

**EXPLORING THE ARTIFICIAL
INTELLIGENCE (AI) LITERACY OF HIGH
SCHOOL TEACHERS IN BOGOR:
PERCEPTIONS, UTILIZATIONS, AND
CHALLENGES IN LEVERAGING
GENERATIVE AI FOR TEACHING**

A Thesis

**Submitted to the Master's Study Program of Education at the Faculty
of Education in partial fulfillment of the requirements for the degree of**

Master of Arts (M.A.)



by:

Nabila Nindya Alifia Putri

04212310009

UNIVERSITAS ISLAM INTERNASIONAL INDONESIA

DEPOK

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ABSTRACT

Nabila Nindya Alifia Putri

04212310009

nabila.putri@uiii.ac.id

MA in Education

Universitas Islam Internasional Indonesia

Artificial intelligence, or commonly abbreviated as AI, has been a greatly powerful transformative force in different aspects, and education is no exception. With the technology of deeply developed AI, this technology is currently used in the educational realm to lead the change of teaching and administration processes, enriching the learning process. However, despite its massive spread in the education sector, the teachers' literacy on AI remains underexplored, especially in Indonesia. Addressing this need, this qualitative case study presents an in-depth examination of teachers' perceptions, uses, and difficulties, especially faced by the four high school teachers in Bogor, Indonesia, when they were applying generative AI into teaching. By following a triangulation of methods (a preliminary questionnaire, semi-structured interviews, a Focus Group Discussion (FGD), and structured observations), this research explores the lived experience of the teachers through the theoretical lens of AI Literacy and AI-technological, pedagogical, and content knowledge (AI-TPACK). The results indicate a dualistic view of generative AI as a double-edged sword: a powerful tool that is appreciated due to its efficiency and creative capabilities, but at the same time, is considered a great threat to academic integrity. Moreover, the pattern of use by teachers is practical, with much emphasis on the preparation of materials for their use, with extreme caution in the use in assessment. The outlined challenges are complex, including the restrictions pinpointed by the limitations of the infrastructure and missing institutional standards, up to the shortages of teacher resources and deep ethical dilemmas. Overall, this thesis research finds that the role of the teachers does not end as mere consumers of generative AI but through reflections of practices, negotiators, by stressing the importance of human control. Such a process offers a contextual, rich depiction of the construction of AI literacy and AI-TPACK competencies' dynamic practice. The core implication is the necessity to promote professional development in the area of pedagogical wisdom and ethics, followed by supportive institutional policies assisting in developing responsible integration of AI in Indonesia's education system.

Keywords: AI Literacy, Generative Artificial Intelligence (Gen AI), High School, Teachers, Bogor

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TABLE OF CONTENTS

| | |
|---|------|
| STATEMENT OF AUTHENTICITY..... | ii |
| ANTI-PLAGIARISM STATEMENT | iii |
| THESIS DEFENSE APPROVAL | v |
| ABSTRACT | vi |
| ACKNOWLEDGEMENT | vii |
| TABLE OF CONTENTS | viii |
| LIST OF TABLES | x |
| LIST OF FIGURES | xi |
| APPENDICES | xii |
| ABBREVIATION DIRECTORY | xiii |
| CHAPTER I | |
| INTRODUCTION..... | 1 |
| 1.1 Research Background | 1 |
| 1.2 Research Questions..... | 6 |
| 1.3 Research Objectives..... | 6 |
| 1.4 Research Significance..... | 6 |
| CHAPTER II | |
| THEORETICAL FOUNDATIONS | 8 |
| 2.1 Literature Review | 8 |
| 2.1.1 The Overview of AI..... | 8 |
| 2.1.2 The Use of Generative AI in Education..... | 11 |
| 2.1.3 Indonesia's National Guideline and Proposed Integration of AI in Secondary Education | 12 |
| 2.1.4 AI Literacy..... | 14 |
| 2.2 Theoretical Framework..... | 18 |
| 2.2.1 AI Literacy Framework | 18 |
| 2.2.2 AI-Technological, Pedagogical, and Content Knowledge (TPACK) | 24 |
| CHAPTER III | |
| RESEARCH METHODOLOGY | 31 |
| 3.1 Research Paradigm and Research Approach..... | 31 |
| 3.2 Research Design | 32 |
| 3.3 Research Subject and Research Context | 32 |

| | |
|--|-----|
| 3.4 Data Collection..... | 34 |
| 3.5 Data Analysis..... | 39 |
| 3.6 Upholding the Trustworthiness | 39 |
| 3.7 Ethical Considerations..... | 41 |
| CHAPTER IV | |
| FINDINGS AND DISCUSSION | 42 |
| 4.1 Research Findings..... | 43 |
| 4.1.1 An Initial Overview: Overall Preliminary Questionnaire Results | 43 |
| 4.1.2 Findings on High School Teachers’ Perception About Generative AI (RQ 1)... | 48 |
| 4.1.4 Findings on High School Teachers’ AI or Generative AI Utilization | 63 |
| 4.1.5 Findings on High School Teachers’ Challenge Upon AI/Generative AI Utilization | 85 |
| 4.2 Discussion..... | 97 |
| 4.2.1 Discussions on High School Teachers’ Perception About Generative AI (RQ1)97 | |
| 4.2.2 Discussions on High School Teachers’ Generative AI Utilization (RQ2)..... | 111 |
| 4.2.3 Discussions on High School Teachers’ Challenge Upon AI/Generative AI Utilization (RQ3)..... | 122 |
| CHAPTER V | |
| CONCLUSION..... | 134 |
| 5.1 Conclusion..... | 134 |
| 5.2 Limitations of The Research..... | 135 |
| 5.3 Future Directions of The Research..... | 136 |
| 5.4 Implications of the Research | 137 |
| REFERENCES | 138 |
| APPENDICES | 167 |

LIST OF TABLES

| | |
|--|-----|
| Table 4.1 Demographic Data Details of 20 High School Teachers Participated in This Research | 43 |
| Table 4.2 Detailed Response from Twenty Teachers in The Preliminary Questionnaire .. | 44 |
| Table 4.3 Overview of Teachers’ Answers Regarding Knowledge of Generative AI | 46 |
| Table 4.4 Overview of Teachers’ Answers Regarding Knowledge and Examples of Generative AI | 47 |
| Table 4.5 Overview of Teachers’ Answers Regarding Teachers’ Challenges in Using AI to Support Teaching..... | 47 |
| Table 4.6 Overview of Teachers’ Answers Regarding Teachers’ Needs to Make AI Use in Learning More Effective | 47 |
| Table 4.7 Demographic Informations of Four Teachers Participated in Observation, Interview, and FGD..... | 49 |
| Table 4.8 Teachers' Answers Regarding Open-Ended Question Items on Types of AI in General | 53 |
| Table 4.9 Teachers' Answers Regarding Open-Ended Question Items on the Definition of Generative AI and Its Examples..... | 54 |
| Table 4.10 Preliminary Questionnaire Results of Human-Centered Education Dimension Summary..... | 58 |
| Table 4.11 Results of preliminary questionnaire regarding ‘AI Assessment’ dimension ... | 75 |
| Table 4.12 Observation Results on How the Four Teachers Do Prompting..... | 78 |
| Table 4.13 Results of Preliminary Questionnaire on Professional Development for Teachers | 81 |
| Table 4.14 Example of The Teachers’ Answers Regarding Challenge in Terms of Supporting Facilities | 86 |
| Table 4.15 Example of the Teachers’ Answers Regarding Challenge in Terms of Guidelines and Regulations Absence | 88 |
| Table 4.16 Teachers’ Answers Regarding Their Challenges Faced on Their Capacity Gap | 90 |
| Table 4.17 Example of the Teachers’ Answers Regarding the Need of Training (Professional Development) in Using AI | 92 |
| Table 4.18 Analysis of The Focal Teachers’ Prompting Techniques Using IDEA Framework | 117 |

LIST OF FIGURES

| | |
|---|----|
| Figure 2.1 Academic Paper Coding and Artificial Intelligence Learning in Primary and Secondary Education (Guideline)..... | 12 |
| Figure 2. 2 The Structural Diagram of the AI-TPACK Framework..... | 24 |
| Figure 4.1 Generative AI Tools Mentioned by Teachers in the Preliminary Questionnaire.. | 64 |
| Figure 4.2 Mr. Ivan’s Screen Shared on Using ChatGPT | 65 |
| Figure 4.3 Mr. Ivan’s Screen Shared on Using Gemini | 67 |
| Figure 4.4 Mr. Rafi’s Screen Shared on Using Magic School | 68 |
| Figure 4 5 Mr. Rafi’s Prompt on Making Questions for Quiz, using Magic School..... | 69 |
| Figure 4.6 The result of making quiz questions in Magic School | 69 |
| Figure 4.7 AI use by Teachers in Terms of Teaching, Learning, and Assessment | 70 |
| Figure 4.8 Utilizing ChatGPT for creating questions | 72 |
| Figure 4.9 Sample Questions in the Indonesian Language Guideboo..... | 72 |
| Figure 4.10 Utilizing video generator and image generator AI for students’ Assignments | 73 |
| Figure 4.11 Examples of Prompts that Mr. Rafi Gives to His Students to Use..... | 74 |
| Figure 4.12 Examples of the AI Video as expected by Mr. Rafi..... | 74 |

APPENDICES

| | |
|---|-----|
| Appendix 1. Items in the preliminary questionnaire adapted from Chiu et al., (2024). | 167 |
| Appendix 2. Semi-Structured Interview Guide. The language used was Indonesian..... | 170 |
| Appendix 3. FGD Guide..... | 171 |
| Appendix 4. Formal Informed Consent for Participants to Join the Research (template).. | 172 |
| Appendix 5. Member Checking Form (template)..... | 174 |
| Appendix 6. Evidence of the Structured Observation Process..... | 175 |
| Appendix 7. Evidence of the Semi-Structured Interview Process..... | 176 |
| Appendix 8. Evidence of the FGD Process..... | 176 |
| Appendix 9. Permit Letter to Conduct Thesis Research..... | 177 |
| Appendix 10 Permission Email to Adapt the Questionnaire to The Scale Developer..... | 178 |
| Appendix 11. Thematic Coding Process..... | 178 |
| Appendix 12. Table of Thesis Research Timeline..... | 179 |
| Appendix 13 Statement of Generative AI And AI-Supported Technologies Used in The Writing Process..... | 180 |

ABBREVIATION DIRECTORY

| | |
|----------|--|
| AI | : <i>Artificial Intelligence</i> |
| AI-TK | : <i>Artificial Intelligence Technological Knowledge</i> |
| AI-TPK | : <i>Artificial Intelligence Technological Pedagogical Knowledge</i> |
| AI-TCK | : <i>Artificial Intelligence Technological Content Knowledge</i> |
| AI-TPACK | : <i>Artificial Intelligence Technological, Pedagogical, And Content Knowledge</i> |
| ANN | : <i>Artificial Neural Network</i> |
| DL | : <i>Deep Learning</i> |
| EdTech | : <i>Educational Technology</i> |
| Gen AI | : <i>Generative AI</i> |
| ML | : <i>Machine Learning</i> |
| NLP | : <i>Natural Language Processing</i> |
| RAG | : <i>Retrieval-Augmented Genera</i> |

CHAPTER I

INTRODUCTION

Artificial intelligence (AI) literacy is an essential issue (Su et al., 2023), that is requisite to be studied. This cornerstone of this research will be on the use of AI in education, specifically generative AI, as it has been emerging due to the expeditious betterment of AI technology. The emergence of AI should not only concern students, but also teachers, as they also have organisational functions and responsibility for creating curricula and managing learning resources. This topic should be of interest due to the fact that the current and future use of AI in the context of education arguably depends on the AI literacy of teachers as noted by several studies (Al-Abdullatif, 2024; Güner & Er, 2025; Tenberga & Daniela, 2024a), which in its turn determines the success of the latter in the modern educational environment.

This section is divided into four parts: Research background, research questions, research objectives, and the significance of the study. It begins with background of the research that elaborates on several aspects considering the importance of AI literacy, Indonesian policy concerning the use of AI, the underlying predicament of the research, the context of the research, and previous studies on the issue. This research is guided by three research questions for which answers are to be found in the findings. Secondly, it proceeds with three research objectives to indicate the purpose of the research. Finally, the importance of the research has been discussed in terms of how this research can provide benefits to education fields and fill the gap in the current literature.

1.1 Research Background

What makes us human is our intelligence, and artificial intelligence (AI) is fully an extension of it (Candela & LeCun, 2019).

The rapid development of AI technology and its wide availability has affected almost all areas of daily life in modern humanity (Tenberga & Daniela, 2024a). AI, or artificial intelligence, refers to machines that can do what humans do, which is problem solving, and language processing (Sajja, 2021). The powerful opening quote above is a relevant reminder to humans that AI is not a distinct entity; rather, it is a representation of human creativity and intellect (Haenlein & Kaplan, 2019). The development of AI by humans expands their cognitive abilities to make machines practically complete tasks that would normally be done using human intelligence (Ruseel & Norvig, 2020). AI in this sense works as a tool to improve natural performance to solve complex problems, analyze large amounts of data and maximize automation processes (Brynjolfsson & McAfee, 2017).

Particularly within the scope of education, this role of AI as a tool to extend human

capabilities is critically important. AI is a core topic for discussion of what it is capable of, both its benefits (such as adapting educational materials to each individual student's needs) and its downsides (including ethical violations) (Holmes et al., 2022). AI as a transformative force in 21st century education has been proven by empirical evidence in how teaching has been carried out, how education administration takes place and how learning has changed (Zainal & Mohd Matore, 2024). Gianninni (2023), argues that these technologies are changing quite rapidly, thus having great impact on both teachers and students.

AI has previously been mostly applied to education in a limited capacity, helping with just one or two simple tasks. For instance, there were intelligent learning systems and automated assessment tools as supplementary aids for teaching and assessment (Kaddouri et al., 2025). There has been a growing interest from academics, due to a recent set of advancements that has emerged from the field of Generative AI. Generative AI is different from its predecessors, as it denotes the systems that create something new from existing information, be it text, images or other media (Chow, 2024; Seth, 2024; Taiwo et al., 2025). In fact, this creative capability has changed its role significantly in the learning process. Therefore, this evolution makes it clear that Generative AI is not only a tool but even a collaborative partner in education (Noroozi et al., 2024). For example, it allows teachers to give students personalized learning and real time feedback for engagement purposes and better performance in academic related field (Escalante et al., 2023; Pesovski et al., 2024). Teachers can also use it to automate their curriculum design, generate various exam questions, and evaluate the complex assignments of the students (Tan et al., 2024).

The magnitude of the spread of AI technology has also been felt by Indonesia. Based on the latest survey released by Statista Consumer Insights (2024), Indonesia is ranked fourth as the most enthusiastic country in using AI in daily life. This shows a positive trend of enthusiasm for AI development (Fleck, 2024). In terms of education, this is also evidenced by several studies in Indonesia that Indonesia has integrated AI at the school level where some of the lessons include Science, Technology, Engineering, and Mathematics (STEM), English, and Indonesian learning (Apriliani, 2024; Mayasari et al., 2023; Subandi & Supardi, 2024). Interestingly, the studies mentioned above (Apriliani, 2024; Mayasari et al., 2023; Subandi & Supardi, 2024 Waluyaningtyas, 2024) have similarities, namely emphasizing the importance of integrity, as well as the importance of teacher supervision in the use of AI.

As an additional fact, the researcher in this study has previous experience in the use of AI, especially generative AI, during an internship as a curriculum developer at an Indonesian private school. The researcher experienced difficulties to develop a curriculum (especially in making the scope and sequence of English lessons). At first, only search

engines were utilized, until the interns mentor pointed out that there are generative AI tools that are already embedded in the school's curriculum website that can help with the task. Although initially hesitant due to reliability concerns, the generative AI tool was finally used effectively to find verbs, to match cognitive, affective, and psychomotor domains, and to conduct curriculum creation. From this personal experience, the researcher reflects that AI is a tool that anyone can use, but the use of AI must involve critical thinking, which means not merely accepting the output without thinking to make better decisions (Kim et al., 2024; Z. Lin, 2024) This can be seen as a core component of AI literacy, for instance: to maintain a critical and thoughtful attitude in embedding AI into work (Fu & Weng, 2024; Velandier et al., 2024).

After assessing the impact of generative AI in education and reflecting on personal experience, it is clear that due to the continued acceleration of generative AI technology, there is certain knowledge and skills that all users, especially teachers, are required to have (Zhao et al., 2022). In reality, however, teachers and students may not thoroughly understand what the underlying technology means and are unaware that there may be different AI types involved (Wilton et al., 2022). There is a basic set of competencies that are essential, which ultimately allows one to critically assess AI technology, collaborate and communicate effectively with AI, and feel comfortable with the presence of AI whether online, at home, or at work. This is what came to be known as AI literacy (Long & Magerko, 2020). It is being able to critically evaluate the abilities and weaknesses of AI, along with the capacity to make use of it ethically and responsibly, as well as coexist with AI in different settings (Holmes et al., 2022; Laupichler et al., 2023). As Long & Magerko (2020) point out, a foundational level of digital literacy is in fact necessary for AI literacy, that if one cannot use a computer, one cannot effectively use AI.

With most countries around the world moving into the era of AI education, the need for AI literacy among teachers is growing exponentially (Cheng & Yim, 2024; Yim & Wegerif, 2024). In fact, this competency translates into two key areas for educators in practice, harnessing AI to enhance pedagogy and how to safely navigate the ethical realm of AI. From an application perspective, AI literacy allows teachers to utilize AI tools to enhance teaching techniques, optimize learning and bring some administrative burdens such as lesson planning, into check (Walter, 2024). While these tools may be provided, this alone would not be insufficient to have an effective impact as it is also essential to possess a core component of this literacy that involves the capacity to critically analyze such tools (Celik, 2023). This would entail checking the reliability and usability of the AI outputs for proper application. This assessment must also take into account essential ethical questions

concerning data privacy and an understanding of the implicit bias of AI algorithms, to enable teachers to use and decipher AI-produced information responsibly (Laupichler et al., 2023; Tenberga & Daniela, 2024).

Furthermore, the Deputy Minister of Higher Education of the Republic of Indonesia, Prof. Stella Christie, in a recent talk show explicitly stated the importance of AI as a useful tool in Indonesian education. Although AI is important, its use requires an understanding by its users of what problems can be solved by AI, and what problems can only be solved with human input. This is the role that critical plays in AI literacy, which the Deputy Minister thinks is important for every AI user (Nelfira, 2024). This idea is also in line with the news reported by Kompasiana, that although AI offers many conveniences, it is important for teachers to maintain a balance in its use. Technology should be seen as a tool, not a complete replacement especially in the context of teachers, they need to be literate in the use of AI because it is essential for the wise and strategic application of AI advantages, while still fulfilling their important role as educators (Savitri, 2024). And moreover, there is a discourse that AI will be included in the primary and secondary education curriculum in the upcoming 2025/2026 school year, according to the Ministry of Higher Education, Abdul Mu'ti (Jatnika, 2024). Similarly, Indonesia's vice president Gibran Rakabuming Raka said AI lessons will be added to the scope of education ranging from elementary to high schools as well as vocational schools in the new school year (Ramadhan, 2025).

As this momentum for policy grows and awareness increases, there still remains an enormous gap in the foundational understanding of AI in Indonesia. This is echoed by the UNESCO regional director, Maki Katsuno Hayashikawa, who pointed out that there is still much room for improvement. A primary reason, according to research conducted by UNESCO (Mediana, 2024), is the fact that there is a common belief that AI technology is neutral and non discriminatory. The implication of this finding is that deep AI literacy is not widespread. Additionally, Hayashikawa notes that the public must be able to recognize not only the potential and usefulness of AI, but also its danger (Mediana, 2024). Previous research by Hamsar et al. (2024), reiterated the same phenomenon found in the UNESCO study where ethical awareness regarding the use of AI among Indonesian university students is still limited and frequently they ignore basic ethical principles. This problem is also compounded by different levels of AI literacy, as well as misconceptions about the role of AI in education, further complicating the issue (Bewersdorff et al., 2023; Ng et al., 2023; Velander et al., 2024).

Apart from the aforementioned problems, Indonesia actually already has in place a National Strategic Plan for Artificial Intelligence of the Republic of Indonesia for 2020-2045

as the basis for policies, regulations, practices, and various activities related to the use of AI in Indonesia issued by Directorate General of Higher Education (Haris & Kusumawardani, 2024). Unfortunately, these regulations and guidebooks are new and only currently available for higher education. While AI literacy guidelines have been implemented for the level of higher education, there is also a need for AI literacy for other levels of education, especially for teachers. The logic is clear: as teachers become better prepared with AI literacy, they will be able to easily work with the tools to manage technical challenges and create a knowledge environment that is conducive to students at all levels of education which can consequently result in better AI literacy for students in general (Yim & Wegerif, 2024).

In addition, studies that discuss the integration of AI in education and its consequences on the teaching and learning process have not yet reached an analysis of AI literacy levels among teachers and their performance in using AI tools in professional tasks (Velandar et al., 2024; Wang et al., 2023; Zawacki-Richter et al., 2019). Teachers, on the other hand, occupy the forefront of education which forms the reason why this study focuses on teachers. Based on the US Department of Education's report (2023), the teachers are leading agents in incorporating AI to be used in education. Their job is to bring new technologies and new ideas about pedagogy into the classroom (Cardona et al., 2023). A need for continuous professional development centered around AI literacy for educators is clear, as Walter (2024) states that educators require the ability to utilize AI tools optimally for effective teaching practice. Nelson (2024)'s study identifies that teachers hold a big responsibility in employing AI to promote student learning outcomes and that teachers who have high AI literacy are able to establish more customized and formative learning experiences. However, most of the existing research concentrates on the theoretical benefits of AI in education or its impact on students (Ayala-Pazmiño, 2023; Kaledio et al., 2024; Seo et al., 2021). In the perspective of the Indonesian context, some studies also concentrate on AI literacy only for students (Relmasira et al., 2023; Ulansari et al., 2024). Therefore, the gaps identified in this study will lead to valuable insights into the importance of AI literacy for teachers, especially in high school teachers and how it can contribute to their professional tasks, contributing to filling critical gaps in the current literature.

Given that the phenomenon of AI integration in the education sector is complex, this research then seeks to fill the aforementioned gaps, by exploring the perceptions, utilization, as well as challenges which encapsulate AI literacy among teachers, particularly how they are related to each other to draw the general portraits of the phenomenon. The perception towards the teachers is important to study since it can be considered as the first foundation or platform on which it is decided whether a new technology is accepted or rejected (AI-

Abdullatif, 2024; Almulla & Adam, 2025; Lee et al., 2024). Next, utilization will be investigated in order to see how the potential and theory of AI is transferred in practice, particularly in classroom settings (Aljemely, 2024; Shi et al., 2024). Finally, the teachers should identify the challenges to create proper professional development recommendations, in which they are directed (Arvin et al., 2023). This research will be carried out in a private high school in Bogor, Indonesia which is chosen to observe generative AI as this has already been embedded in its curriculum system. There are two reasons why the high school level was the focus of this research. To begin with, it is directly addressing the policy gap, with the current regulation of AI in Indonesia mostly found in higher education institutions. Secondly, as the literature states, high school teachers already work with more specialized subject matter, and thus are strategically placed to take advantage of AI literacy in schools, which makes them an important group to study (Casal-Otero et al., 2023; Du et al., 2024).

1.2 Research Questions

This research attempts to answer the following research questions:

1. How do high school teachers perceive generative AI in its use for teaching?
2. How do high school teachers utilize generative AI in its use for teaching?
3. What challenges do high school teachers face when using generative AI for teaching?

1.3 Research Objectives

Based on the aforementioned research background, the purposes of this thesis research are to accomplish these following objectives:

1. To identify high school teachers' perceptions on generative AI in its use for teaching.
2. To explore how high school teachers utilize generative AI for teaching.
3. To find out the kind of barriers that high school teachers face on using generative AI for teaching.

1.4 Research Significance

In general, this thesis research has a considerable impact on the knowledge of teacher-generative AI technologies interaction, especially within the Indonesian education system—notably in the higher secondary level. Theoretically, the case study does not only implement the frameworks, but also presents an empirical example, contextualized and

detailed, of how the ideas of AI Literacy (Long & Magerko, 2020) and AI-TPACK (Ning et al., 2024) are implemented in practice. The results concerning the ambivalence of the teachers' perception of generative AI, which is described as a "two-edged sword", and the high priority of the human agency concept for instance, give subtleties to the theories and indicate the need to integrate elements of critical assessment, as well as professional control as fundamental 'pillars' in the models of teacher competence in the era of AI.

Methodologically, the qualitative case study method employed was able to achieve the richness and complexity of the phenomenon that would not have been achieved through a large-scale survey alone. This study uses triangulation of data collected through initial questionnaires, structured observations (demonstrations), semi-structured interviews, and FGD to bring out a comprehensive and valid image of the perceptions, use, and challenges upon generative AI of the high school teachers.

