Matthews, 2022). Technology Enhanced Learning (TEL), in general, has become an essential component of modern education systems, providing students with tools that support interactive and autonomous learning environments (Al Mansoori et al., 2023; Aghaee & Keller, 2015). According to contemporary literature, engagement or disengagement in TEL significantly impacts student performance, and, therefore, highlights the need to understand digitalization and its influential factors on their learning process and performance, to better support learning outcomes (Rosli & Saleh, 2023; Bergdahl, Nouri, & Fors, 2020; Jaldemark & Lindberg, 2013).

However, the quality variation and attrition in higher education, notably among thesis students, is a major concern for most institutions (Aghaee, 2015b). The quality of a thesis varies due to various challenges in the thesis process, including lack of necessary information support, clear instructions, right type of interaction, good supervision, and digital skills (Bergdahl et al. 2020; Jusslin & Hilli, 2024; Aghaee, 2015a; Aghaee et al., 2014). Although digitalisation in education supports student learning and outcomes (Crittenden, Biel & Lovely, 2019), it is undeniable that there is a gap in understanding how students use digital tools at what scale (Jusslin & Hilli,

2024) and how educators can provide a concrete solution to support the thesis process in higher education Aghaee et al., 2014).

Previous research has indicated that students experience procedural and technical challenges in the thesis courses (Jusslin & Hilli, 2024) and suggesting that they need support in their thesis process (Aghaee, 2015b; Jusslin, & Widlund, 2024). It is a question of whether universities have recognised the need to educate students on how to use digital tools in the thesis courses, in the limited time available for thesis work. In the current landscape, digital competence enables students to utilize various digital technologies and independently adopt additional tools beyond those provided by the university (Crittenden, et al., 2019).

The prerequisite to understand how students use digital tools during the thesis process is to know which tools they use and for what purposes. It is also important to assess whether students see the university as a facilitator in developing these competencies or rely mostly on informal learning tools for educational purposes. According to some references, digitalizing the thesis process and providing structured formal learning guidelines could help address this gap (Aghaee, 2015b; Jusslin & Hilli, 2024). This study hence empirically investigates students' perceptions of digitalizing the thesis process and the tools they use. The study aims to answer the following research questions: 1) What digital tools do students use in thesis courses, and for what purposes? 2) How can educational system facilitate the use of digital tools in the thesis process?

2. Digitalisation of the Thesis Process

Metaphorically, the digitalization of the thesis process parallels playing a card game (Aghaee, 2015a), where players follow rules and learn about them, similar to learners in a thesis course receiving basic requirements, resources, and instructions (Aghaee, 2015a). Supervisors act as advisors, guiding learners like dealers in a card game, yet learners autonomously decide how to play or fulfil course requirements (Aghaee, 2015a). However, the lack of standardized information and instructions limits autonomy and equal learning opportunities (Aghaee et al., 2013). Digital tools, such as Learning Management Systems (LMS) (Al Mansoori et al., 2023), Information and Communication Technology (ICT), and social media, support educational interactions and facilitate educational interactions among learner-instructor, learner-content, and learner-learner, which are crucial for effective learning outcomes, rather than being a hinder (Aghaee, 2015a). This means, the thesis writing demands clear instructions and rules, while a high level of independent research and problem-solving skills are also required.

Based on these insights, addressing the pedagogical and administrative aspects of thesis, promoting autonomous learning and reducing dependency on individual supervision can be achieved through the use of technology (Aghaee, 2015a). It is hence important to determine how digital tools are used in learner-supervisor, learner-content, and learner-learner interactions, and how the structured use of these tools can support the thesis process while ensuring transparency. On the other hand, even if the emergence of Generative Artificial Intelligence (GenAI), particularly tools like ChatGPT, support the autonomous learning, it makes the interactions less transparent. GenAI is transforming higher education by promoting student-driven learning through guidelines, instructions, ideas, and language support (Dai, Liu & Lim, 2023). ChatGPT can enhance personalized learning, conduct autonomous assessments, offer virtual assistance, create content, and recommend resources (Nikolopoulou, 2024). However, given the potential for academic dishonesty, it is crucial to provide ethical training (Chan, 2023) to reduce the risk of GenAI misuse (Rogers, Hillberg, & Groves, 2024; Whalen & Mouza, 2023), particularly in academic writing and thesis courses.