In practice, the results provide an evidence-based guide that can be pursued by different stakeholders. To teachers, the research can be a reflection and a way of validating their experiences. With regard to school leaders and educational institutions, the conclusions about infrastructure-related issues and a lack of guidance, as well as the requirement of targeted professional development, can serve as the foundation for creating policy and supporting frameworks. The outcomes then can be used by the policymakers in developing supportive policies, regulations, and allocating resources to spread AI literacy in schools; and for the use of AI (ethically) in education, especially in the higher secondary level (high school). Lastly, to the education technology (EdTech) developers, the expectations of teachers of more contextualised, integrated, and adapting AI serve as useful inputs to the development of technology solutions that can really solve real needs in the classroom, particularly in the Indonesian context.

CHAPTER II

THEORETICAL FOUNDATIONS

There are two subsections in this section. The elaboration of the literature review on which this study is based in the first part. The chapter starts off with an overview of AI that elaborates about the definition of AI; the evolution of AI into what it is in the current times; and AI types together with components of AI. Then, the use of generative AI, especially in the context of education is discussed. Besides, details about some of the earlier research regarding the AI literacy (AI literacy's importance, AI literacy definition, and the current frameworks of AI literacy) are presented. Furthermore, it explains in detail AI literacy in an Indonesian context to contextualize the previous discussions. The second part (as theoretical framework) is responsible for introducing Long & Magerko (2020)'s AI literacy framework as the 'lens' of this thesis research and subsequent explanation of the AI-Technological Pedagogical and Content Knowledge (TPACK) framework proposed by Ning et al. (2024).

2.1 Literature Review

2.1.1 The Overview of AI

2.1.1.1 The History and Development of AI

“Is artificial intelligence less than our intelligence?”

(Jonze, 2022 cited in Crumbaugh, 2023).

As time grows, everything gets evolved. Human Intelligence is one of its examples. Humans evolved in many phases from ancient times to modern times. Human intelligence is of utmost importance. It is an extremely powerful tool to learn, apply and reinforce the information learned (Corduck & Pamela, 2004). To replicate Human Intelligence and make it more faster and efficient, the term “Artificial Intelligence” was introduced (Sharma & Garg, 2021; Xu et al., 2021). A lot has changed in Artificial Intelligence (AI) since it was conceived in the 1950s. The question about what AI is, was discussed back then by Alan Turing, asking what exactly can a machine think and and sparked a further discussion (Turing, 1950). The history of AI is one that takes a journey from object intelligence (for instance: symbols, behaviors, and agents) to system intelligence (humanity, nature and society).

On 2007, John McCarthy took up the role of an American mathematician and computer scientist to promote the use of AI. Referring to AI, McCarthy initially defined it as: ‘the science and engineering of creating intelligent devices, primarily intelligent computer programmes’ (Mccarthy, 2007). In similar vein, there are different definitions of

AI coming up, depending on the state of the art technological advances and human understanding. Russel & Norvic (2010), for example, define AI as “the science of designing intelligent objects capable of performing human tasks which intelligent objects typically do”. The definition above suggests that research in AI is not only confined to algorithm development, but also of the engineering aspects.

Over time, some of the world's leading organizations such as UNICEF defined AI as a machine-based system that can, with a set of human-defined goals, make predictions, recommendations, or decisions that affect real or virtual environments (UNICEF, 2021). UNESCO-UNEVOC has also recognized AI as a variety of techniques that vary in complexity, but have the same outcome: imitation of human cognition or decision-making (TVETipedia Glossary, 2024). AI is further defined as an area in the field of computer science that focuses on building computers that can help calculate human lines of work similar to learning, reasoning and self correction as defined in Bermejo et al. (2023). Zohuri & Rahmani (2019) also define AI as programming a computer or a machine that can think and learn as a human does naturally and cognitively to the next level applying the Artificial Neural Network (ANN) system programmed in the machine. Also, AI is a technology that allows computers and machines to reproduce the human's learning, understanding, problem solving, decision making, creativity, and autonomy, (Berryhill et al., 2024; IBM, 2024).

AI also proceeded from individual intelligence, which included learning intelligence and developed into metasyntetic intelligence, the hybridizing and synthesizing of many intelligences. As a result of this evolution, it has entered a new era of AI, where innovation and transformation of AI solutions are highly rapid across multiple domains, and that means there needs adoption of an approach to assure the full stack of these AI solutions (Cao, 2022). In its development, AI is not only in the field of science and engineering, but the application of artificial intelligence (AI) across various fields is beyond science and engineering, including: metaphysics as well as in medicine, biology, physics, chemistry, social sciences, and humanities (Sanieva, 2024). Beyond the things mentioned above, there is also proliferation of use of AI in wide range of domains such as social media (Wu et al., 2019), and in education (Zawacki-Richter et al., 2019). AI promises to develop in the future as it applies to more fields. With the development and advancement of AI there would be more complexities that would allow lots of super abilities like quicker diagnosis, vehicle automation and creation of robotics. This will make the life quality much better having intelligent impact in all the everyday needs (Saini et al., 2024).

2.1.1.2 Generative AI

Generative AI has become an impressive technology defining the consequences in numerous fields and industries. It is known that it can create original output, in form of text, images, and code, by making basic inputs by the user, thus stimulating creativity and innovation (Quintero & Iglesias, 2023; Yehia, 2024). The technology found its extensive use, including improving productivity in the field of industrial networking to revolutionizing medical imaging, making the diagnostic process more accurate (Chattopadhyay et al., 2025). The involvement of generative AI is however not free of challenges and criticisms. Although some proponents are pointing to its ability to associate enhanced creativity and innovation to it, some significant amount of research criticizing on it points towards its use as littered with technical and ethical difficulties. As an example, although generative AI demonstrated its potential to support research and education by helping people conduct efficient data analysis and receive personalized learning experiences (Mutawa, 2024), it also puts ethical issues in jeopardy, mainly considering the question of data privacy and algorithmic bias (Shankar, 2024). The argument here is that both utility and risk are not distinct, inventory that both belong to the same technological paradigm, which poses a major dilemma on ethical implementation in the education sector.

Besides these broad risks, there have also risen narrower criticisms by practitioners in different fields. The negative argument against generative AI frequently mentions the virtual absence of any meaningful contributions in various sectors even after huge investment. Respectively, in the pharmaceutical industry for instance, the huge expectations related to generative AI have not yet manifested itself in the form of significant advancement, which is characteristic of the further streamlining of this direction and the improvement of implementation models more effective implementation strategies (Urbina et al., 2024). Also, professional artists, writers, and programmers have been raising concerns about their output being used as training data to generative AI systems, especially concerns regarding lack of attribution and payment or compensation (Samuelson, 2023).

Nevertheless, these criticisms do not stop the research and development of generative AI because of its potential. Research related to its application has advanced different models and approaches of responding to the ethical and practical issues. As an example, generative AI and artistic innovation were found to boost productivity and enhance creativity in the AI-human collaboration (Chu et al., 2025). Furthermore, the analysis of public sentiment shows that opinion toward generative AI is highly divided and that people are worried about losing their jobs and invading their privacy but also acknowledge the possibility of its powerful transformation (Mahmoud et al., 2025).

2.1.2 The Use of Generative AI in Education

The inception of generative AI into learning environments has presented a basic dualism, commonly providing benefits, as well as caused considerable dilemmas of academic integrity and equity, which need to be handled with utmost caution (Francis et al., 2024). Although it is commonly recognized that it can transform the teaching and learning experience, such opportunities inevitably come hand in hand with multiple ethical and practical issues (Francis et al., 2024; Ng et al., 2025). This has led to no easy agreement of how generative AI can best be applied to learning environments today (Giannakos et al., 2024). The heart of the scholarly and professional discussion, thus, is how to approach the balance between harnessing the great power of the tools and minimizing the dangers inherent in them.

On the positive side of this discussion, increasingly fast-growing research addresses the tangible advantages of generative AI, as an effective tool to support teachers and students (Davis, 2024; Saunders et al., 2024). Research indicates that it can become a powerful tool that will allow personalizing the education process, make education more engaging, and redefine the development of educational resources (Zhai, 2024). It becomes possible with the use of advanced natural language processing (Zhai et al., 2021) in such tools as interactive learning assistants and content creators (Latif et al., 2024; Lee & Zhai, 2024; Pahi et al., 2024). As an example, in the particular field of evaluation, one study conducted by Chow (2024) has shown that generative AI could help the teaching professionals create top-quality assessments that reflect complicated mental goals. This and other related apps demonstrate a strong possibility of generative AIs in reducing teacher workloads and also enhancing the learning process.

This optimism however is tainted by various threats and ethical issues. A number of studies refer to bias and misinformation where generative AI systems may entrench biases in what they produce (Ferrara, 2024; Wei et al., 2025). Moreover, when using generative AI tools, it is difficult to keep academic integrity (Gruenhagen et al., 2024; Selwyn, 2019). Some critical issues concerning the use of AI among students are the reproduction of materials using AI without critical thinking and original work, which is not beneficial to the integrity of the academic procedures (Vieriu & Petrea, 2025; C. Zhai et al., 2024). These criticisms emphasize that incorporation of generative AI is not a seamless project and one should account its limitations and ethical concerns in the real world.

2.1.3 Indonesia's National Guideline and Proposed Integration of AI in Secondary Education

Following further discussion in the former sub-chapter with respect to implementation of AI in education, speaking more in the Indonesian context, the discussion on implementation of AI in Indonesia has been developing with great positive force in the national policy level. As a recap (within the introduction section of this thesis research) at the time this research was designed, the official guideline on the use of AI from the Indonesian government at levels other than higher education had not yet been officially circulated, so this was also one of the foundations why this thesis research was initiated. However, as time went progressed, in February 2025, the guideline developed by the government and specifically in a fundamental scholarly article by the Ministry of Primary and Secondary Education of the Republic of Indonesia laid out its strategic plan related to the official inclusion of coding and Artificial Intelligence into the curriculum of primary and secondary schools.



Figure 2. 1 Academic Paper Coding and Artificial Intelligence Learning in Primary and Secondary Education (Guideline)

Source: *BSKAP Kemendikdasmen RI (2025)*

Anchored by the leadership of the Minister of Education, Prof. Dr. Abdul Mu'ti, M.Ed. This initiative is an expression of a top-down approach to getting students ready to

take part in a future that is becoming more dominated by AI. The given document can be viewed as a blueprint of how to introduce the elements of AI literacy and coding into the school curriculum in a systematic way at the primary and secondary stages. It also highlights the need to not just incorporate AI technologies but make sure that such implementation is based on more holistic pedagogical and ethical concerns to enhance an improved and more responsible learning environment (Mu'ti et al., 2025). Therefore, this specific section on this literature review part will be specifically anchored on this guideline created by the Ministry of Primary and Secondary Education of the Republic of Indonesia by Mu'ti et al. (2025).

Furthermore, the plan of implementation carried out in this document is very practice-oriented. It suggests problem based and project-based learning. The given strategy is consistent with the current trends observed in a few test schools in Indonesia where students are not only recommended to engage in certain projects like creation of applications, games, and simple robotic robots on the basis of Internet of Things (IoT). Thus, the present document, which is the Academic Article on Coding and Artificial Intelligence Learning, is a well-planned and far-reaching initiative on the part of Indonesia government. The document in question is not mere implementation guide but also the reflection of the national vision to raise a generation which in addition to being digitally literate is able to be innovative and global competitor with strong sense of ethics. Lastly, this is not just an academic article/opinion-type of a paper, but an official policy document, the product of the Education Standards, Curriculum, and Assessment Agency in the Ministry of Primary and Secondary Education of the Republic of Indonesia. It is used as the most reliable primary source of obtaining a picture of the official position, plans and model of government of Indonesia on AI literacy in education (Mu'ti et al., 2025).

Additionally, teachers, according to this document, do not only establish AI literacy as a technical mastery, but as a coordinated mix of four major competencies professional, pedagogical, personality and social. The biggest part of the standard belongs to professional competencies which are also detailed in great detail and are to be organized in hierarchies based on the educational level of the students to be taught (Mu'ti et al., 2025, p. 76):

- 1) At the elementary level (*SD*) emphasis is made on teacher competencies in terms of their ability to foster the basic level of understanding of the effect of AI in the daily lives as well as instilling basic digital ethics, such as the basic awareness that AI is not always fully accurate and protecting personal information.
- 2) And it continues to develop on the junior high school level (*SMP*) where the teachers should assist the students to examine more complicated topics like bias, hallucination, and dangers of over depending on the AI.

- 3) The teacher competency standards are the highest at the high school level (*SMA/SMK*), where one is expected to be able to provide high level technical skills including:
 - a. Prompt Engineering: create basic AI systems, create applications with the available Application Programming Interfaces (APIs). Moreover, pedagogical competency is yet another way of realizing teachers' AI literacy.
 - b. Pedagogical Competency: AI literacy is the proficiency to establish suitable learning processes and do this with the help of new models like project-based learning and problem-based learning. The personality and social competencies supplement this framework and echo the role of the teacher as an agent of role model who loves to learn and capable of cooperation. Therefore, AI literacy in a teacher constitutes a whole organic construction of deep knowledge, effective pedagogical strategies, and the moral sense of responsibility.

2.1.4 AI Literacy

2.1.4.1 AI Literacy Definition

Artificial Intelligence (AI) literacy is a multifaceted realm, and the intellectual definition has become more versatile, moving beyond a basic set of technical competencies to a more comprehensive definition that includes critical thinking and an ethical implementation. Initial design processes focused on the skills set required on how to learn the fundamental operations of AI and the applications so as to utilize it efficiently (Kandlhofer et al., 2016; Lin et al., 2021). This view espouses AI literacy in terms of the capability to use this knowledge about AI, concepts applied, and applications under various conditions (Druga et al., 2019; Julie et al., 2020; Vazhayil et al., 2019).

When the technology became more integrated into the society, the definition was expanded to refer to higher-order thinking skills, namely evaluating, assessing, and designing in regard to AI systems (Druga et al., 2019; How & Hung, 2019). A more recent key dimension is related to relating AI literacy with social good, and human-centered values such as fairness, accountability, transparency, and ethics (Chai et al., 2020; Gong et al., 2020; How & Hung, 2019). This development reaches its culmination in such thorough definitions defined by Long & Magerko (2020), who consider AI literacy as a combination of the skills that can help people skillfully assess AI technologies, communicate and work owing to them, and employ them as an instrument in various settings.

Such a generalized definition of AI literacy makes it a highly important 21st century competency similar to conventional literacy (Ng et al., 2021; Spante et al., 2018) and media literacy (Hobbs et al., 2013; Mihailidis & Viotty, 2017). Digital literacy is the premise of AI literacy as a basic level of understanding digital technologies and platforms that allow a more comfortable adjustment in relation to AI systems (Becker et al., 2024; Long & Magerko, 2020). AI literacy is not presented in vacuum as it works upon the and combines with decades of these efforts devoted to computational thinking, data literacy, and digital citizenship. Such profound insight spurs educational leaders to build new learning pathways that would accommodate AI literacy or extend the current ones to serve it (Mills et al., 2024).

Effectively developing and enhancing AI literacy begins with getting a clear understanding of current skill levels, both on an individual and organisational basis (Pinski & Benlian, 2024). This is where a "levels- based" approach really helps. By identifying and categorising different degrees (or levels) of AI literacy, it becomes easier to tailor educational and training programmes to address specific needs. In connection with attempts to define and support AI literacy multiple frameworks have been proposed suggesting how different AI components can be connected and what skills, knowledge, and competences can be considered relevant for becoming literate in AI (Cetindamar et al., 2024; Kong & Yang, 2024; Long & Magerko, 2020; Touretzky et al., 2023). There are a number of established frameworks that can provide a structured and comprehensive method for categorising AI literacy levels. These established tools offer valuable insights into both foundational and advanced competencies, allowing for precise evaluation and targeted development:

1. Long & Magerko (2020): A comprehensive framework to define AI literacy as the set of key competencies needed to critically engage and interact with AI, to communicate with AI effectively, to utilize AI as a tool across a number of environments. It identifies 16 competencies grouped into four main questions: What is AI? What can AI do? How should AI be used?, and how do people perceive AI?
2. Kong et al. (2024): The included dimensions here are awareness, application, thinking innovatively and socially responsible (general) with goal to enhance learners' comprehensive understanding of AI and ethical awareness.
3. Cetindamar et al. (2024): This framework was developed by focusing on the workplace where technology, human, work, and learning related capabilities are required employees to work actively with AI in their jobs.
4. The Five Big Ideas Framework by Touretzky et al. (2023): This framework is frequently used by reference particularly in education at the school level, and relates to five fundamental concepts: Perception (how AI systems perceive the world), Representation and Reasoning

(how AI processes information), Learning (how AI systems improve from data), Natural Interaction (how AI interacts with people) and Societal Impact (how AI impacts our society at large).

The combination of these frameworks depicts agreement on the idea that effective AI literacy will be multidimensional, situational, as well as ethically-minded.

2.1.4.2 AI Literacy for Teachers

There is an emerging body of knowledge in the literature of education technology that reiterates that teachers do not necessarily need a strong technical background in order to suitably integrate emerging technologies such as generative AI into the classroom setting (Holmes et al., 2022; Long & Magerko, 2020). The reasoning of this viewpoint is that it is not the central task to involve the educators in becoming makers of AI, but rather enable them within enough literacy of AI, as applied in a critical and pedagogic manner. There is the aspect of learning how AI would be implemented in practice in learning and assisting students to gain the skills necessary to adjust to the technological changes in the future (Holmes et al., 2022). Such a move towards functional literacy is important and in particular when one considers the special role of teachers in the adoption environment.

In framing the purpose of AI literacy among educators, it is important to note that teachers are commonly found to be a non-technical user of the newly emerging technologies. A number of works finally lead to the conclusion that teachers can have little insight into the fundamental principles of how AI functions, and cannot interact with technical details easily (Ding et al., 2024). This is not a drawback, it is a professional fact, they specialize in pedagogy and content and not computer science (Ertmer & Ottenbreit-Leftwich, 2010). This fact demonstrates the reason why new technologies might not be very comfortable to many teachers, and underlines the fact that effective technology skill development for teachers should be rooted in real classroom practice rather than abstract technical instruction (Hew & Brush, 2007), such as various types of AI.

In view of these facts, it has shifted to the debate on what kind of particular skills the teachers require. A new discussion is that AI literacy should also be considered as a critically important field among the wider system of digital competencies, requiring attention to related matters of ethical and responsible application (Tenberga & Daniela, 2024). Few research has started working on operationalization of this, that is, it is necessary to design and evaluate the level of preparedness of teachers to face the opportunities as well as the challenges presented by AI (Tenberga & Daniela, 2024). At the same time, other researchers emphasize that such preparation is impossible to dissociate with the predetermined principles of

technology implementation in learning, stressing that the approaches to the application of such basic models as TPACK need to be updated to accommodate the requirements and challenges posed by generative AI (Al-Abdullatif, 2024). This request to better fit the current frameworks is essential, since the specific characteristics of AI imply that the relationships between technology, pedagogy, and content need to receive an even more subtle interpretation.

Addressing this need, some scholars started to construct even more specific models. The AI-TPACK framework, which was investigated by Ning et al. (2024), is one of the most obvious ones that specifically aims at explaining the intricate interconnections and synergetic effects between AI technology, pedagogical elements, and subject-specific content. This framework can be used to examine in more detail the very competencies that teachers in the AI-era should attain by suggesting the identification of specific components such as AI-Technological Knowledge (AI-TK) and AI-Technological Pedagogical Knowledge (AI-TPK).

Whilst quantitative self-assessment of AI-TPACK and AI literacy in the context of higher education has been effectively established by studies conducted by Al-Abdullatif (2024) and Tenberga & Daniela (2024), there is still yet to be concrete knowledge on how a similar topic is perceived within the context of high school teachers. Qualitative investigation into the way teachers in practice perceive, work with, and negotiate the problems of generative AI is also required. Thus, the research study undertaken in this thesis is taken in the form of a qualitative case study, it being conducted through in depth interviews along with focus groups in order to ensure a rich, contextualized knowledge that supplements and extends the finding of these larger quantitative studies.

2.1.4.3 AI Literacy in Indonesia

AI literacy in Indonesia so far can be seen from early childhood up to higher education scale that shows importance of digital and AI literacy (Qomariyah et al., 2024; Rahmawati, 2023). A study focusing on a three session AI literacy classroom intervention in an elementary and secondary education environment within the STEAM framework grounded in constructivist and transformative learning theories. The use of this approach to reveal clusters of learner experiences led to relevant educational design principles (Relmasira et al., 2023).

Moreover, a community service program in a Universitas Respati Indonesia aimed at supporting AI and robotics literacy among middle and high school at the secondary school level organized interactive training sessions to develop the students' understanding and interest in AI technologies (Ulansari et al., 2024). Another research in early childhood

education shows that computational thinking and basic programming literacy that can be gained through coding and robotics have a big influence on the competence of teachers (Rahmawati, 2023).

Furthermore, AI is used to improve creativity and literacy in the Indonesian language education field. Story and poetry generators, among other technologies have shown to have potential in inspiring creativity of students and personalizing feedback, making learning experience more fruitful (Kurniawan et al., 2024). AI integration in literature has changed the scene of Indonesian literature, the new method to create and analyse the work could use, but not merely substitute, the conventional literary study (Saddhono et al., 2024). Though such applications show the high potential of AI in the Indonesian educational setting, having observed the research landscape more closely, its attention seems to be unevenly distributed.

Unfortunately, apart from the studies mentioned above, there are still not many studies (especially in Indonesia) that discuss AI literacy itself. Most of the literature found mainly only discusses AI as a tool to help develop literacy (Djamzuri & Mulyana, 2023; Fakhri et al., 2024). In addition, if the previous studies on AI literacy in the Indonesian context are searched, instead digital literacy emerges (Fakhri et al., 2024; Trianie et al., 2024; Zega & Batubara, 2024). This indicates that awareness, which in this context is literacy about AI itself, is still not much of a concern in Indonesia. This could be because many people think that AI is just a tool, and it is easy to use so it does not require any special skills (Soesanto et al., 2022). In fact, discussing literacy in the usage of AI is also important. This factor is also what becomes the foundation of this research.

2.2 Theoretical Framework

2.2.1 AI Literacy Framework

This research will mainly adhere to the AI literacy framework proposed by Long & Magerko (2020) which draws from various disciplines (for instance: digital literacy, computational literacy, scientific literacy, and data literacy) (Bawden et al., 2008; Disessa, 2000; D'Ignazio, 2017; Laugksch, 2000). This framework is used as the main theory because it is a robust set of theories upon which the competencies needed for effective engagement with AI technologies can be understood. Moreover, it is a classic a highly-cited publication, which offered one of the earliest comprehensive literacy lists of AI competencies (Faruqe et al., 2021) that focus on an exposed audience of non-experts. The first part of the theory identifies 16 core competencies from which AI literacy stems, and design considerations for making accessible AI tools. The reason to highlight this framework is that it has a very

uniform approach to dealing with both theoretical and practical sides of AI literacy (Krüger, 2023).

In addition, the framework describes what competencies individuals should have, from being able to spot AI in machines to possessing a basic understanding of machine learning (Long & Magerko, 2020). This systematic method helps researchers and educators develop instruction that centers around an education in responsible usage of AI technologies and reasoning over these decisions (Long & Magerko, 2020). Long and Magerko's framework is usable as a manual for successful creation of AI literacy initiatives because they emphasize working on ethical issues in AI as well as learner centric tools, a trend that matches educational goals (Almatrafi et al., 2024).

Long & Magerko's AI literacy framework which was developed in 2020 has provided the necessary guideline in the conduct of studies on AI literacy in different educational settings. This framework identifies four overarching themes that are essential for understanding AI literacy. These are fundamental questions about AI that this theoretical framework answers: What is AI? What can AI do? How should AI be used?, and how do people perceive AI? These thematic questions provide a basis for constructing learning programmes and assessments designed to increase the levels of AI literacy among learners and teachers (Long & Magerko, 2020). The explanations will be further detailed below:

- 1.) The concept of AI

What artificial intelligence can and can not do is the central discussion of this theme. Talking about AI, tasks that AI can perform are often divided into two groups: "narrow AI" and "general AI" (Girasa, 2020). But whereas narrow AI is the system meant to perform specific tasks such as language translation, image recognition, and playing chess along with excellence (Girasa, 2020). Today, these systems are everywhere and are used in many different applications in industries. The models are effective in their domain, but are unable to generalize the knowledge to other areas.

In contrast, general AI is essentially a concept that can be intelligent and apply their knowledge in general sense over a vast range of domains like human intelligence. But there is still no way to make a general AI machine, as this kind of progress is predicated upon understanding, and mimicking—or humanizing (Girasa, 2020). Just as with robots, AI systems can be physical in nature and interact physically with the world. Integrating sensing, perception and action is what robotics is all about, it is how machines are able to perform tasks without direct instruction, since robots are autonomous (Masuta et al., 2016). The design of autonomous agents that can make decisions, plan and use machine learning to

interpret sensory data that could inform action in highly uncertain or dynamic environments is important (Saisubramanian et al., 2021).

Clearly identifying these distinctions is crucial in the context of education, particularly in this research regarding the AI literacy of high school teachers. In education, there are also concerns regarding how the educators would supposedly have used these tools, and how they will be able to adapt to evolving advancements in technology at breakneck speed (Zhang, 2024). Understanding this is important not just for exploring the use of AI in their teaching effectively, but also for developing a critical view about the ethical restraints and the biases implicit in AI systems (Ng et al., 2021; Sahoo, 2024). As a result, this research investigates the perceptions, uses, and challenges of high school teachers in using generative AI, and extends the conversation surrounding AI literacy in education.

2.) The capability of AI

To understand how AI is capable of working, the mechanisms and processes by which machines can do tasks which often rely on human intelligence are explored in this theme. AI systems are built through algorithms which use the data to make a decision or prediction (Khanh et al., 2024). The rule based algorithms follow certain instructions while the ones which use machine learning learn from certain patterns of data to get better systematically over time (Eslami et al., 2019).

Of those, a subset is machine learning (ML), which is particularly interesting because it enables systems to learn from experience (Sarker, 2021). Then it trains models on massive data sets so that they can learn patterns and make decisions without instruction to do something explicitly for each task. Neural networks (NN) are also part of AI, because they are modeled after the structure of the human brain. These are networks of interconnected nodes that have layers that are particularly good at 'image and speech recognition' type tasks (Chao, 2023). One such advancement of AI capabilities among all has been using neural networks with many layers: called Deep Learning (DL) (Sarker, 2021).

Overall, this theme posits that to be literate regarding the capability of AI, the competence is distinguishing between technological artifacts that use AI and those that do not. It also includes understanding the current capabilities of AI and recognizing the differences between general and narrow AI. Recognizing AI's strengths and weaknesses is essential for leveraging AI and human capabilities to solve problems effectively also (Long & Magerko, 2020).

3.) The functionality of AI

This theme is formulated in the context of AI use and striving to understand what to use AI for, introducing ethical dimensions, the process of making decisions in AI and

combining AI with human skills. It should first bring forward the awareness of ethical implications of AI in practice, that is, the awareness of biases in AI systems, and the awareness of societal impact of such technology (Sahoo, 2024). Awareness includes knowing how decisions are made by AI, and being assured by its fairness (Long & Magerko, 2020).

Second is to use AI as a tool to enhance human decision making and problem solving ability (Phillips-Wren & Jain, 2006). It requires people to identify when and where to put AI to use, and how best to coordinate it with our own strengths and weaknesses to get the best of both worlds (van den Bosch et al., 2019). Users have to critically evaluate the role of AI in a variety of contexts and be informed as to when and where to use or not use AI (Anik & Bunt, 2024).

Finally, successful adoption of AI necessitates combining capabilities of AI with human capabilities, which acknowledges that AI and human intelligence work in ways that complement each other, however, AI took its time to improve humanization in technical systems. AI can do the data driven stuff, but humans bring creativity and emotional intelligence to the work, and for optimal outcomes, we need AI and humans working together (Haase & Pokutta, 2024). These competencies help people exercise good judgement when using AI, apply with responsibility and with an ethics perspective (Long & Magerko, 2020).

4.) The Diverse Perceptions of AI

Many things make up public perceptions of AI; these include media representation, and personal experiences with AI (Seth, 2024). This theme discusses how AI can be portrayed in news coverage and in popular media, both the influence this can have on public views of the technology and the reflection of those views back to the public misrepresentations (as they can be) of AI brought about by sensationalized media coverage (Chuan, 2023). The perceptions about who fits in with AI shape the participation of individuals in these AI learning opportunities. Some individuals may consider AI as a difficult and far removed area, notably if they are not coming with a computer science or math background (Ding et al., 2024).

Furthermore, gender differences are also at play in the understanding of AI, and men are more likely to participate in tasks such as tinkering with AI devices because they probably view such actions as more useful (Karakus et al., 2023). As such, this framework highlights the need to address such misconceptions and barriers to entry into AI education by suggesting other ways to not only lower the barriers, but also lower barriers based on interests and identities of the learners so that more inclusive understanding of AI can be fostered (Giray, 2024). Still, there is a need to know how the public perceives AI so that the design of

educational strategies and technologies to achieve AI literacy and promote the use of AI in a responsible manner can be achieved (Ding et al., 2024; Seth, 2024).

Then, according to this framework, in detail there are 16 competencies of individual who is considered as AI literate which are part of the four overarching themes mentioned above.

The competencies that Long & Magerko (2020) mentioned are as following:

Table 2.1 The 16 Competencies in AI Literacy According to Long & Magerko (2020)

| Core Competency | Description |
|--------------------------------|---|
| 1. Recognizing AI | Being able to identify what AI technology is being used in different applications and in context. |
| 2. Understanding AI Principles | Understanding the basic ideas and principles of next generation AI technologies (machine learning, data processing). |
| 3. Evaluating AI Systems | Competencies to evaluate the utility, credibility as well as the restrictions of AI systems. |
| 4. Ethical Implications | Taking into account regarding bias, privacy, liability issues, ethics and social responsibility when it comes to AI technologies should also be considered. |
| 5. Communicating about AI | The ability to explain and discuss the concepts of AI as well as its potential effects across different audiences. |
| 6. Collaborating with AI | The skills that are required in order to work alongside the AI systems include understanding the roles, and the contribution that the AI systems play in the collaborative tasks. |
| 7. Designing AI Tools | Knowledge of how to design and develop AI tools that are user-friendly and accessible. |
| 8. Applying AI in Practice | Ability to implement AI technologies in real-world scenarios, including educational settings. |
| 9. Understanding Data | Knowledge of data literacy, including data collection, analysis, and interpretation as it relates to AI. |

| | |
|------------------------------------|---|
| 10. Continuous Learning | Commitment to ongoing education and adaptation to new AI technologies and methodologies. |
| 11. Interdisciplinary Approach | Ability to integrate knowledge from various disciplines to understand and apply AI effectively. |
| 12. Critical Thinking | Skills to analyze and evaluate the implications of AI technologies critically. |
| 13. Problem-Solving with AI | Ability to use AI tools to address complex problems and develop innovative solutions. |
| 14. Understanding AI's Limitations | Awareness of the limitations of AI technologies and the importance of human oversight. |
| 15. Engaging with AI Responsibly | Skills to use AI technologies in a manner that is ethical and socially responsible. |
| 16. Advocating for AI Literacy | Ability to promote the importance of AI literacy within educational and professional communities. |

Additionally, this framework has been used in recent studies to evaluate AI literacy in higher educational context. As one example, Laupichler et al. (2023) identify a "Scale for the Assessment of Non-Experts' AI Literacy" (SNAIL), which corresponds with the Long & Magerko framework by defining competencies in terms of technical understanding, practical application and critical appraisal. The importance of measuring AI literacy in such a non-expert population is also stressed, in addition to the need for educational programs serving these competencies. Furthermore, research presented at the 2023 CHI (Conference on Human Factors in Computing Systems) examined the role of AI literacy in K-12 education and showed that the Long & Magerko framework can be applied to design learning experiences that build public AI literacy for young people (Long et al., 2023).

Finally, the framework has supported conversations about responsible AI usage. The need for educating students in reflecting about the moral implications of AI technologies, and to prepare them to think about how to use AI responsibly, has recently been emphasized in a paper proposing a model of responsible generative AI literacy (Cox, 2024). In line with the framework's focus on understanding the implications of AI and engaging responsibly with it so that the future generations may be prepared to tackle the complexities related to AI technologies in their personal as well as professional lives.

2.2.2 AI-Technological, Pedagogical, and Content Knowledge (TPACK)

In this thesis research, the AI-TPACK theory is situated as the second theory after the AI literacy framework due to its greater emphasis toward the pedagogical aspects of technology integration in teaching. The AI literacy framework is used to explore the main character of the studied object of research, the AI literacy possessed by the teachers, while AI-TPACK offers the lens needed in understanding how the teachers can apply their technological and pedagogical knowledge in a wider learning context (Chan & Tang, 2024; Ning et al., 2024).

Besides, this research explores generative AI utilization of the teachers based on the premise that being able to use generative AI is a fundamental aspect of their AI literacy and realizing their enactment of their AI-TPACK. Thus, their use will not only be analysed as a tool to an end, but as the evidence of these developing competencies in action. Consistent with literature (Zawacki-Richter et al., 2019; Kizilcec et al., 2013), this framework illustrates the intertwining between content knowledge, pedagogical knowledge and technological knowledge as a necessary precondition for an effective and yet adaptive learning environment.

Moreover, the conceptual framework by Ning et al. (2024) further reinforced this notion. Literacy on AI is identified as a wider circumstances or space of knowledge that includes and determines the whole AI-TPACK framework. Being situated in the outer ring together with other AI contexts implies that AI literacy cannot be reduced to a single, distinct element of knowledge, but is an overall precondition in which teacher knowledge domains exist and interact. In other words, a teacher's AI literacy will be reflected through how he or she designs and employs each element of the AI-TPACK. This can be seen in Figure 2.1 below.

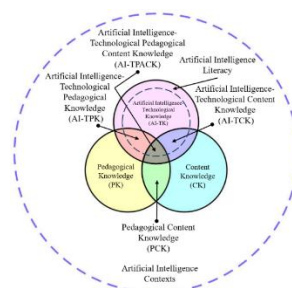


Figure 2. 2 The Structural Diagram of the AI-TPACK Framework

Source: Ning et al., (2024)

Historically, the Pedagogical Content Knowledge (PCK) theory, which was first proposed by Shulman L. S. of Stanford University, was the first theory on teachers' knowledge structure (Shulman, 1986). TPACK is an overarching framework for better understanding the kinds of fundamental knowledge teachers need to effectively use technology in classroom teaching (Mishra & Koehler, 2006). The TPACK framework views the three main knowledge bases of the teacher's understanding of technology, pedagogy, and content (as well as the connections between and among those three bodies of knowledge) as comprising what the teacher needs to know. In this approach, technology in teaching is defined as something that goes far beyond isolated knowledge of specific hardware or software; instead, when technology is incorporated into educational settings, it results in the representation of novel ideas and necessitates the development of an awareness of the dynamic, transactional interaction among all three elements (Koehler & Mishra, 2005).

TPACK competence at higher levels allows educators with expertise in both the technological and pedagogical as well as content knowledge (technological, pedagogical, content knowledge) to join these two seamlessly, leading to improved learning. TPACK framework aims at dynamic and interdependent relationships among pedagogy, content and technology (Koehler & Mishra, 2009). Because teaching is a context bound activity, teaching teachers who have developed their TPACK use technology to design learning experiences for a particular set of pedagogies, content, and learning contexts (Ning et al., 2024). According to timeline, the TPACK model has been examined over the past 20 years by a variety of scholars from a range of methodological and epistemological stances, including Margerum-Leys and Marx (2002), Angeli (2005), Niess (2005), and Harris et al. (2017). This shows that TPACK is considered as a useful and essential framework to understand the meaning of technology integration into instruction (Koehler & Mishra, 2008).

However, civilization has successfully moved from the information age into a new era of increasing intelligence since the development of AI (Brynjolfsson & McAfee, 2017). Whether the current TPACK model is still relevant to the changing demands of teaching and the needs of educators' professional growth is the most urgent question in this regard (Harris & Hofer, 2011). Teaching and learning in the AI era are described as intricate processes including the multidimensional application of information (Tan et al., 2025). As the technology of AI grows, the ways in which knowledge can be acquired have increasingly expanded too (Luckin et al., 2016). Teachers need to be technology, pedagogy, and content-knowledge competent in order to handle this changing environment (Koehler & Mishra, 2008). Each of the elements of the AI-TPACK framework will be further explained in the

sections that follow, along with their interactions with one another, which will serve as the second theoretical basis for this research.

1) Content Knowledge

Content knowledge refers to teachers' understanding of the subject matter that they teach and represents one of the elements of the use or nonuse of technology in instruction. Teachers' understanding on instructional and learning processes constitutes pedagogical knowledge (Koehler & Mishra, 2009). Teachers' technological knowledge includes the skills of the use of different hardware and software and systems, and their capacity of keeping up to date with modern technology (Hava et al., 2024).

In this research on high school teachers' use of generative AI, according to this theory, it is crucial for teachers to master the content they teach as this mastery influences their ability to effectively integrate technology into their instructional practices (Shulman, 1986). Furthermore, how teachers could use AI tools to enhance their curriculum development and teaching strategies depends, in part, on how content knowledge shapes the unique ways of thinking specific to each area (Mishra & Koehler, 2006).

2) Pedagogical Knowledge

Pedagogical knowledge includes pedagogical process, methodologies and practices which involve formulation of instructional plans, selection of teaching methods, classroom management, assessment of student behaviour, academic performance, etc. (Ning et al., 2024). It is the 'domain of the general purpose' knowledge that is unique to teaching. As such, it is the set of competencies that teachers should be able to develop to deliver the teaching and learning activities in the manner that is devised to bring about intended learning outcomes (Darling-Hammond et al., 2017). This includes, but is not limited to, a knowledge of classroom management strategies, student motivation, lesson planning and a means of assessing learning (Hattie & Timperley, 2007). In addition, pedagogical knowledge can be interpreted as knowledge of various teaching methods. It is knowing how to order activities so students build knowledge constructively (Schmidt et al., 2009).

Within the context of this research, the pedagogical knowledge, which educators possess for the use of generative AI in teaching, is key to how and to what extent they integrate generative AI in their teaching. When teachers are using AI tools in the classroom they need to adjust their classroom management approach to help students discuss AI generated material and appropriate use of the technology (Zawacki-Richter et al., 2019). Additionally, knowing how we can capitalize on generative AI to increase student motivation and engagement is essential since generative AI can enable personalized learning experiences that speak to students' interests (Kizilcec et al., 2020).

3) Technological Knowledge

This knowledge implies that teachers must know and utilize these available AI tools. It includes understanding and being familiar with physical and visible forms of AI platforms, tools, products, and learning materials (Yurdakul et al., 2012; Zawacki-Richter et al., 2019; Ning et al., 2024). The technological knowledge includes the capacity to learn and integrate the new technologies, which is particularly important with regard to the generative AI integration into education. Because of the rapid progress in AI tools and platforms, technological knowledge is an ongoing endeavor—as a reflection of the changing technology (Celik, 2022).

Furthermore, technological knowledge refers to the adoption of a pedagogical strategy of using AI in the learning environments, such as encouraging AI literacy (Chai et al., 2010). This research aims to explore the current state of AI literacy among teachers, exploring their perceptions, experiences, and the challenges they face in effectively integrating generative AI into teaching. In the context of this research, by investigating teacher's AI-technological knowledge, from here it will actually be possible to confirm how literate the teachers are of using and integrating AI into teaching.

4) Pedagogical Content Knowledge

Pedagogical content knowledge reflects Shulman's (1986) claim that effective teaching does not end with just a unique understanding of material and pedagogy. Pedagogical content knowledge also recognises that different subjects lend themselves to different types of teaching (Mishra & Koehler, 2006). For example, if a foreign language instructor teaches speaking skills, he or she must use student centered activities in which students undertake real world, authentic communication tasks. In comparison, a lecture using a teacher centered method could be used to help an art professor explain and demonstrate how to interact with art in a graduate level art appreciation class (Harris & Hofer, 2011). In this sense, pedagogical content knowledge is understood to mean a deep understanding of the special relationship between content and pedagogy, rather than expert subject matter knowledge or general pedagogical principles (Schmidt et al., 2009).

Therefore, pedagogical content knowledge goes beyond mere content expertise or typical pedagogical guidelines to encompass a deep understanding of the complex combination of content and pedagogy, which is an essential feature of any teacher's work as they configure generative AI into their instructional routines (Ning et al., 2024). This research will explore how teachers create and use their pedagogical content knowledge to teach with AI, and how it relates to the complexities of teaching with technology and the necessities of educators to support a robust learning environment.

5) AI-Technological Content Knowledge

Based on this knowledge, teachers use AI to equip learners with extremely interactive and immersive learning experiences at the appropriate level of knowledge, cognitive state, and learning preferences (Baser et al., 2016; Lin et al., 2013). In this research, the use of generative AI within educational settings allows educators to tailor their instructional approaches to address the many varied needs of the students (Muyani et al., 2025).

Additionally, AI technological content knowledge is knowledge regarding the connection between AI and the content being taught, for example, the relationship of AI with the content being taught in an AI course (Yue et al., 2024). Knowing this is important to teachers as they navigate the complexities around how to bring AI into their curriculum and take advantage of these technologies in order to increase the instructional effectiveness, as well improve student outcomes (Darling-Hammond et al., 2017). This research is to explore the degree to which teachers are AI literate and to determine how educators are prepared to employ AI tools to infuse teaching and support student learning.

6) AI-Technological Pedagogical Knowledge

An essential aspect is having a dynamic understanding of how the use of AI-technological pedagogical knowledge transforms the teaching and learning processes (Angeli & Valanides, 2008). This understanding includes recognizing the mutual support, provisioning, and constraints between AI technologies and pedagogy, as well as being able to design effective teaching strategies and activities accordingly (Ning et al., 2024). Additionally, technological pedagogical knowledge in this context refers to understanding how AI technologies can support successful teaching and learning tactics, like customizing instruction through AI-based adaptive learning systems (Yue et al., 2024).

Continuing from dynamic understanding of AI technological pedagogical knowledge, it is essential for the educator's AI literacy in order to navigate the complexity of AI integration into their teaching (Zawacki Richter et al., 2019). Teachers using AI tools become familiar with these tools as they begin to use them, and can serve the diverse needs of students in a more engaging and personalized learning environment (Kizilcec et al., 2013). Not only does this increase student motivation, but it also encourages deeper learning, as educators can use AI to give real time, real feedback, real support (Darling-Hammond et al., 2017). Moreover, educators must have an understanding of the ethical consequences of using the AI in education so that among other things ensure that use of such technologies highlight equity and inclusiveness in class (Igbokwe, 2024), which is also one of the roles of AI literacy.

7) AI-Technological and Pedagogical Knowledge

Last but not least is AI-technological and pedagogical knowledge itself or commonly abbreviated as AI-TPACK. Specific expertise about using AI technologies into subject-specific training is included in AI-TPACK. This knowledge includes the ability to use AI technologies to creatively apply pedagogical skills in teaching, to address the difficulties students face when learning concepts, and to either develop new epistemologies or strengthen preexisting ones based on well-established foundations (Lee et al., 2010; Ning et al., 2024; Voogt et al., 2013). This knowledge will be further explored since research seeks to understand how much AI literacy teachers have and how well they are prepared to use their AI-TPACK to use AI in their own instructional practices in ways that will better enable student learning outcomes.

In recent years, Technological Pedagogical Content Knowledge (TPACK) studies have been demonstrated to be important in improving primary mathematics education. A systematic review of the scholarship on the growth of TPACK between 2005 and 2022 demonstrated part of a gap in the literature as it pertains to the application of TPACK in primary mathematics, an area which would benefit from additional focused investigations (Ozden et al., 2024). Secondly, the studies were mostly quantitative and focused mostly on professional development programs designed to increase teachers' integration of technology. For example, case studies have shown how adaptive diagnostic assessments can be successfully embedded into mathematics teaching at the level of TPACK's real classroom application (Polly & Hannafin, 2011).

Moreover, the concept of AI-TPACK (Artificial Intelligence Technological Pedagogical Content Knowledge) has been increasingly discussed in educational research. New studies reveal a strong positive correlation between traditional TPACK and AI-TPACK components, meaning teachers who build good TPACK skills are predicted to do the same for good AI-TPACK skills (Celik, 2023). Many pre-service teachers are not yet ready to effectively use AI-based technologies; therefore, their training, support, and content preparation for learning with AI tools are needed (Forero-Corba & Bennisar, 2024).

The AI-TPACK framework consists of five fundamental components: Six frameworks that aligned with the frameworks developed in the previous study were identified as AI-Technological Knowledge (AI-TK), AI-Technological Pedagogical Content Knowledge (AI-TCK), AI-Technological Pedagogical Knowledge (AI-TPK), Ethics, and Digital Proficiency. Studies show that teachers' digital competence significantly affects their AI-TPACK competencies; teachers with a higher comfort with technology are likely to employ AI into teaching more, which – with the help of AI – will allow teachers to spend

more time teaching and less time with administrative and content related tasks (Ning et al., 2024).

The AI-TPACK framework underscores the importance for teachers to develop both AI literacy and digital proficiency and reform of teacher education programs to systematically bring AI and TPACK frameworks into larger education discussions. The presence of AI tools is starting to rise in education and it will therefore be imperative to tackle ethical concerns, and to upskill teachers with their ability to adopt the use of AI in education, in order to provide equitable learning environments (Forero-Corba & Bannasar, 2024). Together, these findings highlight the need to equip educators with both TPACK and AI-TPACK to excel in the increasingly technical face of today's teaching environments as technology continues to evolve in the educational practice. (Ding et al., 2024; Seth, 2024).

CHAPTER III

RESEARCH METHODOLOGY

Discussions relating to methodology of this thesis research is discussed in this chapter. It has a research paradigm and research approach: the research context, research subject, ethical considerations, data collection techniques, and data analysis techniques. Firstly, it begins with the qualitative study as the research approach, then discusses case study as the research design. Additionally, there are brief explanations of the research context, research subject, and ethical considerations. There are descriptions of how data are going to be collected for the process of doing preliminary questionnaire as a baseline data, structured observation, semi-structured interviews, and focus group discussion (FGD). Also, a reflexive thematic analysis was applied in analysing the data.

3.1 Research Paradigm and Research Approach

The interpretivism paradigm is used in this study to understand how high school teachers perceive, use and overcome challenges when using generative AI. This approach was chosen because interpretivism highlights that individual, subjective experiences and realities matter in understanding a phenomenon (Turin et al., 2024). This paradigm is consistent with Ryan (2018)'s assertion that reality is subjective and focus to what people mean, which in this case, how generative AI is used. To understand the in-depth of teachers' experiences, the data were collected from interviews and Focus Group Discussions (FGDs). Due to the highly context dependent nature of interpretation, this study took place at one school with specific and unique teacher characteristics, where use of generative AI produced a rich, and contextual understanding.

As noted by Creswell (2019), research approach is a clear and detailed plan of the entire process of conducting a research. This research aims to analyze the high school teachers' AI literacy in terms of their perceptive, practical, and challenging aspects. This thesis research used qualitative methodology. Qualitative methodology seeks to provide detailed accounts of people's points of view, interpretations, or feelings about events or objects (Fossey et al., 2002; Lim, 2025). This is more of an exploratory approach that tries to gain an understanding of the depth of a problem and is achieved through data collected by interviews, or analysis of documents (Lim, 2025; Merriam & Tisdell, 2015; Moser & Korstjens, 2017).

3.2 Research Design

The thesis research employed for this research will be a case study, with an exploration of the highschool teachers AI literacy, in terms of perceptions, utilizations, and challenges within the context of using generative AI in their work. First, this thesis research selects the case study design because using the design provides the opportunity to examine a case in depth in the actual setting of a specific case. Case study answer descriptive questions: 'What happened?'. Lastly, there are explanatory questions, or ones of the form, 'how' or 'why' did something happen? (Yin, 2008). Creswell & Creswell (2017) also states that case study allows a deep analysis of a 'case,' which is often a program, activity, procedure, one or more people or an event. The participants in this case are as a 'window' into knowing how the AI literacies relate in context (Stake, 1995). Additionally, this thesis research will draw from each teacher's personal experience which will comprise many factors, such as their knowledge and experiences, which may be different. The result will certainly produce unique and varied findings as the subjects of interest in education and social service are individuals and programs, which are unique and yet have commonalities (Stake, 1995).

3.3 Research Subject and Research Context

The participants of this study were chosen purposively. Purposeful sampling is an approach to sample information rich cases, to maximize the efficient use of limited resources within the purview of a qualitative research technique (Patton, 2014). It is defining and finding a group of people or individuals who are particularly familiar with, or knowledgeable about, a phenomenon of interest (Creswell & Creswell, 2017). The purpose of qualitative methodology is to achieve depth of understanding (Patton, 2014), the ability to communicate experience and views in an articulate, expressive, reflective manner is required; but the participants should be available and willing to participate as pointed out by Spradley (2016) and Bernard (2017).

Based on this condition, the participants of this thesis research will be high school teachers currently teaching in one private school located in Bogor, West Java Province, Indonesia. This particular school is chosen due to its unique aspects such as the existence of AI use in their curriculum canal website dedicated to the teachers and the curriculum developer team which indirectly shows the school's adaptability of technological advancement (Kanal Kurikulum, n.d.).

The participants in this research consisted of four high school teachers who were purposively selected based on the results of initial mapping through a questionnaire related

to the level of AI literacy. Diversity by age, subject and duration of teaching experience were taken into account in making the selection in order to have a multiplicity of views that would reflect the circumstances of the research. In more detail, participant selection also considered variations in the developmental stage of the teaching career, classified according to the framework of Graham et al. (2020), namely: novice (0-3 years), early intermediate (4-5 years), and experienced (>5 years) teachers. This framework was adopted to guarantee the inclusion of a wide range of professional experiences in the study of the dynamics of AI use.