3. Methodological Approach

The purpose of this study was to investigate digitalisation, specifically in the thesis courses from the perspective of university students and, such research demands an instrument of explorative case strategy-based survey study. Furthermore, due to that digital skills and understanding of digitalization significantly correlate with the level of students' use of digital systems, and it can vary from discipline to discipline (Hashim, et al., 2022; Bergdahl, et al., 2020), and the variation of Gen Z daily use of digitalisation in their life and education (Katz, et al., 2022), a case study was chosen for providing a deeper understanding of the unit of measurement concerning specified characteristics in a quantitative study (Roni, Merga, & Morris, 2020). The chosen case, therefore, is students within the informatics discipline at a university in Sweden, and the data was collected during the spring term of 2024. The case was conveniently chosen as the students were doing their theses during this period and were asked to fill in the survey. The population size was over 150 students in total.

Semi-structured questionnaires were used as the data collection instrument. A questionnaire was beneficial in this case since the data is required to be collected and analysed anonymously to avoid any respondents' bias about being honest. As the focus of this study is on the general perspective and experiences of students, regarding digitalisation in thesis courses a representative data sample from the chosen case was needed to be able to make the study more transferable, through the survey results (Bryman, 2006). The questions were designed to capture the frequency and types of digital tools used in the thesis courses followed by a few open-ended questions to reflect on students' experiences of using digital tools and the benefits and challenges of using such tools in the thesis process (in-line with the reflections by Jusslin & Hilli, 2024). There was a total of 52 responses, from two classes (almost 33% response rate).

The composition of the questions includes three segments about digitalisation in the thesis process, namely, 1) for gathering information and language help, 2) facilitating student-supervisor interaction to get guidelines 3) facilitating or compensating peer interaction for exchanging and developing ideas, getting feedback and develop the ideas further, and finally whether there is a clear need of formal education for the use of digitalisation in higher education, specifically for the thesis courses. The structured questions rate the frequency of use of each specific type of digital system/platform in levels of "less than once a week" to "several times a day", in 5 different scales, based on Likert scales. The students were asked to answer honestly based on their own experience of using the tools for this specific thesis course. Some open questions followed the structured ones to let the respondents present their experiences of using tools in their own words and reflect on how useful the tools were for which specific purpose. The open questions aimed to get students' reflections in their own words (Creswell, 1999). However, the finding themes and the codes based on the open questions were also used quantitatively.

The respondents belong to two groups: 17 participants from the master program, who answered almost all questions, while the second group with 35 participants from the bachelor programs, answered most of the closed-ended questions, but fewer answered open-ended questions. The responses to the open-ended questions were merged and analysed together. Both groups of students participated voluntarily and were informed that this would not in any way have any influence on their course results and grades. An informed consent was sent to the participants to get their agreement, before starting the data collection. The respondents were given the option to terminate participation at any point in the data collection process or to skip any questions if they did not wish to answer any questions. Furthermore, none of the sensitive or personal information was collected through the questionnaire.

4. Results and Analysis

According to the literature, digital systems facilitate diverse types of interaction in higher education. Nonetheless, it is imperative to equip students with the necessary information and training to comprehend and effectively utilize emerging digital tools, such as Generative AI, to enhance both their efficiency and ethical application of such tools within academic environments.