Moreover, the four primary respondents chosen (focal teachers) to be part of the semi-structured interview and Focus Group Discussion (FGD) in this case study research were identified using the purposive sampling method with the layering approach to breadth and depth of data. To start with, an initial selection was carried out on the principle of a maximum variation sampling technique of the existing demographic data. The primary factor deliberated was, to obtain variety of opinions, by choosing the teacher who had different background in terms of subjects taught (ICT, Language and Mathematics), teaching experience (senior teachers >5 years and more junior teachers 0-3 years) and gender.

Second criteria of selection were subject to an examination of the preliminary questionnaire outcomes. The final group of teachers identified was those whose marks in the questionnaire indicated a relatively high degree of attention and thinking about AI problems in the educational sphere. They were more inclined to give detailed answers to open-ended questions and have a sufficient level of self-efficacy on a scale of AI competency. The basis of this stratified selection criterion is to be able to provide that the participants that are examined in great depth and details using the tools of qualitative research are information-rich individuals. This research objective reflects on the existing level of awareness and familiarity with AI, which now in line with the objectives of the research questions and means that this research will have direct access to the nuances of the perception, more complicated usage practices, and more profound dilemmas. Additionally, coordination with the school was also conducted in order to mark their availabilities and to match with their schedules during the data collection.

Lastly, although the number of participants was relatively small, this is a valid practice in qualitative case studies, where depth of data is favored over quantity (Merriam & Tisdell, 2015; Patton, 2015). Case studies do not need very many participants because its priority is the richness of the descriptions, contextuality, and elaboration of the findings (Yin, 2014).

3.4 Data Collection

The data collection in this study aimed to address three main objectives: understanding and perceptions of teachers; their utilizations, and the challenges they face upon utilizing generative AI to assist their teaching. Therefore, to obtain these objectives, the study will use several methods such as: preliminary questionnaire, focus group discussion (FGD), structured observation, and semi-structured interview.

The four participants provided an in-depth understanding of how teachers perceived, used, and struggled when it comes to using generative AI in their practice by making use of data triangulation methodologies using preliminary questionnaire, structured observation, semi-structured interviews, and focus group discussions (FGDs). Preliminary questionnaire, observations were used, followed by interviews, and finally FGDs- confirm sequence of data collection that employs sequential triangulation, which increases the validity of the data exploration process (Creswell & Poth, 2007; Shenton, 2004). The following explains more about it:

3.4.1 Preliminary Questionnaire

The data collection procedure in this thesis research was first conducted through survey as an initial data to map the extent on the teacher's AI literacy descriptively. The preliminary questionnaire used in this research does not function as a data collection or generalization tool like scientific experiments operate, as it only collected fundamental informations about participant experiences, and AI familiarity ahead of subsequent data collection approaches. Timeline wise, the process to collect the data for preliminary questionnaire was a month in total, starting from February until March 2025.

Information about participants, including demographic information, professional background and experiences, participants' knowledge and utilization of AI and their familiarity with the features or components of AI were collected through this questionnaire. It is essential because from the information collected, it enabled the researcher to purposively select participants who fit this thesis research's purposes. The questionnaire also gave preliminary insight into participants' literacy level upon AI to help formulate subsequent data collection approaches. Noteworthy that the questionnaires were conducted online through Google Form.

Moreover, the scale used on the preliminary questionnaire in this research is teacher AI competency scale (TAICS) by Chiu et al. (2024). The authors adopted Falloon (2020)'s digital competence framework for teachers to develop their proposed framework for AI competence in educators. The authors incorporate five components from UNESCO's (2024) draft K-12 teacher AI competence framework that correspond to aspects within the TAICS

scale. The framework developers wanted to build a simplified model because the already established models proved too complicated for K-12 teaching environments (Chiu et al., 2024). Additionally, the preliminary questionnaire also contained several open-ended questions, the rationale for which was that there were some aspects that were not covered by the TAICS scale alone. Some additional open-ended questions included asking teachers about their knowledge of AI in general and generative AI, the challenges they face when using generative AI, and asking for their opinions on what is needed to make the use of AI in learning more effective. These are things that have not been covered in the TAICS scale.

In addition, the preliminary questionnaire in this thesis research consists of 27 items, using a 5-point Likert scale. The Likert 5 points scale was used as it accords with the response format used in the creation and validation of the original TAICS scale by Chiu et al. (2024) on which this questionnaire is based. Methodological continuity is afforded by the use of the same scale as does the possibility for comparison (although it is not the main purpose of a qualitative study). Secondly, the 5 point scale was considered to strike a good balance between making participation easy for respondents to provide answers (Croasmun, 2011), capturing enough variation of teachers' perceptions or self efficacy, and also providing on neutral option for those who may initially not have a strong position in favour or against a statement.

As for the relevance with the the AI literacy framework presented by Long & Magerko (2020), this framework provides essential knowledge that focuses on teaching staff understanding of AI concepts alongside the interpretation of AI societal effects and ethical perspectives. This theoretic framework acts as the foundation for this thesis research to properly map teachers' AI understanding at the starting level. AI literacy assessments in the preliminary questionnaire is incorporated to accurately evaluate fundamental comprehension and perception before addressing particular facets of AI competency. Second, The AI-TPACK framework extends TPACK to include distinct knowledge and skills about artificial intelligence while exploring tech-pedagogical-content knowledge applications for AI contexts. The framework provides essential understanding about teacher adoption of AI tools through their teaching methods and their ability to maximize AI potential within educational settings. The preliminary questionnaire which uses AI-TPACK terminology enables the research to map teachers' confidence about AI-assisted pedagogical enhancement and student learning achievement. Noteworthy that though TAICS is not particular to generative AI (the focus of this thesis research), the dimensions of competence measured, like 'AI knowledge', 'AI pedagogy' and 'AI ethics', are wide enough to give some preliminary perspectives about how teachers think about their ability in interacting with different kinds of AI, including newer and more specific like generative AI.

3.4.2 Structured Observation

According to an article by Wilson & Streatfield (1981), structured observation is one research method that places an observer in a social setting that observes all activities decided the focus as the research. This method is one of research strategies for understand how high school teachers use generative AI and it has the observer asking teachers to show how they usually use the technology for different purposes, including teaching related purposes. The 'structure' of this structured observation is decided by the purpose of research which in this case is to understand what teachers with generative AI do.

The observer (which is the researcher, in this case) essentially observe teachers who are interacting with generative AI, also similar to Wilson & Streatfield (1981)'s observation of people in their everyday work role, like talking, and conducting information seeking or information production. The structured observation approach is well suited to generating basic information about how, when and why information is used in a given organization or setting which in this thesis research's context can produce rich information regarding teacher use of generative AI. This strategy was selected to gain real-life facts about the use of AI that cannot be limited to verbal descriptions. Noteworthy that this structured observation was held on April 14th 2025, prior to the semi-structured interview. The session lasted equivalent to 1/3 of the class period for each teachers, this is due to the time split between the structured observation and the semi-structured interview at one session in a day (particularly in one class period).

The things observed by the researcher in this thesis research were directly observable, which required the selected teachers to do demonstrations including the selection of generative AI tools used by teachers, the prompting process, the use of generative AI, and the teacher's interaction with the generative AI tools used, as well as how teachers evaluate the output generated by generative AI. The observations in this thesis research are based on the framework proposed by Kong & Yang (2024). The use of Kong & Yang's framework is justified on the condition that the framework puts teachers in an active position, not only merely using technology, but also in a position of being involved in the process of creating, together with AI. Within this framework, it recognizes prompting as a pedagogical skill rather than just technical which involves creativity and context.

Further, AI output is also looked to be critically evaluated by teachers which is also being considered as an important aspect of critical literacy. This framework draws on a human centered, practice based approach to offer a firm and rich theoretical starting point for the analysis of teachers' (learned) practices in using generative AI to reflect upon and make meaningful sense in the context of teaching. The Kong & Yang (2024)'s framework is

still aligned with the Long & Magerko (2020). They are similar in that they both stress the competencies of interaction, prompting and evaluating AI and then AI literacy in both technical and critical forms. Moreover, this framework also further confirms with AI-TPACK (Ning et al., 2024) by more concretely showing AI usage practices as the integration of technology, pedagogy and content knowledge for teachers' AI usage practices. The Long & Magerko (2020) AI Literacy Framework aligns with both frames, in that they focus on the competencies of interacting with, prompting and evaluating AI as well as technical and critical aspects of AI literacy. Furthermore, this framework strengthens AI-TPACK (Ning et al., 2024), as AI usage practices are seen as the integration of technology, pedagogy and content.

3.4.3 Semi-Structured Interview

The interview in this thesis research was conducted on 14th April 2025 after the semi-structured observation with the total duration equivalent to one class period long for each teacher with a concise interview towards four selected teachers. A triangulation methodology approach was used to achieve maximum richness and depth of the study data. The separate interview sessions were created to investigate the personal views and experiences of every participating teacher. The researcher is aware that this length can create certain conditions to miss some points, and so this study was preconditioned with a Focus Group Discussion (FGD) the next day. This FGD had two strategic goals: the first one was to undertake a follow-up confirmation of some of the findings that were identified through the interviews, and the second was to investigate group dynamics and collective perceptions that were not captured in the individual sessions like how the teachers collectively overcame the challenges and the strategies of using AI.

While collecting the data, the researcher used semi structured interviews to dig deep on the answer of the research issues (Flick, 2022). Semi structured interview is a way for respondents to articulate their thoughts and more information (Creswell & Guetterman, 2018). In order to gain deeper insight of participants' perception, their practice upon utilizing generative AI, and the difficulties they face in using generative AI for their teaching, the researcher did semi-structured interviews with participants who were interviewed one person at one time by the researcher, asking questions and recording the answers from each study participants (Creswell, 2019). These interviews were done to give participants the opportunity to reflect on their experiences, and contribute rich, and in depth narratives that complement the preliminary questionnaire data.

Moreover, the semi-structured interview questions contained 13 questions, in which

each of them were carefully designed to maximally obtain the teachers' views, utilizations, and challenges they face in using generative AI for teaching. Some of the questions were derived from previous studies, some were referred from the theoretical lenses used in this thesis research. Lastly, in order to be exploratory in approach this case study also provided some open-ended questions which were inductive. These were not developed on priori assumptions of a hypothesis, but were intended to pick up unique, emergent themes and unexpected perspectives in the literal narrations of the participants themselves. Details of the questions can be seen in the appendix section (see Appendix 2).

3.4.4 Focus Group Discussion

When conducting a focus group discussion, there are several steps applied to get nuanced insights. To begin with, the researcher drafted specific objectives in order to direct formulation of relevant questions (Krueger & Casey, 2014). To achieve a purposeful sampling of participants, the researcher will select participants to represent diverse perspectives (Morgan, 1998). Preparations by the researcher were made through open ended and structured questions to spark discussions (Patton, 2014). In Focus Group Discussion (FGD), moderating a conversation is important, as a skilled moderator will be able to move the conversation along and allow all parties their voice (Vaughn et al., 1996). Additionally, as an information, the researcher took the role to be the moderator in this FGD.

The participants in the FGD in this thesis research were the same number as the interview participants, namely 4 people. The selection of these 4 participants was not only because of the reason of following the interview participants, but also, previous studies discussed that in bigger groups it is likely that some of the participants will have to stay silent or will have to talk very little, while the smaller groups (say 4 up to 8 participants) often create an environment when all of the participants are playing an active part in a discussion. In smaller groups, there is more room for everyone to participate in the discussion, to talk, and explore the themes in detail to achieve interesting and relevant data (Brannen et al., 2002, as cited in Smithson, 2007).

The session began by introducing the purpose of discussion and read out the FGD rules (Sutrop & Lõuk, 2020). In addition, participants gave their consent for discussion to be recorded with detailed notes added. Finally, the data were transcribed and analyzed using key themes and insights that come out from the transcription (Braun & Clarke, 2006; Patton, 2014). Moreover, the FGD in this thesis research was conducted with the focus to create a discussion untuk to explore participants' views, experiences, and perceptions on an issue in more depth (Krueger & Casey, 2014), regarding perceptions, challenges, and teachers'

future expectations on generative AI especially in the realms of teaching with the total of 11 questions, which was conducted on April 15th 2025, equivalent to 2/3 one class period. The FGD guidance that guided the researcher can be further accessed on the Appendix 3 part.

3.5 Data Analysis

Data analysis was started with structuring the large amount of information acquired. It was done through two tasks: transcribing spoken or written words to a typed file and deciding whether to parse through data by hand or with some software (Creswell, 2019). Additionally, this thesis research applied reflexive thematic analysis in analysis of the data by utilizing Quirkos application. As stated by Braun & Clarke (2019), six stages of the reflexive thematic analysis were applied which consist of identification with the dataset, coding, yielding foundational themes, developing and refining, defining and naming of themes and writing up.

3.6 Upholding the Trustworthiness

The concept of trustworthiness is the source of rigor and quality of the findings of this thesis research. This will make the findings of the research progressive, stable and well based as the reality of the participants. An attempt to achieve trustworthiness within the context of the current research was done by the use of four broad criteria as stated by Lincoln et al. (1985): credibility, transferability, dependability and confirmability.

3.6.1 Credibility

Credibility attempts to make certain that the interpretation given is a true indication of the acted reality that the participants were experiencing (Lincoln et al., 1985; Morgan, 2024). This thesis research used a number of strategies in order to achieve this. The primary method was triangulation of methods, in which the data was not collected based on the single source only, but rather from the multiple sources (semi-structured interviews, focus group discussions (FGDs), structured observations (demonstration sessions) and preliminary questionnaires). The triangulation of data allowed for better and more comprehensive data to be constructed on, comparing, and contrasting various sources of data (Morgan, 2024). Moreover, the long-term work with the data in the context of the intensive analysis helped the researcher to get to know the specifics and intricacies of the teachers' views more precisely.

In addition, this thesis research also involved its participants in the validation of finding (or known as member checking). This has been undertaken in order to make the

interpretations true to teachers' backgrounds and thoughts, to increase the validity and credibility of findings (Candela, 2019). The teachers received their individual transcripts of the semi-structured interviews and FGDs through text message in a docx format which requested the participants to go and check through their transcripts during May 2025. All the four participants gave feedbacks and these participants already approved the accuracy of their transcriptions.

3.6.2 Transferability

In the qualitative context, this implies that these findings are not applicable to all school settings. Instead, the objective would be to leave readers with enough information that will enable them arrive at their own judgement, about how much of the findings can be applicable or how much of it can be transferred to their own situations (Shenton, 2004). To accomplish this, this thesis research offers a thick and rich description of the case under research: the particular setting of the private school in the city of Bogor, the variety of the characteristics of the subjects taught by the teachers (according to subject, gender and teaching experience), and the findings of the research outcomes backed by plenty of direct quotations of the studied participants. With this contextual information, readers may sensibly judge applicability of these findings in other situations.

3.6.3 Dependability

The preference to reliability is dependability (Lincoln et al., 1985). In dependability, the objective is that in case a second researcher considers the research process, she or he will be in a position to comprehend the chain of logic followed in data collection to conclusion (Shenton, 2004). Dependability was also pursued in this thesis by discussing the research design, the process of selecting participants, procedures to conduct interviews and FGD, and the way in which the data were analytically processed thematically (for instance: through the use of the Quirkos software) as what Shenton (2004) mentions. Therefore, the research process becomes as transparent as possible in order to allow following the flow of findings and comprehending it.

3.6.4 Confirmability

Confirmability is the corresponding concern of a qualitative investigator to objectivity. In this, steps should be taken to do what can be done to be as sure as possible that the findings are those formed by the experiences and ideas of the informants, and not by the interests and preferences of the researcher (Cope, 2014; Shenton, 2004). In the findings

chapter, every theme and argument is accompanied by direct quotes of the participants (FGDs and interviews). Being able to give the voice of those involved a chance to be heard well, this presented thesis research makes an attempt at the reality of the participants to be represented adequately enough through the conclusions.

3.7 Ethical Considerations

Due to ensuring participants learn the purpose of this research in detail, a formal informed consent procedure was meticulously conducted, based on Human Research Protection Program (HRRP, 2024). All participants that were involved have already gave their consent with the view that the participation is voluntary beforehand, and their anonymity by using pseudonyms or codes (Sutrop & Lõuk, 2020). Details about the formal informed consent form can be seen on [Appendix 4](#). Moreover, rigorous security protocols were used to handle the collected data and strict storage regulations were put in place to reduce data access to only the researcher. Further, researcher ensured all the participants have the right to volunteer in the research and be free to withdraw any time without causing any harm (Dahal, 2024). In addition, since this research used an adapted questionnaire, an informed consent to use the scale was conducted through email to the corresponding author of the scale developer. Lastly, the researcher had already make sure that during the data collection process did not disturb their teaching activity by coordinating with the respective teachers in each subjects, and also the school coordinator.

Additionally, in describing positionality, the researcher was initially an intern at the school for several weeks. Thanks to this experience, the researcher finally got to know the environment, and had the opportunity to establish connections with the school until now. The positionality of the researcher here creates both unique opportunities and perspectives. Despite the familiarity with the environment, however, the time the researcher spent there was not long enough to know the environment there in detail. On the other hand, distant detachment allows the researcher to cast an objective eye and conduct objective, critical, balanced analysis from the outside in, without moving inside the scene being studied (Creswell & Poth, 2007). Despite of this situation, the researcher tried to develop rapport and was genuinely interested in the participant's experiences. Lastly, cultural sensitivity is of paramount importance since it means that when conducting a research in an educational context that it has to be done ethically and respectfully by respecting the norms and values of the educational context (O'Neill, 2024).

CHAPTER IV

FINDINGS AND DISCUSSION

This thesis research's results from the data collection process about the high school teachers' AI literacy which encompass perceptions, utilizations of AI, generative AI particularly, and challenges will be discussed thoroughly with previous studies and also the main theoretical frameworks that stemmed as the 'main lenses' in this thesis research. Consequently, it will be divided into three parts. The first part of this chapter will discuss about the high school teachers' perception about AI — generative AI to be specific, which encompass their response or attitude towards AI, their view of AI, knowledge of AI tools trends, their future expectations of AI, and their suggestions about future AI development to answer the first research question: *How do high school teachers perceive generative AI in its use for teaching?* The second part will explore the high school teachers' AI utilization— mainly generative AI for teaching and learning purposes, assessment and feedback, experimentation and explorations, last but not least AI use for administrative tasks with the second research question: *How do high school teachers utilize generative AI in its use for teaching?* Finally, the third part of this chapter will explain and demonstrate the obstacles faced by high school teachers in using AI, especially their ability to critically evaluate and overcome the challenges or risks associated with using AI for teaching or learning purposes to answer the third research question: *What challenges do high school teachers face when using generative AI for teaching?*

Moreover, this thesis research employed a case study with purposively selected participants who were active high school teachers, totaling 4 teachers from a private school in Bogor Regency, Indonesia. Data collection in this thesis research was collected through several methods in the following order: 1) preliminary questionnaire with the total of 20 teachers participated; 2) structured observation with the same 4 teachers from the semi-structured interview where they demonstrated how they use AI/generative AI briefly; 3) semi-structured interview with 4 teachers selected from the preliminary questionnaire results; and 4) Focus Group Discussion (FGD) with the same 4 teachers from the semi-structured interview. After a thorough negotiation and coordination, the time that was agreed upon with the school to conduct the structured observation and semi-structured interviews with the teachers was a maximum of 45 minutes so that it did not interfere their teaching schedules. Meanwhile, the time agreed with the school for the FGD was a maximum of 75 minutes which also aimed not to interfere with their teaching schedules.

4.1 Research Findings

4.1.1 An Initial Overview: Overall Preliminary Questionnaire Results

Prior to the discussion of the main findings, this part includes a descriptive analysis of the AI self-efficacy tendencies of the participants to outline results of the preliminary questionnaire. Adapted from Chiu et al. (2024), it was conducted to 20 teachers which is the total number of the high school teachers in this school. It is used as a preliminary mapping about the context, demographics, perceptions, and overall level of teachers' efficacy, as well as challenges faced on using generative AI. In detail, Table 4.1 shows the teachers' demographic profile.

Table 4.1 Demographic Data Details of 20 High School Teachers Participated in This Research

| Demographic Characteristics | Classifications | Amount (in percentage) |
|-----------------------------|------------------|------------------------|
| Gender | Male | 60% |
| | Female | 20% |
| Age | 26-34 Years Old | 20% |
| | 35-43 Years Old | 20% |
| | 44-53 Years Old | 60% |
| Teaching Experience | 0-3 Years | 30% |
| | 4-5 Years | 0% |
| | > 5 Years | 70% |
| Subject cluster | Language | 15% |
| | Arts and Culture | 10% |
| | Social Studies | 15% |
| | Mathematics | 15% |
| | Science | 15% |
| | Computer (ICT) | 5% |
| | Religion | 25% |

20 high school teachers were asked to fill in the preliminary questionnaire, offering a general depiction of the situation of the case in study. The gender distribution is also skewed towards the male side with a larger proportion of the male gender than the female genre. Regarding age, most respondents are located in the older age (44-53 years old) whilst the proportions of respondents in the younger and middle-age age groups are also equal.

The teaching experience is also heavily skewed towards the experienced teachers most of them with over five years of experience, and a relatively small portion are new in

teaching. It is notable that there are completely no mid-experience (4-5 years) participants. In case of subject cluster, Religion is well represented, thereafter a balanced cluster of Language, Social Studies, Mathematics, and Science. The lowest representation is of Arts and Culture and, Computer (ICT). Table 4.2 below details the results of the Preliminary questionnaire from the Close-ended questions.

Table 4.2 Detailed Response from Twenty Teachers in The Preliminary Questionnaire

| Items | Teachers' Responses | | | | |
|---|---------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| I can distinguish whether a tool is AI-based or not. | 0% | 5.3% | 26.3% | 47.4% | 21.1% |
| I can use AI to create learning content, such as learning materials or presentations. | 5.3% | 5.3% | 10.5% | 47.4% | 31.6% |
| I can explain what AI is. | 0% | 15.8% | 21.1% | 42.1% | 21.1% |
| I understand how to choose the right AI-based tools so that tasks can be completed effectively. | 5.3% | 5.3% | 26.3% | 42.1% | 21.1% |
| I can choose AI tools to use in the classroom that can help improve what I teach, the way I teach, and what students learn. | 5.3% | 5.3% | 26.3% | 42.1% | 21.1% |
| I can teach by combining subject matter, AI tools, and the right way to teach. | 5.3% | 10.5% | 31.6% | 42.1% | 10.5% |
| I can help others to manage the use of lesson materials, AI tools, and how to teach. | 10.5% | 5.3% | 36.8% | 42.1% | 5.3% |
| I can use AI tools to support assessment in learning. | 5.3% | 5.3% | 36.8% | 47.4% | 5.3% |
| I can design assessment methods to improve student learning in an AI-based environment (e.g., learning with ChatGPT). | 10.5% | 10.5% | 31.6% | 42.1% | 5.3% |
| I can assess student learning in an AI-based environment. | 10.5% | 0% | 52.6% | 36.8% | 0% |
| I can choose AI tools to encourage students' self-assessment. | 10.5% | 10.5% | 26.3% | 42.1% | 10.5% |
| I can ensure my health and well-being when using AI tools. | 5.3% | 5.3% | 21.1% | 47.4% | 21.1% |
| I can teach ethics (the use of AI tools) to students. | 10.5% | 0% | 10.5% | 57.9% | 21.1% |
| I teach students how to use AI tools safely and responsibly. | 5.3% | 0% | 15.8% | 57.9% | 21.1% |

| | | | | | |
|---|------|-------|-------|-------|-------|
| I can protect sensitive content from AI tools (e.g. exams, student grades, and personal data). | 5.3% | 5.3% | 36.8% | 42.1% | 10.5% |
| I can assess the benefits of an AI tool | 0% | 5.3% | 15.8% | 57.9% | 21.1% |
| I can assess the risks of AI tools. | 5.3% | 0% | 36.8% | 47.4% | 10.5% |
| I realize that humans are responsible for bias in AI. | 0% | 5.3% | 26.3% | 31.6% | 36.8% |
| I can explain how AI impacts our society. | 0% | 0% | 26.3% | 47.4% | 26.3% |
| I can search and select various AI tools by using different websites and search strategies. | 5.3% | 10.5% | 15.8% | 57.9% | 10.5% |
| I'm actively looking for professional development activities (related to the use of AI tools) outside of my educational organization. | 0% | 26.3% | 52.6% | 21.1% | 0% |
| I actively share my teaching experience using AI with peers inside and outside my school. | 5.3% | 26.3% | 36.8% | 31.6% | 0% |
| I am excited to help my colleagues/colleagues design learning activities that utilize AI technology. | 5.3% | 26.3% | 36.8% | 31.6% | 0% |

On the most fundamental level, the teachers were very competent. The majority of them believe that they can clarify what AI is—more to the point, they can tell which devices or applications are AI-powered or not. The fact that the two items—*“I can tell if a tool is AI-based or not”* and *“I can explain what AI is”* achieved overwhelmingly positive responses shows that a general awareness and basic conceptual literacy of AI has diffused wide among the teachers. This means that the teachers are already familiar with AI itself.