4.1 Technology for Information Seeking

The results revealed diverse ways that digitalisation can support student interaction, such as playing a role as an information resource, covering and fulfilling peer support to get inspiration and ideas, exchanging ideas and even getting language help. Figure 1 shows that students on average believe that they generally use the different types of resources in the following order:

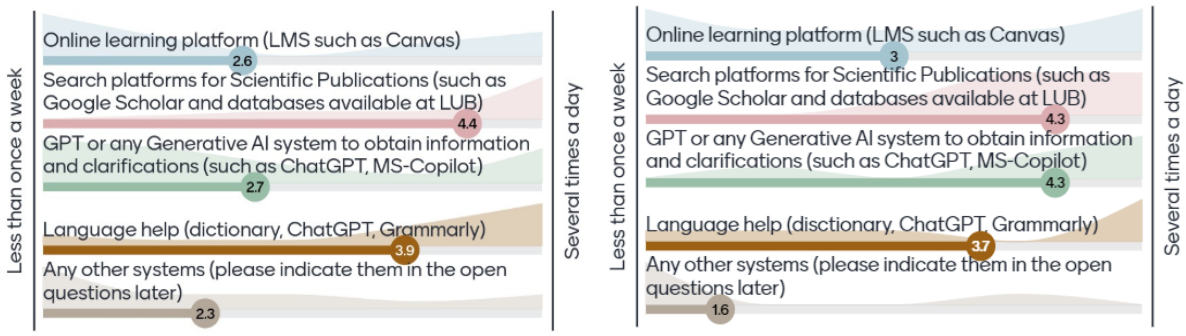

Figure 1: Digital systems to access information among bachelor's (left) and master's students (right)

As shown in Figure 1 (left), the highest average frequency of the usage of technical tools among the bachelor's students is for the "Search platforms for Scientific Publications" and Generative AI systems to obtain information and clarification, with a frequency scale of 4.3 out of 5, which means almost several times per day. The distribution of technology for search is also skewed towards the right end, which means almost everybody uses these types of tools more frequently. For the use of GenAI, a few participants do not use it frequently for obtaining information. The result also shows an average use of technology for language help with a frequency scale of 3.7 out of 5. The comparatively lower average for the use of LMS reflects the fact that the LMS may not contain the information they frequently sought. This is similar among both bachelor and master students (Figure 1- right). However, master students are not using GenAI as frequently as bachelor students for information seeking.

The students also explained how and why they have been using the chosen technology tools, for e.g., "*ChatGPT for summarising papers and assisting with paraphrasing, Grammarly for language and consensus AI for searching relevant papers*". Google Scholar was the main source of information among many students, i.e., "*Google scholar was most helpful as we found the literature and research gaps from there*"; "*Google Scholars. It is always the starting point of every research I make. I don't like to use chat GPT if not for seeking specific documents or have any general ideas about something I don't know*". These reveal their priority of subject-specific information seeking and explain the reasons for accessing LMS (Canvas) which may have the general information of the course, as the detailed responses describe, "*ChatGPT 4 was used most frequently, however, it was not used for obtaining necessary information. Canvas, Google Scholar, the most helpful in that regard. They were crucial in obtaining articles*", and "*Canvas, because it is the source of the information*".

4.2 Technology for Student-supervisor interaction

Regarding the outcome of the technology for supervisor-student interaction, Figure 2 shows the averages and distribution of the types of tools used for this purpose.

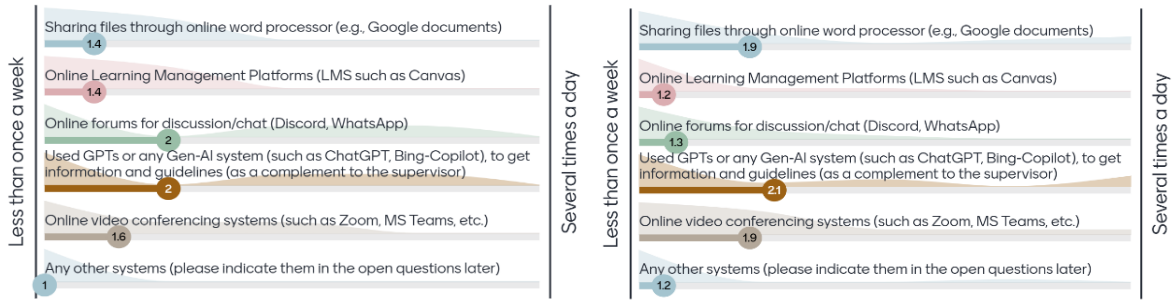

Figure 2: Digital systems to facilitate student-supervisor interaction for bachelor's (left)/master's (right) students