As the question changed to application and not conceptual knowledge, there was a slight rise in the level of confidence that remained at the highest point among teachers. The teachers expressed an unusually high level of agreement when it came to their excellent skills in using AI to create learning materials, including teaching or presentation materials. The strong consensus at this item indicates that the teachers have found and feel at ease with the most obvious and immediate application value of AI: to be used as an aid in the creation of resources.. This is an indicator of the instrumental perspective of AI—an effective tool to reduce labor costs and create materials fast. This extremely high confidence level on hard specific outcome-oriented work is a crucial point of entry.

Moreover, when the emphasis was changed to using tools to the pedagogical selection of tools, the strong consensus started to diminish on questions like; *“I understand how to choose the right AI-based tools so that tasks can be completed effectively.”* and *“I can choose AI tools to use in the classroom that can help improve what I teach, the way I*

teach, and what students learn.” Whilst most of the teachers continue to share their agreement, the number of teachers who expressed neutrality or disagreement rose considerably. This was one point where broader confidence started to turn to a more refined kind of uncertainty. The teachers are less assured that they can make more complex pedagogical choices that is, selecting the tools to address the right learning outcomes.

The difference between the technical and pedagogical beliefs is most prominent in the final statement, which is the utmost form of representation of teaching expertise: *“I can teach by integrating subject matter, AI tools and the right teaching methods.”* In this case, the most split responses of teachers are obvious. The proportion of those who reported Strongly Agree (SA) has decreased drastically, and those who are inclined toward the neutral and disagree groups have critically increased. This is where an interesting contrast is revealed, since most teachers believe themselves very competent to educate students on ethical, safety and responsible use of AI, but reveal much less confidence in measuring learning outcomes in AI-based settings (assessment). Lastly, there is a tendency that the teachers are indecisive when it comes to professional growth and cooperation. The majority of teachers do not proactively find self-development opportunities concerning AI outside their institutions and do not initiative sharing their experience of doing teaching with AI with their peers.

In a bid to enrich the portrayal presented by the close-ended questions, this analysis will involve addressing new insights presented as per the open-ended questions, which present more details and explanations on what the teachers know regarding generative AI and the issue they experience when working with generative AI in addition to the views based on the way they think learning experiences using AI can be made successful. The questions in this open-ended type consisted of four questions:

- 1) Describing the types of AI in general

Table 4. 3 Overview of Teachers’ Answers Regarding Knowledge of Generative AI

| Item: What are the types of AI that you know? Please briefly describe the known types of AI. | |
|--|------------|
| Frequent Answers (Summarized in Theme) | Percentage |
| 1. Generative AI (for example: ChatGPT, DALL-E) | 50% |
| 2. Narrow AI (task-specific tools like Canva AI, Grammarly) | 30% |
| 3. General/super AI (theoretical concepts only) | 10% |
| 4. Some teachers are unsure or do not know | 10% |

2) Explaining and giving examples of generative AI

Table 4.4 Overview of Teachers' Answers Regarding Knowledge and Examples of Generative AI

| Item: Do you know what Generative AI is? Please briefly explain both the definition and examples of tools from generative AI that you know. | |
|---|------------|
| Frequent Answers (Summarized in Theme) | Percentage |
| 1. AI that creates new contents (like: texts, images, videos) | 20% |
| 2. Directly mentioning the tool name: ChatGPT, DALL-E, Gemini | 70% |
| 3. Some teachers displayed uncertainty | 10% |

3) Mentioning the biggest challenge of using AI tools in teaching

Table 4.5 Overview of Teachers' Answers Regarding Teachers' Challenges in Using AI to Support Teaching

| Item: What is the biggest challenge you face in using AI tools to support teaching? | |
|---|------------|
| Frequent Answers (Summarized in Theme) | Percentage |
| 1. Inadequate AI trainings | 40% |
| 2. Infrastructure limitations (internet, hardware) | 30% |
| 3. Compatibility with the subject | 20% |
| 4. Ethics and data privacy (bias, plagiarism) | 10% |

4) Opinions about teachers' needs to make the use of Ai in teaching and learning more effective

Table 4.6 Overview of Teachers' Answers Regarding Teachers' Needs to Make AI Use in Learning More Effective

| Item: What do you think is needed to make the use of AI in learning more effective? | |
|---|------------|
| Frequent Answers (Summarized in Theme) | Percentage |
| 1. Teacher trainings about AI | 50% |

| | |
|--|-----|
| 2. Infrastructure upgrade (internet, hardware, premium access) | 30% |
| 3. Ethical guidelines and curriculum | 15% |
| 4. AI future improvements | 5% |

The open-ended question result indicates the increasing interest of the teachers in the AI tools, especially such generative AIs like ChatGPT and DALL-E, which many educators utilize to create the content and plan the lessons. Although everyone is now aware of the potential of these tools, knowledge is still an issue since there are teachers who are not able to fully recognize the concept of AI, and ones who simply are not able to implement it in practice. Then, such problems as simple unreliable infrastructure, and even whether or not the field of AI is worth teaching in school are frequent. Furthermore, other ethical factors were listed, such as bias or data privacy, to a lesser extent, which indicates that those are those areas that are not given enough attention until now but should gain it along with the growth in the prevalence of the AI.

Moreover, the teachers focused on the requirements of professional training, additional resources, and instructions to improve the integration of AI. Practical experience with the help of AI would allow the teacher to better operate in them, and better infrastructure would allow solving the problem of accessibility. The policy frameworks are also required to provide ethical practice and the curriculum uniformity. Overall, despite the changes in the trend of teachers adopting AI, structural support remains a fundamental concern that must facilitate the knowledge gap, address logistics challenges, and advance responsible use in various learning environments. Taken together, these results provide a depiction or reality check of how these 20 teachers acknowledge and embrace AI in the school setting. This translates to further discussion in the subsequent section.

4.1.2 Findings on High School Teachers' Perception About Generative AI (RQ 1)

Referring to the first research question on this thesis research is *How do high school teachers perceive generative AI in its use for teaching?* This question is answered based on the major themes and sub-themes appeared that emerged from the preliminary questionnaire results, semi-structured interview transcripts, and FGD transcripts. Themes and sub-themes are based on teachers' knowledge, view, and experiences in using AI for teaching.

In answering the research questions, four teachers were portrayed in focus to give a more detailed, and nuanced perspectives (which they became the focal teachers). This is also applied for the other two research questions as well. Moreover, the demographic data of the

four teachers participated in this thesis research are presented as follows—noteworthy that names of the participants that appeared in this chapter are all in pseudonyms (not their real names).

Table 4.7 Demographic Informations of Four Teachers Participated in Observation, Interview, and FGD. All Names Are Pseudonyms.

| Participants | Gender | Age (years) | Teaching Experience | Subject Taught | Grade Taught |
|--------------|--------|-------------|---------------------|---|--------------|
| Mr. Rafi | Male | 52 | > 5 years | Information and Computer Technology (ICT) | 10, 11, 12 |
| Mr. Ivan | Male | 33 | 0-3 years | Indonesian Language (<i>Bahasa Indonesia</i>) | 10, 12 |
| Mrs. Eny | Female | 51 | > 5 years | English Language | 10, 11, 12 |
| Mr. Mahfud | Male | 27 | 0-3 years | Mathematics | 11, 12 |

The data were analyzed using Braun & Clarke (2019)'s six phase framework for thematic analysis. Four dominant themes were revealed by this approach (see Table xxx for a detailed summary): 1) Generative AI as a potentially transformative technology, 2) Generative AI as a Double-Edged Sword, 3) Generative AI should remain under human control, and 4) Generative AI is an evolving technology. These themes gave rich contextual insights into participants' view, knowledge, and experiences with generative AI tools.

4.1.2.1 Generative AI as a Potentially Transformative Technology

This theme will specifically analyze how views on the significant transformative power of this technology trigger a complex and diverse spectrum of attitudes among teachers at the research location (the private school). It is precisely because of its potentially transformative nature that generative AI is responded differently by teachers. From various data collection methods (preliminary questionnaires, interviews, and FGDs), it was revealed that the perceptions of these educators on the presence and use of generative AI in the teaching context vary greatly. Most of the teachers display great openness towards (and use of) generative AI at work. By open means, the teachers in this private school acknowledge this unstoppable technology. Not only do they solely 'accept' it, but they also embrace the use of generative AI, especially for teaching purposes.

Starting from the results of the preliminary regarding openness attitude, it can be referred to the 'AI Knowledge' dimension, where the items in the scale are:

“I can use AI to create learning content, such as learning materials or presentations.” , and *“I know how to choose the right AI tools to effectively complete a task”*.

In terms of results, 33.3% of the total 20 high school teachers overall answered “strongly agree”, 50% answered “agree”, 11.1% answered “neutral”, and 5.6% answered “disagree”. Similarly, the item on teachers’ understanding to choose the right AI-based tool also showed that the majority of teachers answered “agree” with a percentage of 44.4%, “neutral” 27.8%, “strongly agree” 22.2%, and “disagree” as much as 5.6%.

The percentage of teachers who reported ‘can use AI to create learning content’ and ‘understand how to choose appropriate AI tools’ was high, which can only mean that the majority of teachers have at least some practical experience and engagement with AI. The reported capabilities are hard to achieve without using the technology on a regular day-to-day basis. Significantly, the majority of teachers indicated that they had these competencies, which might imply a general openness (or at least, suggests high willingness) among a broad class of high school teachers to discover and also take in generative AI modern technologies in their expert practice. Despite the fact that these items measure perceived knowledge and skills, rather than attitudes such as openness towards generative AI, however, the levels of capabilities that these indicate most respondents have developed suggest that generative AI is neither thoroughly rejected nor ignored, but that it has been met with significant engagement and on-the-job use.

In addition, the findings from the initial questionnaire hint at the emergence of a critical attitude towards generative AI at high school teaching level. Mostly such a critical perspective is mirrored in their responses to items regarding the balanced evaluation of AI (which includes benefits and risks), especially concerning their capability of evaluating various aspects of AI tools. This is well-depicted in the ‘Human-Centered Education’ dimension, especially on the items:

“I can assess the benefits of an AI tool.” , and *“I can assess the risks of an AI tool”*.

In terms of results, 61.1% of the total 20 high school teachers overall answered “agree”, 22.2% answered “strongly agree”, and 16.7% answered “neutral”. This means that majority of teachers believe that they have the capacity to determine and evaluate the strengths and possibility available with the diverse AI tools.

On the other hand, the item on teachers' understanding to assess the risks of an AI tool also showed that the majority of teachers answered "agree" with a percentage of 50%, "neutral" 38.9%, and "strongly agree" 11.1%. Out of all the teachers, 38.9% were 'neutral' about their ability to assess the risks, but the fact that more than half (55.3%) thought they could assess the risks of AI tools is an important indication. The findings from this preliminary questionnaire of twenty teachers provide good insights for the researcher to find out the 'reality' of high school teachers' openness and critical attitudes about AI and generative AI in this particular school.

Now focusing on the four selected teachers, based on the semi-structured interview and FGD data, their early perceptions of AI were also 'coloured' by first impressions, which grew alongside greater openness upon generative AI. One of the teachers' statements shows this:

My first encounter with AI was actually back in 2022 during a digital workshop. When I was at the training at that time, an AI was mentioned like: *'try using ChatGPT'*, then it was like *'How do you write in ChatGPT then?'* The instructor continued *'ChatGPT is meant to be used like this... like this... then you just type... just type what you want, it will usually answer'*. From that moment, I basically thought (generative AI) was like Google, but smarter. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

Moreover, AI, especially generative AI in this private school, is seen as a helpful tool which can help them to solve various problems, specifically in terms of teaching and learning. All the four focal teachers agreed to this, and this can be well-represented from the example of statements made by the following teachers:

As teachers, we think that this (generative AI) is just a tool, not the main thing. So it is back to the teacher or the instructor themselves on how they can explore the features in AI that can enhance their work in relation to teaching, and also minimize the negative impact that AI can cause. (Mr. Rafi, ICT Teacher, interview, April 14, 2025)

For me, it is really needed to help me solve various problems. But what we need to realize is that this is a tool and we should be the main 'brain'. We still have to think about what we want. And yes, the point is that all the core 'brains' still have to be in us, because if we rely too much on the control of the AI, first, maybe we will lose in the long run, and second, it's just not like what we want. (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025)

From the open attitude towards generative AI shown by these focal teachers, many of them eventually try to further explore this fast-growing technology, especially for their teaching needs. This open attitude towards generative AI leads to further exploration and interaction with generative AI. It is from this exploration and interaction with generative AI that teachers' critical attitude towards generative AI slowly emerges as shown by one teacher, Mrs. Eny:

Even though I really rely on using Gemini or ChatGPT to help make lesson plans or worksheets or rubrics, we still have to check carefully because it turns out to be wrong. And this happens not just once or twice, it happens very often. So, I really have to match the understanding, whether the understanding of the material that I mean is the same as what the generative AI produces. In terms of grammar, it also happens very often. (Mrs. Eny, English Teacher, structured observation, April 14, 2025).

Similarly, the same opinion was also shared by other teachers, where one teacher stated that it is important to cross-check the output results of generative AI. One of it is Mr. Ivan:

Even though generative AI can cut down time greatly, however, it cannot be used in one go, especially for Chat GPT and Gemini. There are mistakes, and that has to be reviewed over and over again. The hope is that we can use the AI in one go, and make the assessment rubric in one go. But in the end....I know that this development (of generative AI tool) has not been completed, and will still develop in the future. That is the first thing. (Mr. Ivan, Indonesian Language Teacher, Interview, April 14, 2025).

From several statements expressed by the focal teachers, it shows that they are already aware of how generative AI works and the quality of output produced by generative AI regardless of the generative AI tool used. In addition, by being 'critical' here there are 2 meanings. First, many of the teachers, where in this thesis they are also critical, especially of the output produced by generative AI where in this context, they are aware of the imperfections of AI. Then secondly, on the other hand, teachers also criticize how the generative AI system is not yet perfect.

The results also imply that, overall, the focal teachers perceive that they can accurately assess both the benefits and risks of AI tools and are not simply viewing the technology as passive consumers of it. Instead, it means that they are becoming more critical and reflective toward and integrating generative AI into their professional practices. An essential foundation for a critical stance on the adoption of this rapidly evolving new technology is the ability to evaluate both sides of the spectrum: the risks and benefits. In regard to this, the next section will discuss in greater depth the variety of other perceived benefits and risks of generative AI.

4.1.2.2 Generative AI as a Double-Edged Sword

This theme then discusses more in-depth about teachers' knowledge regarding generative AI in general, which encompasses perceived benefits, as well as risks of generative AI just like a double-edged sword. Knowledge about generative AI is also still connected to the previous theme, namely teachers' open attitude and critical attitudes towards AI which in other terms they realize that it is a potential transformative technology. Additionally, based on the data in the previous theme, it can also be indicated from the

preliminary questionnaire that teachers are quite able to accurately assess both the benefits and risks of AI tools. However, before discussing further, the findings from the preliminary questionnaire show interesting results. The overall teachers' knowledge about AI is first reflected in the preliminary questionnaire, especially one of the examples in the open-ended questions that the researcher asked in the questionnaire in the 'AI Knowledge' dimension with questions that read:

“What are the types of AI that you know? Please explain the types of AI that you know briefly.” , and

“Do you know what Generative AI means? Please explain briefly, both the definition and examples of generative AI tools that you know.”

These questions are essential to be asked, since AI itself comprises of several types, where generative AI is one of it (Strobel et al., 2024). Reviewing the 20 teachers' answers regarding the types of AI they know, most of their answers are directly mentioning the name of the AI tools themselves. Only a few teachers correctly mentioned the types of AI. This can be seen in the following summary table:

Table 4.8 Teachers' Answers Regarding Open-Ended Question Items on Types of AI in General

| Teachers' Answers | Percentage | Sample Answers |
|--|------------|---|
| Mentioning the types of AI | 16.6% | “Narrow AI has a limited task in data search, General AI has the ability to process a number of data to produce new data/information in general, Super AI is predicted to have the ability above human intelligence in processing data to make a conclusion.” |
| Mentioning the types of AI along with examples | 5.5% | “(1) Text-based (chatbot): ChatGPT, Gemini, Copilot. (2) For visual: Bing Image Creator. (3) Specific fields: Grammarly, Google translate. (4) Robots: Tesla autopilot. (5)” |
| Directly mentioning the names of AI tools | 66.6% | “Chat GPT, Canva, DeepSeek, Meta AI, Dall E” |
| Don't know about the types of AI | 11.1% | “Never really knew about the types of AI” |

Majority of the teachers did have more practical knowledge because they could actually name a particular AI tool. This means that these teachers have seen or used AI tools,

more than they have a broader conceptual understanding of how to classify or know the typology of AI. A small proportion of teachers were able to give more theoretical understanding, 16.6% were able to name the kind of AI in general and about 5.5% were able to name the kind of AI and give an example of each. In contrast, 11.1% of the teachers did not know about the types of AI and, therefore, required a further basic familiarisation with the topic. Meanwhile, when asked directly about generative AI, it is shown that most of them can define what generative AI is and even provide examples. This can be seen in the following summary table:

Table 4.9 Teachers' Answers Regarding Open-Ended Question Items on the Definition of Generative AI and Its Examples

| Teachers' Answers | Percentage | Sample Answers |
|--|------------|---|
| Defining what generative AI is, and giving example | 66.6% | “AI which is used to produce something (text, images, videos, music), for example DALL.E for images, ChatGPT for text.” |
| Directly mentioning a specific task that generative AI can do | 5.5% | “Weird videos, impossible becomes possible.” |
| Directly mentioning the generative AI tool name and what it can do | 16.6% | “ChatGPT, helps make short questions if you suddenly need to ask a question” |
| Don't know what generative AI is | 16.6% | “I don't know.” |

Interestingly, from these two results, the teachers' understanding of the AI landscape presents an interesting dynamic between their knowledge of broader conceptual knowledge about AI, and their familiarity with more specific and popular concepts in AI. When talking about 'AI in general' however, very few teachers were able to articulate a type of AI, with or without examples. The results are in contrast to instances when the question was more oriented on “generative AI,” in which a majority of teachers were able to describe the general concept of generative AI and provided examples of what they thought generative AI is. That distinguishes it from the other types and implies that though there is not a general understanding of different typologies of AI, popular and exposed use of specific generative AI tools has potentially made teachers better to recognise and understand this particular category of AI. This also fits in with other findings that two-thirds of teachers had more familiarity and knowledge, and were able to name specifically specific AI tools directly. In

addition, the four focal teachers were able to mention the types of AI, what generative AI is and examples of tools correctly in their questionnaire answers. The findings from this preliminary questionnaire provide good insights for the researcher to find out the 'reality' of high school teachers' knowledge about AI and generative AI in this particular school.

Elaborated from the 20 teachers' preliminary questionnaire results (which included the four focal teachers being investigated), the researcher further found that what these four teachers know about generative AI is quite diverse. In addition, from the results of interviews and FGDs, some teachers have shown themselves knowledge about the variety of generative AI tools that exist from the familiar ones like ChatGPT and other generative AI tools; as the ICT teacher says:

Actually, there are many choices (of generative AIs). I do not use Magic School only. Some can also be used too. There is Gemini, there is Chat GPT 4.0. But indeed, yes, this is just comparing... it is usually for questions that are quite common. Indeed, Magic School is quite able to provide appropriate results. Because this computer (material) is quite common. So there are many resources available. Either in Indonesian or English, in my opinion, the Magic School can make it well like that. (Mr. Rafi, ICT Teacher, structured observation, April 14, 2025).

Another teacher, which is English language teacher also mentioned other functionalities of generative AI tools, especially for image creation. For example, in an English lesson for making quiz questions:

For image creation, I usually use Bing Image Creator, Copilot. I usually use that, and it is quite helpful if you have to make several images, for instance: for multiple choice type of questions, text narration... and usually I would check... which image fits this narration that is helpful? (Mrs. Eny, English Language, interview, April 14, 2025).

This initial technical knowledge also laid the foundation for the fact that teachers already had an idea of what generative AI can and cannot do, which is aligned with what they answered in the preliminary questionnaire. Next, with this knowledge and understanding in hand, the researcher saw a great enthusiasm from the focal teachers as they discussed the different benefits they imagined from using generative AI. AI is an innovation that promises tremendous improvement in creating all kinds of work, but especially developing the teaching materials.

... of course for myself as a teacher, (the use of generative AI) speeding up the search for content and theories, meaning... theories that I might have forgotten. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

(using generative AI) is indeed faster than having to think about looking for references like I did in the last few years, I would say 2 years ago... having to look for references, having to google

again, or at most, I made it myself. But with generative AI, it only takes a moment to be done, then our part is to examine which is right, which is wrong. Like earlier, it's faster (referring to the demonstration session while making quiz questions in the structured observation), because we just scan and then 'oh this is wrong', then correct it, 'oh this is wrong', then ask to be corrected... or we correct it ourselves (Mrs. Eny, English Teacher, Interview, April 14, 2025).

...Generative AI basically helps me a lot. I usually use it to find mathematical formulas that I tend to forgot . (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025).

Moreover, there is an additional unique insight. Generative AI is regarded by the ICT teacher, among others more than as a tool, it is expected to foster creativity and help in making more appealing learning content. What the ICT teacher said is an additional insight that generative AI is not only useful for teachers, but also for students:

What we can take from some of the advantages (of generative AI) is that we can be more productive to be creative with our materials in class, then also the children will be more...*hmm..* their imagination will be more open to exploring crazy ideas that were previously very difficult to realize. (Mr. Rafi, ICT Teacher, FGD, April 15, 2025).

Even so, the four focal teachers are aware of the risks that accompany generative AI which they perceive to be present behind the perceived benefits. Of importance, however, is the 'shadow' of dependence that lurks behind them and by which they themselves are also necessarily dependent, along with the potential for eroding critical thinking skills and the original creativity. As a representative in regard to this, the English teacher stated:

The drawback is dependency. For instance, when suddenly there is no internet or my cellphone dies, there is a sense of loss, I mean... I want it..., it is a dependency, I see it from me personally, an adult who has lived for half a century, with thoughts or needs for integrity. And also, since we are in the field of education, that problem is a higher concern, especially if it is in children (students). (Mrs. Eny, English Teacher, FGD, April 15, 2025).

Similarly, the Indonesian language teacher teacher also expressed:

The downside is that, maybe if students have used it... my opinion would be the same as Mrs. Eny, that later there will be an addiction, so the students will become addicted. Little by little they will sneak to keep using it. And they weill be lazy to read. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

Then, the English teacher added further opinions in regards with generative AI dependency and the decline in creativity:

And of course another risk that we already know very well is that the use of AI will reduce a person's level of creativity. Because it depends on what is presented by AI. Which often exceeds our expectations, like 'oh yeah if you use AI it can be like this'. That means (by using generative AI) can be more creative, it can be more detailed. In the end of the day, there will be dependency.

We, both teachers and students, rely on the creativity of AI. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

This awareness of the risks of generative AI suggests that teachers should not simply accept this technology without consideration, but rather approach it with reasonable caution. However, despite being aware of generative AI's risks, another teacher also highlighted an important notion that there is actually a paradigm shift that occurs when teachers/someone uses generative AI in the current era. He explained that it is actually not quite right to address someone who uses generative AI that they will eventually become lazy. Because according to him, making the prompt also requires critical thinking skills, so that the desired results can be in accordance with the goals or desires. Furthermore, he said:

Then there is also this problem, the problem of thinking or paradigm. That notion that if we use AI, our brains will become lazy, well...I do not think so. Because our brain has to work hard to make prompts. If the prompts are not made correctly, then it won't work either. (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025).

This view of the paradigm shift, emphasizing the demand for new skills around using AI more than giving up to the technology is also consistent with that of teachers even when they know the risk, it does not necessarily stop teachers from using generative AI. Instead, this caution appears in keeping with a fundamental trust in the necessity of human agency and control in the steering of this technology, especially them, as teachers. The next theme will delve more fully into teachers' beliefs about human agency and control in utilizing generative AI for teaching and in education.

4.1.2.3 Generative AI should Remain Under Human Control

The next crucial theme that comes out in the series of teachers' perception about generative AI is this very particular theme. With growing awareness of the inherent risks of generative AI, comes a belief that seems fundamental to the high school teachers at this school: that dominant human control and agency should be exercised in every interaction with this technology. Teachers are far from resigned to technological progress and see generative AI as a tool that should, regardless of how sophisticated it gets, remain oriented and under control of humans. This perspective comes through very strongly.

Moreover, although discussing broader issues related to the implications of human control in the use of AI, the results of this preliminary questionnaire can actually be an initial depiction of how teachers in this school perceive the role and control of humans in the use of AI, where the humans in this context are themselves, the teachers. Items on the preliminary questionnaire, especially on the 'Human-centered education' dimension such as "*I realize*

that humans are responsible for the biases in AI.”, and *“I can explain how AI impacts our society.”*”, are quite illustrative of this theme.

Table 4.10 Preliminary Questionnaire Results of Human-Centered Education Dimension Summary

| Items | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|-------------------|----------|---------|-------|----------------|
| I realize that humans are responsible for the biases in AI. | 0% | 5.3% | 26.3% | 31.6% | 36.8% |
| I can explain how AI impacts our society. | 0% | 0% | 26.3% | 47.4% | 26.3% |

Based on the preliminary questionnaire results, it can be seen that a majority of the teachers agreed or strongly agreed that humans are the reason behind the biases in AI, showing a well-developed awareness of the cause of biases in AI. In addition, the teachers showed solid confidence in their ability to explain the impact of AI on society, with the largest group feeling capable and none of them feeling incapable. The implication of these results is that teachers have a strong foundation of AI literacy, both ethically and socially.

Somewhat different from the findings from the items in the questionnaire which may slightly focus on awareness or knowledge, based on the interview and FGD results of the four focal teachers, to them, AI or generative AI is an entity that serves human purposes, not otherwise which are set by humans. This shows that the focus here is more towards actions, and this can be seen from the reactions of the teachers, especially in FGD, who expressed the following opinions which is best represented by the English teacher’s statement:

This is what I usually repeat in class (telling to her students): AI is our subordinate, we are the boss. Do not get it the other way around. So, if we are being ‘regulated’ in this case, whatever indication we receive, it means we are the ‘subordinates’. However, we are the bosses, we regulate our ‘subordinates’, and it can be achieved by our analysis of the results given. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

Teachers also practice this belief in their active involvement within this digital era. They consider themselves as selectors, limiters and guides of AI to ensure it helps reach the main aims and values of education. This is reflectively represented by the ICT teacher:

What approaches are there to keep AI in education centered on students? Because in learning, that is what becomes... well, even though the center is on the students, but we as teachers are the ones who direct it. So, teachers must always prepare a plan, prepare boundaries, prepare targets. So that the students do not get lost in the wilderness of the forest that they do not know. We as teachers are adults who are around the residents. We as people who set boundaries, people who give direction, the rest is up to them and their imagination. (Mr. Mahfud, ICT Teacher, FGD, April 15, 2025).

This also serves to reinforce the mindset that human intelligence has an irreplaceable role yet human intelligence plays indispensable role. One of the teachers elaborates on this further:

So one of the most important things about teachers, maybe what we often hear, is that we do not just transfer material (knowledge), but we transfer values. Values such as morals, spiritual, in my opinion, can not be transferred from a person, a machine, a robot, an AI. But for moral and spiritual values, maybe they can only be obtained from fellow humans, in this case, us as teachers. (Mr. Mahfud, Mathematics Teacher, FGD, April 15, 2025).

Further, the English teacher also elaborated on this matter despite she knows that one day, AI has the potential to take over human role, and teacher is no exception:

What is clear is that teachers will play a smaller role, although they will not disappear. Because let's say robots can control emotions, which robots can... now. But still... connecting physical emotions and spiritual aspects is still not possible. And in my opinion, even though we have not yet reached the future, it still cannot be 100% replaced, the function of teachers cannot be 100% replaced by robots. But certainly the function of the teacher will get smaller, less and less, because of many things. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

Another teacher also added up similar idea that human intelligence will be still needed, especially teachers, since AI cannot pass down spiritual aspects. However, things that are procedural will be inevitably taken over by AI:

In my opinion, for teachers, they are indeed still irreplaceable in the near future for me.. let's say... in 25 years. Because the development of AI also requires a process, in terms of training models. But for the long term, for example, 100-200 years into the future, it might be like Mrs. Eny said, there are several things that have been replaced. Especially if it is something procedural. Because there are many, for example in greeting classes, greetings can definitely use AI. Then in that way, like mathematics, this is really, some of its functions will definitely be taken over by AI. Then for example from the side of science lessons, there will also be more. But maybe from the spiritual side, its nature cannot replace the role of teachers as humans. (Mr. Rafi, ICT Teacher, FGD, April 15, 2025).

Therefore, trust in human control is thus an important foundation guiding teachers to better, safer and more responsible use of generative AI, especially in school environments. This belief in human control as the foundation of today's wise use of generative AI also forms teachers' expectation where the development of AI will go in the future. In the next theme, the

findings about their expectations on AI, especially generative AI in the future in this thesis research will be deepened more.

4.1.2.4 Generative AI is an Evolving Technology

This being the last theme, focusing on generative AI as an evolving technology in the series of discussions for the first research question, specifically looks at teachers' expectations pertaining to this technology's future direction. Unlike some of the earlier themes whose trends could be plotted based on the responses achieved in the preliminary questionnaire results, there were salient findings which came out in a natural and profound manner based on interview and FGD responses. This theme was not addressed directly in the questionnaire scale, but it represents the proactive and anticipatory outlook of the four focal teachers concerning the dynamic quality of the technology they are handling. Why this becomes crucial to understand is because teachers' expectations in this regard are critical. First, teachers' hopes and desires can help technology developers build AI tools that are actually better aligned with their real needs in education; such effort can enhance the optimal use of those tools for the teachers. Second, their expectations of what roles and capabilities AI will one day perform are also elements of their perception; that is, their view of how teachers imagine an AI future is shaped by their current view, hope, or even concerns of the technology.

Expectations for more sophisticated features or functionality or for more integrated, contextually relevant and more holistic supporting of the education ecosystem in general, characterizes their expectations. From FGD and individual interviews they were hoping generative AI in future will overcome certain limitations they currently feel. They expected existing generative AI to be able to handle more complex and diverse input, recognizing handwriting, for example and be more adaptive to different teaching and assessment needs. Two teachers of linguistics scope, namely the Indonesian Language teacher and the English teacher especially hope for an improvement on receptive generative AI:

If what needs to be improved according to what I have been constrained so far ... I think what can be improved is the receptive problem. So the input given in language teaching means that there are children, the results, the product is writing. Yesterday I also said that I once tried to take a photo then processed it by AI, however, for optical the recognition, it is still not optimal. So if the child's writing is good, the results can be like being scanned directly. But if the writing is blurry, it is still far from the quality of the eye in recognizing writing ... the quality of the natural eye in recognizing writing. Because human writing is a visual form. So what I see is still very far from the sophistication of AI optical recognition when compared to optical recognition created by God. If the writing does not look good, I can still respond, *'oh this is what it means'*. It turns out that AI has not reached that point yet. So in providing input or the AI's receptiveness, that's what I feel is still far away. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

Then, the Indonesian Language teacher also added up:

That is right, as Mrs. Eny said, especially for language teachers, it is necessary to be receptive. If, for example, I need to quickly finish assessing handwritten texts. That really needs to be improved. Because using PDF, Adobe Acrobat Reader, sorry I immediately mentioned the brand. Adobe Acrobat Reader is actually... after we scan PNG or JPEG then change it to PDF, it can actually still change the scheme, by using PDF. If the PDF is inadequate, it will use the web. There are some that can be from photos and then whatever and we can copy it directly to Word if we need it. But yes, if, for example, before there was AI, the application or web application could already do it, it should be smarter in my opinion, that is why the receptiveness needs to be improved. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

Besides hopes for better quality, teachers' expectations are also directed to better integration of AI systems. AI must no longer be standalone applications, but seamlessly integrated into existing educational technology systems or platforms such as a Learning management system (LMS) and assessment systems, that teachers already have or use. This is evidenced as what Mr. Ivan stated:

I need an AI that can answer. Why is my answer becomes strange? Because in my view, AI must be attached to a system. For example... Apps, Canva... which is manual at first which might be able to work according to our hands, finally AI is installed (within it). Then the learning management system, LMS, where we save worksheets or save children's grades, that's just a system. But if the AI can be installed, it will make it easier with our program. For example, please enter all these grades based on objects. So, what I need is the apps first, or the web apps first. But from there, if you want to install AI, then you have to be able to install flexible AI that can answer. That's for the needs of teachers (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

Similarly, Mrs. Eny also stated:

Yes, although there are already many advanced generative AIs, which are specifically for certain fields, such as for schools: Magic school, for research, there are also some that are specialized. But what I see is that they are still separated. Hopefully there will be a special one, just like what Mr. Ivan said earlier, there will be an integrated one. So, not just like Magic School, that is general. But one that we can use in a school environment, so that our work can be integrated there, and material storage too. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

Wrapping up her statement, she further said:

Maybe in the future, if there is AI or generative AI that focuses more on the world of education, which can also be integrated with the assessment system, it will be very helpful. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

This expectation is due to the demand for more efficient workflows and smooth user experience, when AI is then seen as a necessity in the school digital ecosystem, especially at the school where the thesis research is conducted and it is also the uniqueness of this school, which already uses digital ecosystem.

In addition, the need was strongly articulated in terms developing an AI that is more contextual and in accordance with local needs. Many current AI tools, especially generative AI tools are still very much orientated for international/global or a Western data. Therefore, many times, it cannot provide localized content or solution for an Indonesian cultural context, curriculum, or a particular Indonesian related subject, many teachers felt. Two teachers expressed this. The first one is Mr. Ivan, the Indonesian language teacher:

As for the subject I teach, Indonesian Language, it is because it is still too international and cannot solve the problems of this particular subject. It has not been found yet. So, I do not know what form it will take. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

Therefore, the hope is also high for more local training data in future AI development, so the results can be more relevant to the Indonesian context. It is also an important expectation to have access to AI or generative AI resources at a national curriculum aligned level to support more effective implementation in the classroom. The second one to give this opinion is Mr. Mahfud, the mathematics teacher:

Which aspect should be improved from generative AI? I think, the problem of localization, localizing. The problem is that this (generative AI) is still too international. So if the problem is how to localize it, it means that these AI machines need a lot of training data from Indonesia. Indonesian context. So that it is more contextual. Because that is also one of the things I have encountered, for example, wanting to create story questions or project-based learning ideas that are more contextual, that are closer to Indonesian conditions, Bogor conditions for instance, conditions around us, it seems that they still lack data or knowledge. (Mr. Mahfud, Mathematics Teacher, FGD, April 15, 2025).

These teachers' expectations indicate a desire for generative AI that gets smarter, but also wiser, more adaptive and able to actually empower teachers to create better learning experiences overall.

4.1.3 Summary of Findings on Teachers' Perspective About Generative AI for Teaching (RQ 1)

The findings represented in the main themes that answer the first research question answer how teachers perceive generative AI, especially related to teaching. What needs to be underlined here is that perception is not only related to their views, but also contains their valuable experiences that ultimately shape their perceptions. At this school, teachers tend to regard generative AI as a potentially transformative technology, with a significant number of aspects of their work likely to change, but a positive view of its potential is tempered by an appreciation of the challenges and risks that exist, and that need to be addressed, and managed carefully.

There was variation in levels of understanding of AI itself in teachers: while there was an apparent familiarity with the names of popular AI tools, often there was more report of familiarity with the names of popular AI tools than deep conceptual understanding of different types of AI; but most participants were aware of the term “generative AI” and its meaning. And among all of these considerations there was one enduring, firm belief: that humans have control and agency over AI. For teachers, AI is perceived as a tool to be kept guided and wisely controlled by humans, not the other way round. However, perceived notions of safety, accuracy and human empowerment as an enabler also heavily influenced their expectations related to future development of generative AI as technology that is safer, more accurate, more contextually relevant and still empowering the teachers.

4.1.4 Findings on High School Teachers’ AI or Generative AI Utilization

The second research question on this thesis research is *How do high school teachers utilize generative AI for teaching?* This question is answered based on the major themes and sub-themes appeared that emerged from the structured observation results, FGD transcripts, and semi-structured interview transcripts. Themes and sub-themes are based on teachers’ hands-on experiences on utilizing AI, particularly generative AI for teaching and learning. In answering this second question, data from structured observations will be used extensively along with semi-structured interviews and FGD.

Data garnered were also further analyzed using Braun & Clarke (2019)’s six phase framework for thematic analysis. This analysis resulted four main themes: 1) using various generative AI tools for teaching, 2) using generative AI for teaching, learning, and assessment, 3) applying technological, content, and pedagogical knowledge of generative AI in teaching, and 4) improving professional skills of generative AI. These themes gave rich contextual insights into participants’ view, knowledge, and experiences with generative AI tools.

4.1.4.1 Using Various Generative AI Tools for Teaching

Delving into the utilization aspect, the first step to apply complex knowledge or use it in more specific usages like for instance assessment, therefore one needs to know and master and apply the many generative AI tools around. At this stage there is familiarization, exploration, and practical knowledge of various generative AI tools. In the preceding discussion of perception, it is found that teachers’ level of knowledge and familiarity with a variety of AI tools plays an important role in forming and ‘coloring’ their general attitudes, and subjective perception of generative AI in general.

To continue, as it now turns to the aspect of utilization, the focus with this knowledge element will be expanded upon in a more practical and applicable aspect. Once again, the 'knowledge of tools' component is the focus, but this time, the analysis will focus on how teachers' knowledge and mastery of a variety of AI tools, especially generative AI work as initial capital and operational foundations. This enables them to try out, filter, and apply these tools themselves to precisely answer their teaching tasks. In other words, in the discussion of perception, knowledge was one of the 'driver' for the perspective. However now in the context of utilization, knowledge is discussed as one of the driving and guiding actions in using generative AI.

This thesis research's one important finding is that teachers were aware and explored the variability of the range of AI tools (particularly generative AI tools) which can be used to support the teaching process. It turns out that from the findings in this thesis research, these teachers are not only using generative AI for the purposes of assisting teaching. Furthermore, they also use it for student learning, and even assessment. However, teachers are not fixated on one type of generative AI tool. They have known and even used various generative AI tools. This is indicated from the preliminary questionnaire, especially in the open-ended question regarding variability of generative AI tools that they know. They mentioned generative AI tools such as: Chat GPT, Gemini, Magic School, Dall-E, and HeyGen.



Figure 4.1 Generative AI Tools Mentioned by Teachers in the Preliminary Questionnaire

Source: Google.com

Continuing from preliminary questionnaire results, in FGD and structured observations, one tool that appeared to be dominant that was mentioned, recognized and practiced most by teachers was ChatGPT. Its popularity is indicated by the high frequency of mention, especially in FGD. Here are some of the things the teachers said:

I like to use ChatGPT, because at my current age, it turns out that I prefer something that can respond to what I'm looking for. In general... I mean a conversation partner. Because once again, AI, especially ChatGPT that I use, is intended to make it easier to find something. I feel the need

to have the convenience of finding information quickly, one of which is by having a chat or conversation. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

... So, for example, in ChatGPT, to express ideas or thoughts in the form of chat, in the form of conversation, I think that is good. (Mr. Rafi, ICT Teacher, FGD, April 15, 2025).

One of the reasons that makes ChatGPT a widely used generative AI tool is because of its ease of use, and ChatGPT has been around for quite a long time, namely since 2022. In this sense, the teacher felt that ChatGPT is more well-established, and it is more than enough for him to cater his needs. This is as stated by the following teacher:

(I use ChatGPT) More because of its easiness. I am more familiar with GPT than the others, because it has been around for a long time, right? It was already available since 2022. So it is more like that. But on average, after I tried and compared, maybe Magic School was more helpful in the past. But the current AI ChatGPT is better... in the last few years. Now it is very... to the point where it can be made in table form, right? And that is very helpful. For me, I think ChatGPT is enough for my needs in making questions and so on. (Mr. Ivan, Indonesian Language Teacher, interview, April 14, 2025).

This screenshot during the demonstration session by Mr. Ivan also confirms that he often use ChatGPT for his needs, namely for making questions.

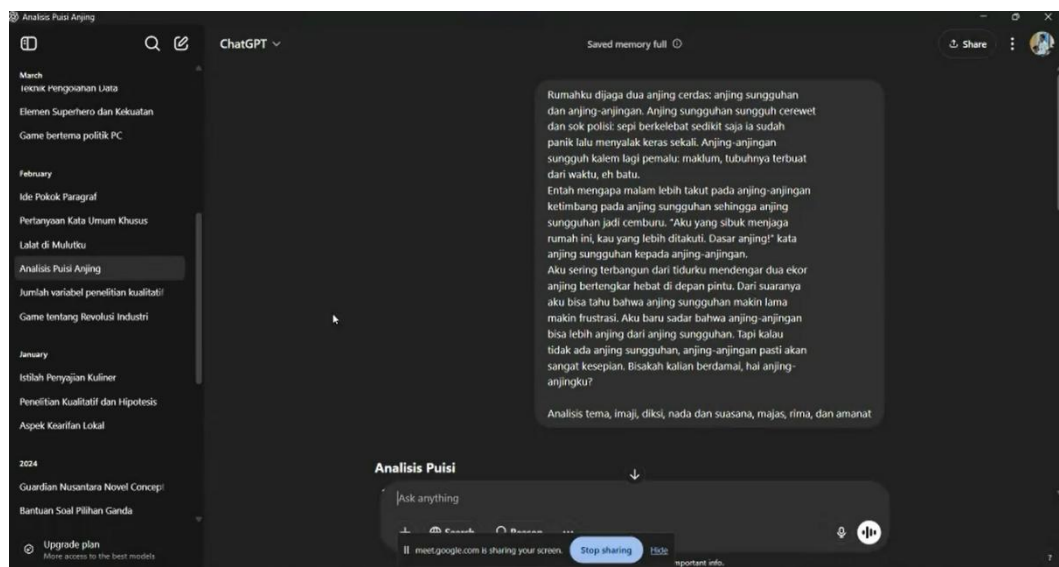


Figure 4.2 Mr. Ivan's Screen Shared on Using ChatGPT

Yet, ChatGPT is not the only generative AI tool teachers are familiar with. ChatGPT is certainly not the only generative AI tool to emerge on the field after it. Other tools such as Magic School and Gemini also turned into dominant generative AI tools. This shows that the

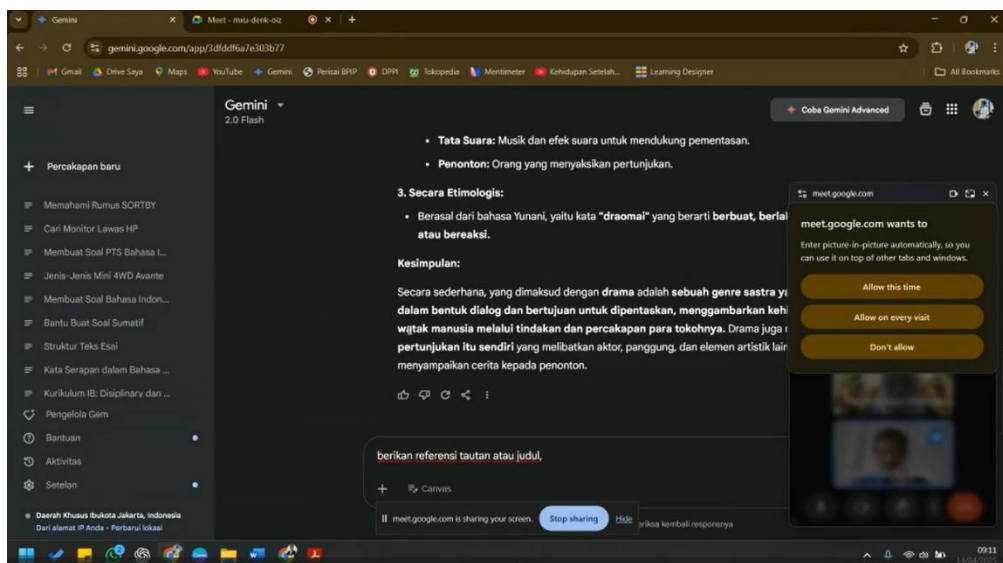
teachers are also exploring other AI tools as well. As shown by this teacher, for example. Mr. Ivan for instance, also utilize Gemini aside from ChatGPT.

But I feel that Gemini is directly connected to the source I want. For example... I have saved it earlier (in the chat history in Gemini). The point is when I ask for a reference, Gemini will usually immediately bring up... or I will create a new simulation. (Mr. Ivan, Indonesian Language Teacher, structured observation, April 14, 2025).

He then demonstrated how he used Gemini for making questions for drama topic in Indonesian Language lesson.

I will ask (Gemini) what is meant by drama. Then compared to Gemini's GPT chat, the way to answer is actually the same. But the difference is when I ask for a reference link or title, Gemini tends to provide a link that is directly connected to this. (Mr. Ivan, Indonesian Language Teacher, structured observation, April 14, 2025).

Mr. Ivan then further prompted to Gemini: *"give link to the reference"*. And showed to the researcher what he meant by Gemini provide link to the references. For more detailed image, see Figure 4.3, within the yellowed circle.



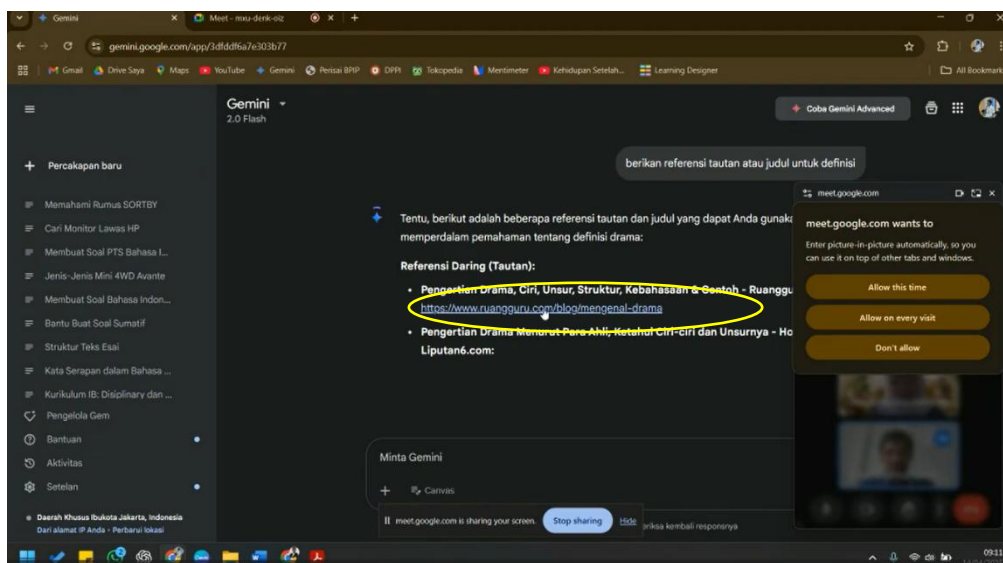


Figure 4.3 Mr. Ivan's Screen Shared on Using Gemini

For this reason of convenience, Mr. Ivan found it easier to use Gemini in addition to ChatGPT. Moreover, interesting findings also came from Mr. Mahfud who tends to use Gemini for a second opinion only, or in other words, seeking how other AI might answer with the same question/prompt.

The first one I use is Chat GPT. Because the memory is already stored there. Sometimes I have stored some memories there. So, I use it there. If I need a second opinion, for example, I want to know if there are new insights from other AIs, then I will go to Gemini or Deepseek. (Mr. Mahfud, Mathematics Teacher, structured observation, April 14, 2025).

On average, almost all teachers who use both ChatGPT and Gemini feel that both generative AI actually work the same way. It is just that Gemini is sometimes felt by them able to provide external links directly when they give a prompt to include the source. Additionally, besides ChatGPT and Gemini, there is another generative AI that is often mentioned by the four teachers who participated in this thesis research, namely Magic School.

The Magic School AI is unique when speaking in the context of the school where this thesis research was conducted. Because, almost all the participating teachers, both the four focal teachers, and other 16 participants who answered in the preliminary questionnaire mentioned Magic School (in addition to other generative AI tools). This means that this school is specifically introduced to teachers. It can be seen from the researcher's interview with one of the following teachers:

Well, for this Magic School AI, it was more...in fact, the first time I used Magic School was because there was an introduction during induction training at this school. (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025).

Then, still related to Magic School, another teacher, Mr. Ivan added:

... Almost the same, for me ChatGPT is more...what is it? Broader, I think. Magic School is more specific, because it has several tools, some of which are specific. For example, if we want to make a lesson plan or a rubric, it's already there...and presentations are also already there. What do you call it?...the channels or tools are already there in Magic School. So just enter the prompt according to your needs, and that is it.. (Mr. Ivan, Indonesian Language Teacher, interview, April 14, 2025).