In general, the interaction with the supervisor is not so frequent. Irrespective of the group they communicate with supervisors through online communication tools (synchronised), and LMS-like platforms (asynchronised). Complementary guidelines are sought through advanced technology, such as GenAI as well.

4.3 Technology for Peer-to-Peer interaction

According to Aghaee & Hansson (2013), peer support and peer interaction help generate knowledge. It has great potential in the autonomous learning process, which also makes the learning more learner-centred and less dependent on their supervisors. Peer interaction through different digital systems is common in the thesis process (4 out of 5). Can GenAI serve as a peer for students to help achieving the learning outcomes? Surprisingly, the answer is yes, although not to a high degree, as shown in Figure 3. The score for using GenAI as a study buddy exceeds the average for peer communication and learning.

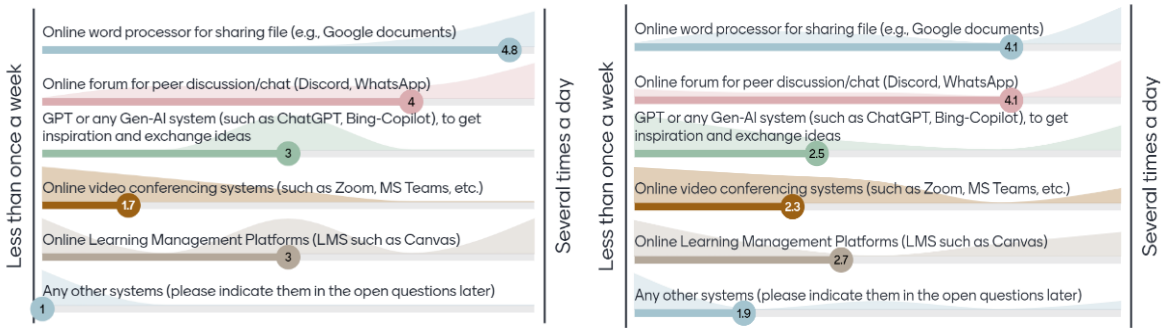

Figure 3: Digital systems to facilitate peer interaction for bachelor's (left) and master's (right) students

These findings indicate that students increasingly rely on GenAI for many aspects and interactions in their thesis work. Hence, to prevent misuse of this technology, clear instructions and guidelines are necessary, as they can enhance the communication and information-gathering skills essential for research and thesis writing. Consequently, supervisors not only retain their traditional responsibilities of supporting and guiding students through the thesis process, but also have an additional responsibility to instruct students on how to effectively use AI-based digital tools as structured learning aids, rather than as means for academic dishonesty.

4.4 Digital Tools in the Thesis Process

Apparently, students use a spectrum of tools at different stages in the thesis process. The open questions regarding the main digital systems they used mostly in their thesis work are for capturing their reasoning behind the choice of the tools. In Figure 4, word clouds, the left-hand side shows the respondents indicated their three highest prioritised and most used tools in their thesis. The word cloud on the right-hand side however shows the times they mentioned the most important tool in their thesis.