From what Mr. Ivan said, it can be indicated that AI Magic School is indeed a type of generative AI that is specifically designed for school needs. Still related to Magic School, there is one teacher who demonstrated the use of the free version of Magic School to create questions. In this case, Mr. Rafi shared with the researcher:

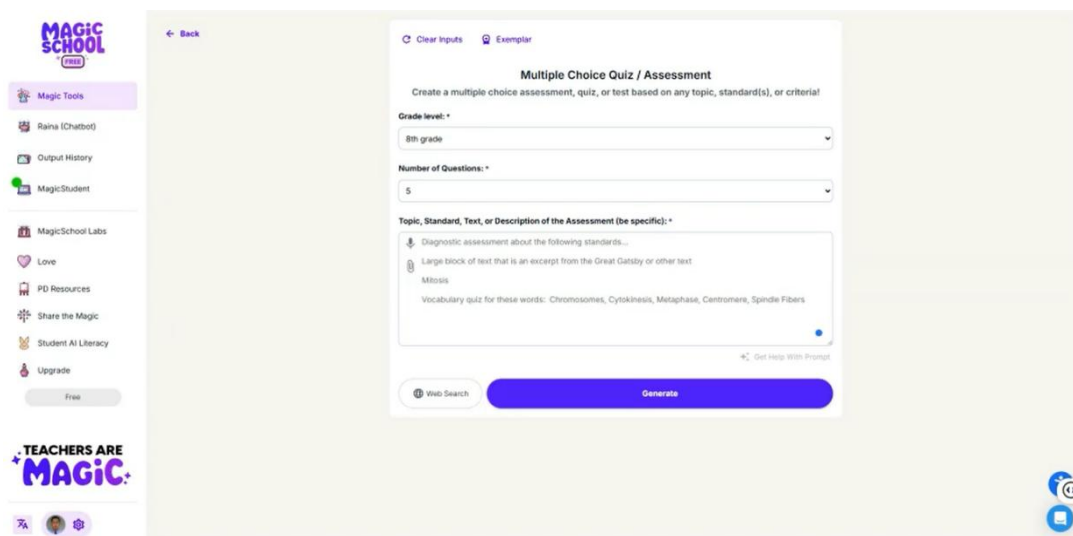


Figure 4.4 Mr. Rafi's Screen Shared on Using Magic School

“So, usually to create questions like this, we open Magic School, then we choose the class and the number of questions to be created because it is just a quiz, so the number of questions is small, like that.”

He then continued,

“Then here we type the prompt”

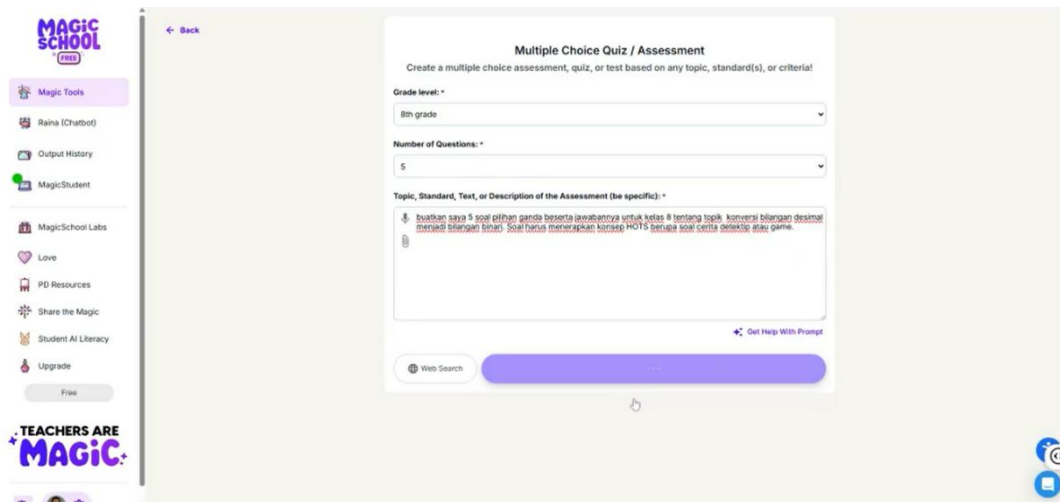


Figure 4.5 Mr. Rafi’s Prompt on Making Questions for Quiz, using Magic School

“And the result is like this, miss” (Mr. Rafi, ICT Teacher, structured observation, April 14, 2025).



Figure 4.6 The result of making quiz questions in Magic School

From those illustrations above, the teachers’ technological knowledge is mirrored by exposure to the variety of generative AI tools reflected in the findings of this thesis research. Not only do they know the names of the tools, but the intertwining of their understanding of the functionality of each tool helps create a specific teaching need and learning objective that is then tailored to specific generative AI tool. For example, Mrs. Eny said that he used Gemini AI to make the substance of a poster for teaching materials. Then, after Gemini generated the substance, what should be there. After all that was done, then she moved to

another generative AI to generate images, like Microsoft Copilot. This provides an illustration of how teachers are utilizing different generative AI tools, for different purposes.

Actually, I usually use Gemini more to ask for suggestions on what substances should be in a campaign poster for rhetorical devices. Then finally from here I have to go to another AI for poster making, to make a poster based on the draft that has been made in Gemini. But here the details are already there, like what the title is, then what the image is, what rhetorical devices should be used, what key features should be there. Well, later I will input this into another AI like Microsoft Copilot which makes the poster for the instructions, for the prompts, then the posters are made for each topic. (Mrs. Eny, English Teacher, structured observation, April 14, 2025).

Overall, for teachers to more effectively and relevantly incorporate generative AI technologies, their process of identifying, exploring and selecting from a range of AI tools is a fundamental step. In the next theme, it will be elaborated more on how familiarity with these tools translates into actual use of generative AI in teaching applications, to support student learning, and for assessment.

4.1.4.2 Using Generative AI for Teaching, Learning, and Assessment

This theme illustrates how educators incorporate generative AI knowledge into different core of education features such as supporting teaching, facilitating student learning and serving in assessment implementation. This thesis research has found that the level of technological knowledge, content knowledge and pedagogical knowledge to which this teacher element is exposed to performs a vital role in their utilization process. But before venturing deeper, the results of the preliminary questionnaire on items related to teaching, learning, and assessment show the following.

Figure 4.7 AI use by Teachers in Terms of Teaching, Learning, and Assessment

| Coverage | Items (That are Representative) | Teachers' Responses | | | | |
|----------|--|---------------------|----------|---------|-------|-------------------|
| | | Strongly Disagree | Disagree | Neutral | Agree | Strongly Disagree |
| Teaching | I can teach by appropriately combining subject matter, AI tools, and teaching methods. | 5.3% | 10.5% | 31.6% | 42.1% | 10.5% |
| | I can help others to organize the use of subject matter, AI tools, and teaching methods. | 10.5% | 5.3% | 36.8% | 42.1% | 5.3% |
| | I can use AI to create learning content, such as | 5.3% | 5.3% | 26.3% | 42.1% | 21.1% |

| | | | | | | |
|------------|---|-------|-------|-------|-------|-------|
| Learning | learning materials or presentations. | | | | | |
| | I can design assessment tools to improve student learning in AI-based environments (e.g., learning with ChatGPT). | 10.5% | 10.5% | 31.6% | 42.1% | 5.3% |
| Assessment | I can use AI tools to support assessment in learning. | 5.3% | 5.3% | 36.8% | 47.4% | 5.3% |
| | I can assess student learning in an AI-based environment. | 10.5% | 0% | 52.6% | 36.8% | 0% |
| | I can choose AI tools to encourage student self-assessment. | 10.5% | 10.5% | 26.3% | 42.1% | 10.5% |

According to the data obtained using the questionnaire, the confidence of teachers in using AI in three key areas: teaching, learning, and assessment, receives differences. The most confident area is the learning area or in terms of creating learning content with the help of AI where 63.2 % of the respondents agreed or strongly agreed. In teaching domain, the level of confidence in teachers in incorporating AI into teaching practices and assisting colleagues is quite satisfactory, as the percentage of those who agreed on those two aspects of teaching is 42.1% in each of those. Nevertheless, the biggest challenge is the assessment area; to be specific, most of the teachers (52.6%) were neutral when asked about their capability to evaluate the learning of the students in an AI-based environment which points to indecisiveness or unawareness in that area.

Moreover, structured observation, FGD, and individual interview findings show that generative AI is already being employed in these three domains though with varying levels of depth and frequency usage. Moreover, it also unfolds a fact that the teachers in this school are actively exploring the use of various generative AI tools, and yet that choice is situated based on their specific needs.

Generative AI Use for Teaching

With regards to teaching, the most commonly used form of generative AI is as a productivity tool to support the creation and preparation of teaching materials for teachers. Teachers extensively utilize generative AI to design lesson plans (RPP), create attractive worksheets, create posters, and produce questions for practice or quizzes. During structured observations where teachers demonstrated the use of generative AI, the uses demonstrated were quite diverse. Some created questions, some created teaching modules, and some

simply asked about complex mathematical formulas. The following is one of the examples on the use of generative AI by one teacher:

The Indonesian Language Teacher (Mr. Ivan)

In the context of assisting teaching, Mr. Ivan usually uses ChatGPT to create questions (see Figure 4.8). He said that she uses ChatGPT's help because in Indonesian, especially high school, if referring to the guidebook, it is quite rare to have multiple choice questions type of question because most of the questions in the guidebook are essay questions (see Figure 4.9). He said that the requirements from the school required 30 multiple choice questions and 5 essay questions.

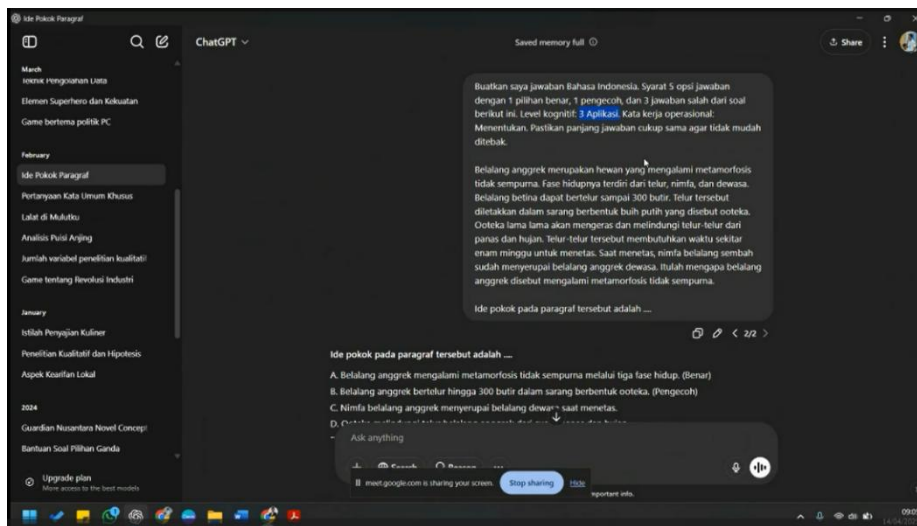


Figure 4.8 Utilizing ChatGPT for creating questions

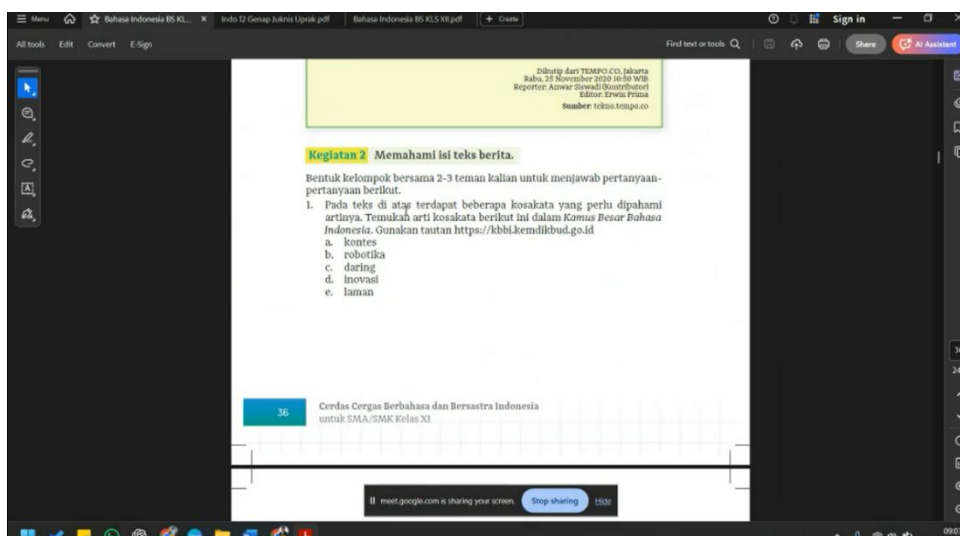


Figure 4.9 Sample Questions in the Indonesian Language Guideboo

Generative AI Use for Learning

In the realm of student learning, generative AI is being eyed and tested as a tool to help enhance and personalize the learning experience by the teachers. The application may not be so widespread as for teaching preparation, but there are already some interesting practices sprouting up. But some teachers, for instance, have their students use AI tools when the task requires their creativity. For example, students are tasked with drawing or otherwise creating visual elements in a character design project, but with clear guidance and boundaries from the teacher. This can be inferred from what Mr. Rafi doing:

The ICT Teacher (Mr. Rafi)

For grade 10, Mr. Rafi requires his students to use generative AI to create video scenes (like scenes in movies). However, before that, he requires his students to master the prompts first, and introduces AI tools that can generate images such as DALLE-3, Tensor, or Leonardo. In this case, he also uses Google Classroom as a Learning Management System (LMS) for students to access materials and assignments (See Figure 4.10). In the image below, he can be seen providing details into the example prompt, where the example prompt shows a detailed and clear structure (See Figure 4.11). The provisions that he requires are that students are required to be as creative as possible in creating the characters they want, and first try to create them in the AI image generator, especially also creating prompts like the ones he exemplifies. The expected output is in the form of an AI video, which tells about the objects they visit during the study excursion (see Figure 4.12). For the characters, they must create personalized characters, so the provisions must be similar to the student's own profile.

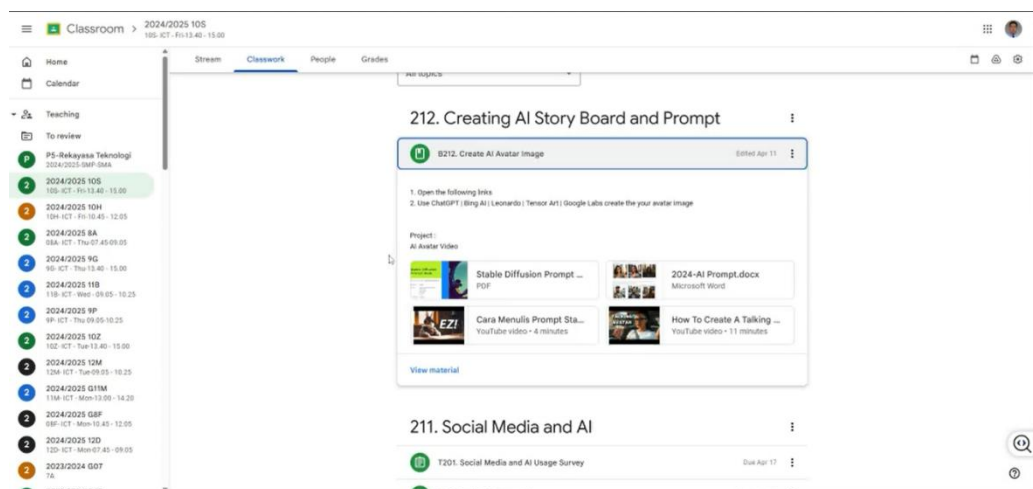


Figure 4.10 Utilizing video generator and image generator AI for students' Assignments

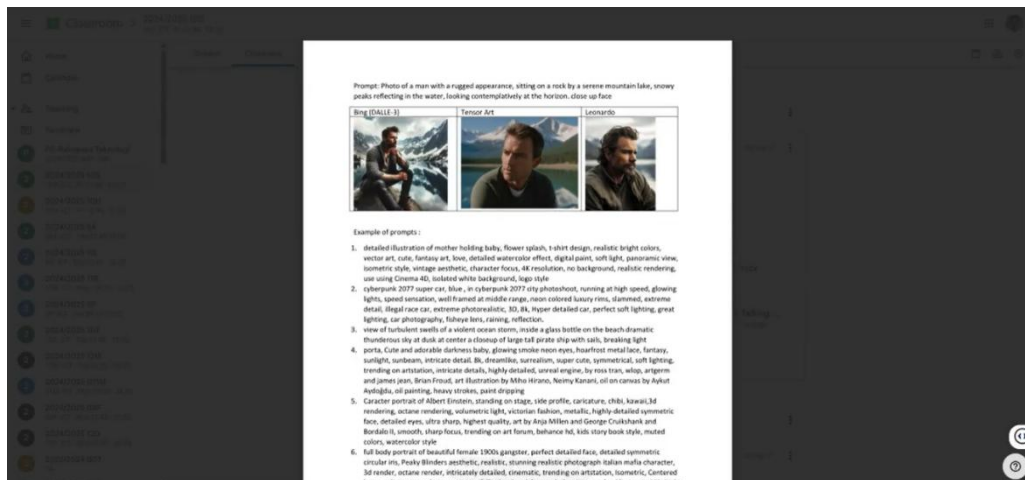


Figure 4.11 Examples of Prompts that Mr. Rafi Gives to His Students to Use

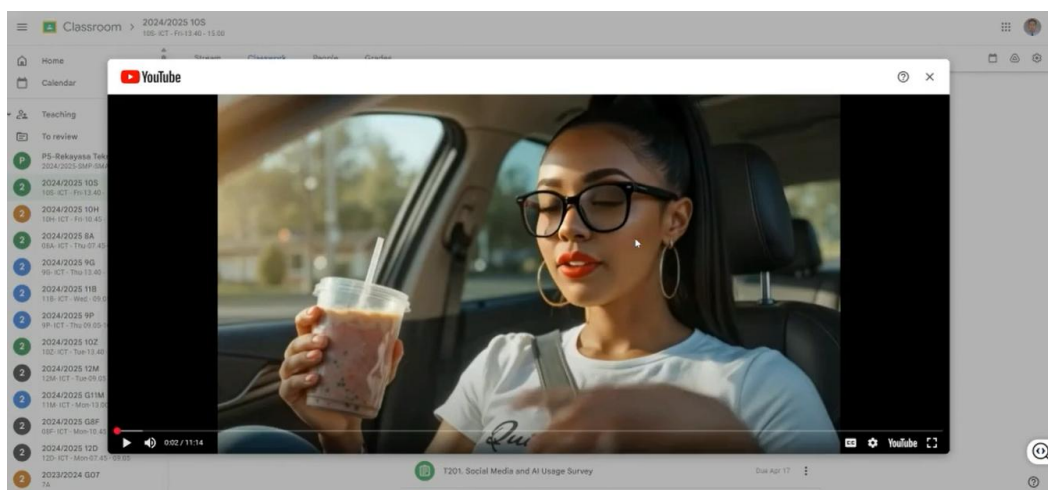


Figure 4.12 Examples of the AI Video as expected by Mr. Rafi

In addition, a teacher has even begun to encourage or at least permit students to use generative AI as a self-personalized learning tool. For example, to gather further information, viewing different perspectives or receiving early formative feedback on a draft, although the tutoring techniques for this student self-exploration still vary. This will be discussed in detail in generative AI use for assessment.

Generative AI Use for Assessment

In terms of assessment aspect, teachers tend to be cautious and only at the initial exploration stage with regard to generative AI utilization. The results of the preliminary questionnaire shown in the ‘AI assessment’ dimension showed mixed results.

Table 4.11 Results of preliminary questionnaire regarding ‘AI Assessment’ dimension

| Items in ‘AI Assessment’ | Strongly disagree | Disagree | Neutral | Agree | Strongly Agree |
|---|-------------------|----------|---------|-------|----------------|
| I can use AI tools to support assessment in learning. | 5.3% | 5.3% | 36.8% | 47.4% | 5.3% |
| I can design assessment tools to improve student learning in AI-based environments (e.g., learning with ChatGPT). | 10.5% | 10.5% | 31.6% | 42.1% | 5.3% |
| I can assess student learning in an AI-based environment. | 10.5% | 0% | 52.6% | 36.8% | 0% |
| I can choose AI tools to encourage student self-assessment. | 10.5% | 10.5% | 26.3% | 42.1% | 10.5% |

Preliminary questionnaire results on the dimension of ‘AI Assessment’ reflected varied confidence levels of the teachers. In general, while some teachers voiced being neutral or less confident, many of them expressed their capability or at least openness to the use of the AI tools as assessment support in learning and to also foster student self-assessment. Nevertheless, teachers seemed more neutral when asked more specifically about the ability to build AI backed assessment tools or assess student learning right in an AI environment. This implies that not much AI as an assessment tool is being embraced by teachers, with the only usage that seems to be more accepted is its use as an assessment tool, though by deeper and direct ways in the actual assessment process.

In addition to the findings from the preliminary questionnaire, some teachers have attempted to use generative AI to produce items or to help come up with ideas for different types of assessment. Some see how AI can offer quick feedback, particularly on some parts of student work. This enthusiasm is also matched by a great deal of caution, as what illustrated by what Mrs. Eny does here:

... Yes, like I said earlier, sometimes I give the students independent assignments to find feedback with detailed prompts that I provided to them. So, I provide the prompt, it contains the assessment rubric, and all sorts of things. So, they just have to copy the prompt from me, then copy their work, their writing that I have told them to type... then ask for feedback to ChatGPT. Then later, they see what ChatGPT gives feedback, and from there they revise themselves. This is for formative assessment in daily activities. So, from there, they could learn, ‘*oh yes it turns out I used this*’ or ‘*it should be like this*’, ‘*better like this*’, or ‘*this is wrong*’ In terms of grammar, or in terms of text type features, or also the structure. (Mrs. Eny, English Teacher, interview, April 14, 2025).

Furthermore, based on the results of personal interviews with teachers, many teachers questioned the validity, reliability and possible bias that the AI output may contain

as said by Mr. Ivan: *“I have not yet using AI to assess, because in my opinion, let alone assessing... for solving problems, AI is sometimes still wrong.”* Hence, as stated by Mrs. Eny, this requires teachers to evaluate, cross verify and substantially modify any AI output that is going to be used for purposes of assessment:

Meanwhile, for summative, the final assignments must get a grade from me. I have also used it several times, and yes, maybe the success rate if I say around 80 percent, it still can not be 100 percent because I still have to see it. But at least, I just scanned it. So, I have used it if I see the situation.. I ask for essays in my exams. I would take a photo of the essay, then I attach it to Gemini or ChatGPT, then I give an assessment rubric. it must be clear first the aspects we want to see, for example, I want to check grammar points 1A, B, C. Then, this is a narrative text type, it means it must be there, the key convention narrative must have this, this, this, and this. Well, that is just the rubric that I put in the prompt, then ask to be checked. Well, the success rate is about 80 percent, especially when the children's writing is good or quite legible. But if the children's writing is already messy and unclear, I just check it myself if I am already dizzy. But AI is quite helpful, and I have done it, and when I double-check, cross-check, I usually be like: ‘oh yes, that's right too’. But sometimes there is some uniformity in the results. So if that happens, oh that means the prompt is not right. Or usually it could be because there is uniformity, I look at the text again, oh this one is less than this, or there is more than this. (Mrs. Eny, English Teacher, interview, April 14, 2025).

Therefore, the prospects of AI, particularly generative AI in this field can be applied, as long as this can be implemented with fidelity and within a robust structure of human control. This also complies with one of the themes of the first research question (see 4.1.2.3), which showed that human control is needed in how AI is employed.

Despite the advances in use of AI for teaching, learning and assessment, the teachers have continued to express a critical and responsible attitude towards its use, leaving AI to be seen and used as a supportive tool whose use is always subject to the teacher’s professional consideration and validation. Generative AI is experienced as such professional consideration and validation in practice by teachers who can draw on their technology, content and pedagogy knowledge and apply it in an integrated manner to address situations with generative AI. The following theme therefore will describe how these three knowledge domains are applied by teachers in the cases of using generative AI in the content of teaching.

4.1.4.3 Applying Technological, Content, and Pedagogical Knowledge of Generative AI in Teaching

With the critical understanding of generative AI as a support tool that needs validation, as highlighted by the high school teachers in this thesis research, the next crucial step is the application and integration of their knowledge domains of technology, content and pedagogy (TPACK) in their daily teaching practices with generative AI which is depicted through this theme. In the previous theme, the researcher outlined different aspects

of using generative AI in general. Contrary to the other themes, the presentation of data provided by the preliminary questionnaire will not be used to start this theme, because the most significant results of the questionnaire to address teachers' competencies have already been introduced and enriched in the previous theme in order to prevent repetition of information (see 4.1.4.2).

This part discusses the data collected via structured observation, interviews, and FGDs to discuss how teachers taking part in this thesis research started to utilize and combine their technology, content, and pedagogical knowledge when applying generative AI in learning situations. The idea is to gain a clearer insight on how teachers can employ their technology, content and pedagogy basic competencies as they deal with generative AI tools. In addition to the TPACK framework informing the analysis, the discussion will revolve around enactment of each domain of teacher knowledge in the practice. The second part points to the use and integration of these areas in real-life classroom use of generative AI and describes the dynamics that arise when educators try to synergize their knowledge of generative AI tools, content, and pedagogy.