Figure 4: Word Clouds indicate the digital tools used by most students (n=52) (left) and as the most important tool for students (n=51) (right) in the thesis process

Students elaborated on the importance of digital tools at various stages, i.e., "*Technology has assisted me a lot during the writing process*"; specifically, for:

- ideation; "Generate ideas for getting the writing going. Had massive struggles with motivation and generating ideas to write about helped a bit",
- language correction: "Spelling and Grammar check - because English is my second language, writing in academically correct manners need checking",
- resource finding; "Finding and collecting materials (journal articles, statistics et c.)"
- summarizing texts; "Thinking critically, analysing big text, moving past jargon to get core ideas, summarizing, comparing textual data to spot how far my results add to the literature"
- reference styling; "It is hard to keep up with the APA guidelines as they are in constant change. But it is also hard that the university has their own guidelines that do not always align to APA"
- solving the writer's block; "Mainly writers' block. Generative AI helps but it doesn't feel good to submit AI generated text as guidelines are vague"

The final point above also shows the student's pain of not having clear guidelines for using GenAI in their thesis writing. Furthermore, students are uncertain about many other aspects regarding the digital tools they can or have to use, e.g., "*I know some students uses Overleaf for structure the thesis. I do not know if that would be*

easier, but it definitely has its benefits". For some students "*The structure of the thesis was sometime a challenge, what should be included and what needed to be included. That was solved by reading previous work published on Canvas and asking ChatGPT/Teacher*". The more advanced technology appears the more confusion and uncertainty can occur such as "*Part of the fun of writing the thesis is developing a writing style. I think students who constantly use AI tools are at risk of losing their own judgement and miss out on their learning development*".

5. Discussion and Concluding Remarks

This study addresses challenges in students' thesis works, building on earlier research (Eco, et al., 2015; Jusslin & Hilli, 2024; Aghaee, 2015a), highlighting issues like insufficient support and lack of digital skills (discussed by Bergdahl, et al., 2020; Jaldemark & Lindberg, 2013) and the variation of Gen Z daily use of digitalisation (Katz, et al., 2022). The result emphasizes providing tools for interactive and autonomous learning environments (Al Mansoori et al., 2023; Rosli & Saleh, 2023; Bergdahl et al., 2020), which is defined by Aghaee (2015a), as students gathering information independently to enhance self-directed learning, using digital systems. Digitalization improves learning outcomes, as discussed by earlier studies, also evidenced in this study by over 80% of students positively responding to technology, especially GenAI in thesis courses.

Students rely on GenAI for most of their needs in the thesis work, which is emphasizing the need for educators to provide clear guidelines to help students use these systems effectively and pedagogically, echoing the importance of guidelines (discussed in prior studies Jusslin & Hilli, 2024), rather than misusing such tools (as discussed by Rogers, Hillberg, & Groves, 2024). The results of this study show digital tools that are predominantly chosen and used by the students (shown in Figure 4) without a systematic way of embedding them into the process of thesis work (also discussed by Aghaee, 2015a; Rogers et al., 2024; Whalen & Mouza, 2023). The study's findings serve as a warning to educators to provide clear guidance on GenAI usage, as the extensive use of GenAI exceeds the traditional resources such as LMSs and even surpassing use of scientific publications and resources.

This study also indicated majority of students utilize digital tools, including GenAI for constructive learning activities such as brainstorming, developing ideas, and seeking inspiration. Students reported that these tools significantly enhance their ability to conduct independent research and manage the thesis writing process more effectively. This emphasizes the importance of formal education on digital tool usage, which equips students with the necessary skills to use these tools responsibly and productively (Jusslin & Hilli, 2024; Aghaee, 2015b). The use of technology for the benefit of interactive and autonomous learning is also highlighted in this study; providing structured support and reducing confusion about the various phases of the thesis process is appreciated (Aghaee, 2015a).

As mentioned by earlier studies, there is a lack of necessary information support, clear instructions, right type of interaction, good supervision, and digital skills (Bergdahl, et al., 2020; Jusslin & Hilli, 2024; Jaldemark & Lindberg, 2013). It is so important to provide students with tools that support interactive and autonomous learning environments (Al Mansoori et al., 2023; Aghaee & Keller, 2015; Rosli & Saleh, 2023). Hence, to equip learners with more instructions and information about the available tools and technologies in the thesis courses is a must, as they can engage more professionally and morally, which metaphorically means, playing a more professional game (as mentioned above). As also showed by the result of this study, students valued the enhanced peer interactions facilitated by digital systems, which simulate real-world collaborative dynamics and improve the overall quality of the academic work.

As mentioned above, autonomous learning is a more learner-cantered approach (Aghaee, 2015a), which provides possibilities of learning under learners' own control and preferences. The answers to the open-ended questions in the survey revealed concerns about the potential misuse of digital tools, particularly GenAI (as also studied by Rogers, et al., 2024). Some respondents admitted using such tools for academically purposes could be considered dishonest, underscoring the need for clearer guidelines and more comprehensive training on ethical tool usage (Chan, 2023). This justifies the growing need to educate students on the proper use of digital tools to ensure digitalisation enhances academic performance, students' skills, and future employability rather than hinder them.

5.1 Technologies and Tools for Thesis Writing

In the realm of thesis writing, several technologies and tools have emerged in the survey outcome. Among these, ChatGPT stands out as a versatile companion. It excels in translating articles swiftly, providing feedback on structural elements, and even rewriting sentences. However, its strength lies in its ability to generate ideas—a crucial aspect of any scholarly work (Jusslin & Hilli, 2024; Jusslin, & Widlund, 2024). When combined with Gemini,

ChatGPT becomes a dynamic duo for brainstorming and refining concepts (Whalen & Mouza, 2023). In addition, Consensus (ChatGPT 4) is shown effective for searching relevant papers, ensuring that the literature review process is comprehensive and efficient. The result helped escalate pedagogies to enhance supporting and develop the digitalisation of higher education (as discussed by Crittenden et al., 2019). To enhance the thesis writing process, the study result led to the development of the following strategies:

Refine Idea Generation: ChatGPT and Google Gemini offer valuable insights, providing more specific prompts and guidelines, which may yield better results and higher learning outcomes. By teaching students how to use the tools in the best and most effective way, we encourage them to explore various angles and contexts when seeking creative ideas, information and guidelines.

Improve summarization and language development: Investigate why Adobe's AI assistant fell short in summarizing papers. As suggested by respondents, fine-tuning ChatGPT 4.0 for summarization could bridge this gap and help students reach out for more scientific articles, find the most relevant theoretical basis and relevant studies, and develop better conceptual frameworks in their theses (as also discussed by Evans, et al., 2011). A well-crafted summary can save time and help students grasp the essence of complex research areas and develop their thesis based on cutting-edge and relevant studies. Hence a structured education about how to do the summaries and how to use digital tools to assist in summarizing and using the literature would be immensely useful (Dai, Liu & Lim, 2023; Nikolopoulou, 2024)

Collaborative Tools: Beyond individual efforts, collaborative tools like Overleaf or Google Documents foster teamwork. Students can collaboratively structure their theses, share ideas, and collectively refine their work through collaborative tools if they learn how to use them systematically. By combining human expertise with AI assistance, the educational aspects and learning outcomes elevate the quality of thesis writing and contribution to academic excellence. Peer interaction (Aghaee & Keller, 2016) is a very important part of the thesis, both with their groupmates as well as their opponent groups. Using collaborative tools to find a partner in the thesis course, decide about the topic, and continue collaborative work throughout the entire thesis work, would enhance peer interaction (Anderson, 2008). GenAI can also play the role of a peer to get inspiration and reflection from.

5.2 Concluding Remarks

The study underscores the critical role of digital tools in enhancing autonomous and constructive learning and improving the thesis process in higher education. Students' perceptions highlight the benefits of these tools in facilitating independent research and fostering interactive learning environments. However, the potential for technology misuse necessitates the implementation of educational strategies that promote responsible use. Integrating formal training on digital tools into academic curricula can ensure that students are well-equipped to use these technologies effectively and ethically, ultimately improving academic outcomes and preparing them for future professional challenges.

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