The results from the FGD and individual interviews indicate that the use of generative AI technological knowledge is clearly shown in the teachers' practical skills. They are familiar with various generative AI tools and consciously picked from them according to their requirements. This familiarity with various generative AI tools can also be seen in the previous themes and in one of the themes of the first research question, where they discuss their knowledge of AI in general (see 4.1.2.1), and also various generative AI tools (4.1.4.1). Furthermore, prompt literacy (ability to formulate effective prompts) plays a central role in their technological knowledge as they are able to explore (learn through experience) and interact with AI to receive the desired output. This allows for a technical foundation of drawing upon how the tool works, also allowing one to ask how it does such things and what these capabilities actually represent, but also allows one to ask what the capabilities of the tool potentially enable. Teachers' abilities to do prompting were clearly confirmed through the demonstration session in the structured observation. How the teachers created the prompts are summarized below. Noteworthy that all example of prompts in the table below were written and observed in Indonesian Language to pursuit authenticity (except Mrs. Eny's and Mr. Mahfud's).

Table 4.12 Observation Results on How the Four Teachers Do Prompting

| Teacher | Prompting Techniques Observed | Example of Prompt |
|----------|--|--|
| Mr. Rafi | Mr. Rafi employs a formal and specially structured way of instruction. The number of problems are clearly mentioned, answer format, target audience (grade 8), the precision topics (decimal to binary conversion) and it ask the application of HOTS concepts with special presentation style that it should be in the form of detective story problems and games. The goal with this approach is to tell the AI in detail what to generate so that the output is highly likely to be what the specific needs are. | <p>Tool used: Magic School AI (free version) Grade level: 8th grade Number of questions: 5 Topic, standard, text, or description of the assessment (be specific): <i>“buatkan saya 5 soal pilihan ganda beserta jawabannya untuk kelas 8 dengan topik konversi bilangan desimal menjadi bilangan biner. Soal harus menerapkan konsep HOTS berupa soal cerita detektif atau game”.</i></p> |
| Mr. Ivan | Mr. Ivan gives the target audience (grade 11), and the context of the question straight up, followed by very detailed instructions on what the desired characteristics of the answer options should look like. There are requirements such as the number of options needed, the composition of correct, error, wrong answer options and cognitive level constraints, operational verbs, display properties such as the similarity of length of answer options so that guessing is not easy. It aims at building an answer option structure for previously asked questions. | <p>Tool used: ChatGPT (free version) <i>“Buatkan saya jawaban Bahasa Indonesia untuk kelas 11. Syarat 5 opsi jawaban dengan 1 pilihan benar, 1 pengecoh, dan 3 jawaban salah dari soal berikut ini. Level kognitif: 3 Aplikasi. Kata kerja operasional: Menentukan. Pastikan panjang jawaban cukup sama agar tidak mudah ditebak.</i></p> <p><i>‘Belalang anggrek merupakan hewan yang mengalami metamorfosis tidak sempurna. Fase hidupnya terdiri dari telur, nimfa, dan dewasa. Belalang betina dapat bertelur sampai 300 butir. Telur tersebut diletakkan dalam sarang berbentuk buih putih yang disebut ooteka. Ooteka lama-lama akan mengeras dan melindungi telur-telur dari panas dan hujan. Telur-telur tersebut membutuhkan waktu sekitar enam minggu untuk menetas. Saat menetas, nimfa belalang sembah sudah menyeruai belalang anggrek dewasa. Itulah mengapa belalang anggrek disebut mengalami metamorfosis tidak sempurna.’</i></p> <p><i>Ide pokok pada paragraf tersebut adalah...”</i></p> |
| Mrs. Eny | Mrs. Eny employs an approach that builds upon attached external templates (using the school’s template), supplies rich content descriptions and exhaustive learning goal. The instruction asks for explicit standards such as the number of learning activities to be included in the module, learning objectives, details of the use of writing conventions, outputs in the form of | <p>Tool used: Gemini (free version) She attached the school’s template before giving prompt. Accordingly, her prompt is: <i>“Using the attached teaching module template, create a teaching module with 2 TLAs. The learning objective is to apply the persuasive/advisory writing conventions to produce school campaign posters using rhetorical devices (rhetorical questions, anaphora, aliteration, personification, metaphor, simile, onomatopoeia, and</i></p> |

| | | |
|------------|--|--|
| | posters, use of rhetorical devices and the appropriate audience (high school students) and asks for ready to use supporting materials. So this shows an effort to complete a set of teaching materials with thorough pedagogical specifications. | <i>hyperbole) on various issues related to high school students' lives. Also provide the ready-to-use materials for the activities"</i> |
| Mr. Mahfud | Mr. Mahfud uses a form interface to create a structured prompt using a prompt builder. Mr. Mahfud does not write free form commands, instead, he enter specific fields like the grade level, number of questions, math topic and story theme. Once that data is entered in its respective field and click 'Generate', then start the content creation process. Based on this method, the user is guided through input systematically (and controlled) to provide all key parameters necessary for input into the system which are then synthesized into the proper output. | Tool used: Magic School AI (free version) Grade level: Year 12 Number of questions: 5 Math standard/objective/topic: <i>"three variables simultaneous linear equation"</i> . Story topic: <i>"soccer, market, airport"</i> . |

In addition, in the utilization process, teachers visibly show how they leverage their content knowledge as a critical filter and to customize the output generated by generative AI. If they use AI to generate teaching material or ideas or questions, teachers have to go and look at the accuracy, relevance, depth of the material according to the standards of their discipline.

For the selection of which AI to suit the topic, of course, I will look at the characteristics of the topic. For example, the topic that is like making videos, for example, making advertising content or making a movie browser is dynamic, requires creativity, requires things that are adjusted to changes or conditions at that time. Generative AI plays a very important role because our ideas are extraordinary and can be explored, but for static content, for example, I let them to use Google Veo 2, or maybe Tensor, or Leonardo. So it is just to go back to increasing children's creativity like that. but in my own materials, not all of it uses AI. (Mr. Rafi, ICT Teacher, interview, April 14, 2025).

However, they do not solely consume the AI generated information they adapt. Instead, they modify and fine tune it to suit the curriculum and to suit accuracy of the subject matter. The ability to choose the most appropriate AI or generative AI tools to illustrate or support exploration of particular content is expression of emerging technological content knowledge, in which teachers engage with the affordances of technology on the content of what they teach, taking consideration of its unique characteristics.

For the selection of which generative AI tool that suits the topic, of course, I will look at the characteristics of the topic. For example, the topic that is like making videos, for example, making advertising content or making a movie browser is dynamic, requires creativity, requires things that are adjusted to changes or conditions at that time. Generative AI plays a very important role because our ideas are extraordinary and can be explored, but for static content, for example, I let them to use Google Veo 2, or maybe Tensor, or Leonardo. So it is just to go back to increasing children's creativity like that. but in my own materials, not all of it uses AI. (Mr. Rafi, ICT Teacher, interview, April 14, 2025).

... Usually in the 11th grade material on writing scientific papers. Maybe previously you have received information that in this school, specifically for 12th grade, there is something called a final paper or assignment test. Even in some other schools, there is also a practical exam for Indonesian, namely a defense, but since this is for 11th grade, this scientific paper needs to be simplified. But it is said that because the expectation is to be like a semi-thesis, the structure of the thesis then needs to be ultimately reduced. Well, that is it, I use AI to review and simplify which ones can be conveyed immediately and easily to students. For the structure in particular, especially the structure of the scientific paper. (Mr. Ivan, Indonesian Language Teacher, interview, April 14, 2025).

Next comes the application of pedagogical knowledge, that is, what teachers do in the planning, managing of student learning using generative AI. Teachers are not only considering what can be 'created' with AI; but how its usage can support effective teaching strategies and learning objectives. Their attempts at designing learning activities including design of learning activities with AI are also representative of this. It shows in their efforts to use AI in creative activities such as character design for their creative tasks (as reflected in the interview), as Mr. Rafi did by teaching the students how to use AI to design characters; instilling students' independent exploration of generative AI, as Mrs. Eny did; or attempting to develop ways for students to remain at the center of their learning while using the AI, as what Mr. Rafi and Mrs. Eny did.

... So, the first thing is how to ensure that students stay at the center of learning is of course the assessment rubric. So, the assessment rubric is clear. Definitely the desired output. Then maybe, the criteria or sub-criteria are clear. The timing, how long it takes. And so on. So, indeed the rubric becomes a benchmark that realizes, how students may not use different AI. If not, what are the AI options. That is already in the rubric that has been provided. If there are many, it means more freedom is given. Or if there are few, it means that the child must stick to one type of application or AI used. (Mr. Rafi, ICT Teacher, FGD, April 15, 2025).

In class, I have a session where, please use what you want, what you want to do, it is free. But that means things that are not related to competency assessment. So, it is more about opening up insights. (I told the to) Please look for feedback, how to make this good. Then, learn from it. Compare your results with AI's results, keep learning. That means where it should be good. That is free. What you want to use, whether you want to translate, whether you want to use grammar, whatever you want. But there are times, it is limited. I ask it like this, I provide the prompt, and it is based on what to look for. So, it is back to teacher control. For the limit, we want to see how far,

how small, the role of AI in our learning in the classroom. (Mrs. Eny, English Teacher, FGD, April 15, 2025).

The findings would suggest, overall, that high school teachers in this thesis research are embedded in an ongoing process of articulating these three domains of knowledge (technological knowledge, content knowledge, and pedagogical knowledge) within the utilization of generative AI. While proficiency of tools and depth of integration of tools and between tools varies, the realization is that truly effective and responsible use of AI in teaching requires more than technical tools mastery. The discussion of pedagogical wisdom that ‘generative AI’ requires to ascertain when, why, and how the former can best foster student learning while respecting educational values and the central role of an educator. To achieve an idealized effect and responsibility in the use of AI, it is necessary to master the AI technology and to develop other professional skills which are related to generative AI. Therefore, the topics of the next theme are: how teachers improve their competencies.

4.1.4.4 Improving Professional Skills of Generative AI

The necessity to become effective and responsible users of generative AI, which has been recounted in the previous section finally prompts teachers to find different means of enhancing their professional abilities. These findings are started with the preliminary questionnaire results in particular with the dimension of professional engagement. There are 5 items that are representative of the development of teachers' professional skills in generative AI. The summary of the results obtained in the preliminary questionnaire is as follows:

Table 4.13 Results of Preliminary Questionnaire on Professional Development for Teachers

| Items | Teachers' Responses | | | | |
|---|---------------------|----------|---------|-------|----------------|
| | Strongly Disagree | Disagree | Neutral | Agree | Strongly Agree |
| I can search and select various AI tools using different websites and search strategies. | 5.3% | 10.5% | 15.8% | 57.9% | 10.5% |
| I actively seek professional development activities (related to using AI tools) outside of my educational organization. | 0% | 26.3% | 52.6% | 21.1% | 0% |
| I actively share my teaching experience using AI with colleagues inside and outside my school. | 5.3% | 26.3% | 36.8% | 31.6% | 0% |

| | | | | | |
|--|----|-------|-------|-------|----|
| I am enthusiastic to help my peers/colleagues in designing learning activities that utilize AI technology. | 0% | 21.1% | 36.8% | 42.1% | 0% |
|--|----|-------|-------|-------|----|

According to the results of the preliminary questionnaire, most of the teachers were confident in their personal capabilities to search and choose among different AI tools, and 57.9% agreed to the statement. There is however less confidence on action in terms of external professional development where most respondents (52.6%) were neutral (52.6%) or disagreed (26.3%) that the teachers actively seek activities beyond school. Furthermore, there existed reluctance towards discussing teaching experience with AI with colleagues, which was reflected in the responses that have been spread across disagree (31.6 % in total), neutral (36.8%), and agree (31.6 %). However, the willingness to assist co-workers in the designing of AI-based learning was rather positive, as 42.1% said they were willing to help.

This result is an indicative of the discrepancy between personal technical competence, and collaborative professional development efforts. Teachers believe that they can independently find technologies, although they are passive in upgrading (the knowledge). They are not active in acquiring new knowledge externally and have not developed effective knowledge sharing culture in their working environment. The results of this preliminary questionnaire adequately described the initial situation of the teachers in this school for the researcher. Interestingly, the results of the interviews and FGDs demonstrated another and more dynamic reality.

Moreover, findings from interviews and FGDs of the four teachers revealed that high school teachers, especially in this school are conscious and making deliberate efforts to improve their professional skills when it comes to the generative AI technology. Understanding the importance of being competent in AI literacy, they are continuously motivated to develop their competencies. In regard with this, a teacher said:

I think the focus here is on AI literacy, where literacy itself can simply be described as being literate. AI literacy is being literate in AI. Any illiteracy will certainly pose risks. If the teacher is not literate in AI or does not understand what AI is, then many risks will arise. Whether it is misuse, inability to use it, or accidentally accessing data, even though that is unlikely to happen. Now, from the students' perspective, the risk when students are not literate in AI is... well, if the teacher is not literate, the students are not either. It just does not connect or makes no sense. That is all. (Mr. Ivan, English Teacher, FGD, April 15, 2025).

Another important aspect is a willingness to keep learning toward the optimal and responsible usage of AI in teaching. This can also be reflected from teachers' answers during interview:

I will use a short quote that I once heard from my mentor. I once heard this quote: *“if a teacher stops...”* I mean... *“no longer wants to learn, then it means that it is time for that teacher to stop teaching”*. So, if a teacher no longer wants to learn, then it is better for them to stop teaching. Now, AI and similar technologies can be seen as challenges, but they can also be seen as opportunities, so we still have to face them, we still have to learn them... can this technology help us learn faster? Or does this technology pose a challenge to our learning? We still have to learn it so we know what we are facing, what the challenges are, or even if this becomes something that helps us make teaching easier. (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025).

Meanwhile, another teacher, Mrs. Eny, said in an interview that her non-stop learning in utilizing generative AI is through trials and errors, meaning, she had undergone some experiments:

For me... (learning to use AI) has to be done repeatedly. In my opinion, I have been actively using it for the past year. So, through trials and errors, I can figure out like *“oh... this does not work, oh... this works.”* (Mrs. Eny, English Teacher, interview, April 14, 2025).

But what is most noticeable and what becomes a driving force in the building of these skills, is informal initiatives undertaken individually or collectively. Teachers are actively embarking on independent exploration territory, whereby they are teaching themselves through trials and errors, trying out different features and exploring what generative AI tools could be capable of through actually using them.

I have been using it for quite a while now, because I happened to follow it from the beginning, starting from when ChatGPT was first launched. I have been following it and continuing to try to use and learn it, because I also happen to teach IT. (Mr. Rafi, ICT Teacher, FGD, April 15, 2025).

Actually, I have been tinkering with and learning how to use ChatGPT for quite some time now, which means... if I calculate it, I have been using it for 3 years to prepare lessons and create questions. (Mr. Ivan, ICT Teacher, FGD, April 15, 2025).

Through trials and errors (of using AI), I can figure out *“oh... this does not work, this works.”* It's just that maybe those who do not use it much will not be able to see which ones can be used to their full potential. What I mentioned was informal sharing, so that is about it. (Mrs. Eny, English Teacher, interview, April 14, 2025).

So, for several months I explored Magic School, and after delving deeper, I discovered that there were so many tools that could be used, both inside and outside of Magic School and elsewhere. (Mr. Mahfud, Mathematics Teacher, FGD, April 15, 2025).

In addition, one of the key findings here is the culture of sharing and collaboration among peers. It is a place where teachers are exchanging practical information, tips and tricks, problem solving strategies and even inspiration on how AI can be implemented by incorporating it into different teaching scenarios in a practical way. This is depicted from the teachers' answers:

Yesterday, my friends participated in a teacher training session organized by the Department of Education, where they had to analyze videos, answer questions, and so on. I did not participate, though. Some of my friends told me they used AI to generate text from YouTube videos they had to watch, which saved them a lot of time. So, my friends who attended the training...they also share to each other how to use it for the training. (Mr. Rafi, ICT Teacher, interview, April 14, 2025).

A similar practice, where sharing information, tips and tricks, problem solving strategies and even inspiration is also evident on Mrs. Eny:

... Then, there was also the training session organized by the Ministry of Education, where we had to answer a lot of questions, all in essay form. So we had to write. Yes, essays. So, it can be done, but it takes a long time if done manually by thinking on your own. So, I ended up typing out the prompts, creating them, finishing them, and then sharing them with my friends, saying, *“Go ahead, use my prompts tat I have made.”* And some friends who used them could do it faster. Even though they have to type, the results are already there and they're personalized based on each teacher's situation. So my prompts are general but detailed based on the teacher's specific conditions, subjects, or whatever else is relevant to them. (Mrs. Eny, English Teacher, interview, April 14, 2025).

Mr. Mahfud also added that he used the chance (sharing between peers) to ask to senior teachers about AI tool to enhance his teaching:

Well, that is what I experienced last year. I just joined this school... one year and a half as for now. And to be honest, I never had any exposure to AI or anything like that before. After joining here, there was an induction period... From there, I discovered generative AI like Magic School and others... I forget the names. But what really stuck with me was Magic School. So, during the first few months I was here, I really delved into Magic School. I also asked senior teachers who were more experienced than me about using Magic School—what it was like, what can it do? And other similar software or tools that I could use, like that. (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025).

Taken together, these efforts for professional skill improvement are testament to the dedication and agility of teachers to keep growing and developing ourselves in step with the fast evolving generative AI technology, in the end, to have a better understanding of this rapidly growing technology, and most importantly, to give students a more relevant and meaningful learning experience. It is possible that in the future, AI, especially generative AI, will be used more extensively, particularly in the context of learning.

4.1.5 Summary of Findings on Teachers' Utilization of Generative AI for Teaching (RQ 2)

The findings to the second research question reveal that high school teachers actively use generative AI which is chiefly used to enhance the process of producing and developing teaching materials. They rely on different types of AI tools, commonly ChatGPT for making

Lesson design, worksheets and test questions, plus concepts reinforcement which reputedly is dependent on how well a person can create prompt and decide which AI tool to use. Besides, generative AI is also being leveraged to assist students' learning activities directly, e.g., to complement students' work in creative tasks or to facilitate students' self directed exploration, although the adoption level is still different. Its main usage in the world of assessment is highly limited and more often done with caution, where teachers are still at the center of final validation as they fear accuracy and integrity and its main use is for initial assistance, like generating question ideas or formative feedback.

The use of AI in these different aspects depends on teachers' ability to implement their technological, content and pedagogical knowledge (TPACK) in a balanced way. While recognizing the rapidly changing nature of AI, teachers also adopted a continual commitment to their own professional development, using a variety of formal and informal channels, including independent exploration and peer collaboration, to do this. Overall, from this study, teachers' uses of generative AI are seen to be an adaptive and pragmatic process, in which teachers tried to seize the possibilities of this technology while maintaining a critical mindset and responsible methodology to guide them through this changing technology.

4.1.5 Findings on High School Teachers' Challenge Upon AI/Generative AI Utilization

The third research question on this thesis research is *What challenges do high school teachers face when using generative AI for teaching?* This question is answered based on the major themes and sub-themes appeared that emerged from the open-ended questions in the preliminary questionnaire, structured observation results, FGD transcripts, and semi-structured interview transcripts. Themes and sub-themes are based on teachers' hands-on experiences upon the barriers that they experienced in utilizing AI, particularly generative AI for teaching and learning.

Data garnered were also further analyzed using Braun & Clarke (2019)'s six phase framework for thematic analysis. This analysis resulted four main themes: 1) accessibility and supporting infrastructure constraints, 2) absence of guidelines for AI use in the institution, 3) teachers' capacity gap for effective AI implementation, and 4) teachers' dilemma in maintaining students' academic integrity. These themes give insights into the reality that occurs, especially related to obstacles or challenges in the use of generative AI, which in this study is at the high school level, specifically in Indonesia.

4.1.5.1 Accessibility and Supporting Facility Constraints

With the development of technology, it will also require supporting facilities and infrastructure so that this technology itself can be run. If the facilities and infrastructure in an institution are not or have not been said to be adequate, then this can be a challenge in itself. With this, one major challenge that teachers encountered when implementing generative AI, which in this regard pertains to accessibility and supporting facility constraints. Teachers are very excited to try out what seems to be new, exciting technology, but in practice, using AI is not always smooth. Teachers conveyed that the availability and the quality of technological infrastructure in the school environment are fundamental and if these are not adequate, they can quite limit the potential use of AI. The initial conditions described by the results of the open-ended questions in the preliminary questionnaire indicate that there are teachers who mention that facilities and infrastructure such as the availability of hardware and also a stable internet network are a challenge in using AI tools, especially generative AI tools. Examples of teachers' answers from open-ended questions in the preliminary questionnaire can be seen in the following table:

Table 4.14 Example of The Teachers' Answers Regarding Challenge in Terms of Supporting Facilities

| What are the biggest challenges you face in using AI tools to support teaching? |
|---|
| Internet signal, evenly qualified gadgets |
| Wifi signal, because sometimes the internet connection are not as expected |
| Supporting facilities such as internet network |
| Computing resources, good internet connection |
| Completeness of electronic devices that support the implementation of AI-based teaching |

Then, the findings of the initial indications from the preliminary questionnaire results were also corroborated from all the four teachers in the interview session, where they said that in this school, the facilities that support the use of generative AI, which in terms of hardware are still not qualified. One of the statements from the teachers, as Mr. Rafi said is:

Then also in terms of the specifications of the computer or laptop used. And so on that is also a challenge in itself. Because not every PC or laptop can generate AI. Especially now that there are many models that can be generated offline. So it does require higher specifications than the usual ones. (Mr. Rafi, ICT Teacher, interview, April 14, 2025).

In addition, some specific cases that were related to this constraint are the stability and speed of the internet connection in the school area. Many of the generative AI tools are

online based and so, the reliability of an internet connection heavily depends on the performance. Overall, reports of connections at certain points or times being unstable or slow are a real challenge to overcoming these issues without disruption to the flow of learning activities using generative AI. Similarly, the availability and specification of adequate hardware for teachers and students where interactive use of AI on a classroom scale is considered something to account for. The practical barrier can be the fact that the specifications are not qualified enough to run certain AI applications. This is as expressed by the teachers as follows:

Yes, maybe sometimes here ... sometimes it is just like before (referring to the demonstration session in the structured observation), I was about to use it, but it died (the computer). That means it's more technical. Infrastructure that is not yet modern in line with technological developments, that's all. (Mrs. Eny, English Teacher, interview, April 14, 2025).

.. one thing that still not quite adequate is from the infrastructure. Maybe from devices that are less modern, less to work fast with existing technology. (Mr. Mahfud, Mathematics Teacher, interview, April 14, 2025).

In turn, these conditions have created the perspective among some teachers that there is an imperative to enhance facilities which would allow the potential of AI or generative AI to be leveraged more thoroughly in the school context. While these are technical infrastructural constraints, they may ultimately impact the rate of adoption, the frequency of use, and the performance of generative AI tools in achieving pedagogical goals. This is also in line as what Mr. Rafi said:

However, there are indeed some things that must continue to be improved. Because AI is always evolving. Upgrading computers, upgrading connections are things that must be underlined. (Mr. Rafi, ICT Teacher, FGD, April 15, 2025).

The problem is the internet connection. Because the wifi is wide, and there are many people using it. When 20-22 children use the internet in one class, let's say on the third floor, of course it's not strong. There is a solution in our school, so when it's the season of making final papers or there is a lot of use of the internet, we can apply for a special connection. And that is possible, the wifi is specifically directed here. Other than that, it's just houses. Everything is submitted here, to my room, you can use it. But it's on request, and it can't be impromptu. So when there is an impromptu inspiration or want to do something, it can not be done. So that's the main problem, the internet connection is not always able to support online use, online lessons. In my opinion, this should be upgraded in the future (Mrs. Eny, English Teacher, interview, April 14, 2025).

Hence, it is apparent that infrastructure is a key prerequisite, that without the necessary facilities and infrastructure, the effort of maximizing the educational benefits of Generative AI will always be constrained by the basic prerequisites.

However, teachers' challenges do not end at physical and technical limitations. Once the infrastructural constraints have been discussed, the discussion examines another layer of

challenges which are organizational and procedural in nature and revolve around the absence or even lack, of formal guidelines and policies from the institution regarding how to be getting used with this rapidly developing technology. This will be expanded on in the next theme.

4.1.5.2 Absence of Guidelines for AI Use in The Institution

Apart from these physical and technical challenges, non-technical aspects like the absence of guidelines and regulations have also become critical challenges. The next structural challenge focuses on the lack of institutional guidelines or policies. If the infrastructure is in place, but there is no clear guidance on what teachers can do with it, they may still be reluctant, insecure or do not know about how to employ AI. This is a system/organizational level problem which prevents individuals to function. In this regard, the open-ended questions in the preliminary questionnaire indicate this problem as follows:

Table 4.15 Example of the Teachers' Answers Regarding Challenge in Terms of Guidelines and Regulations Absence

| What do you think is needed to make the use of AI in learning more effective? |
|---|
| Clear boundaries on the use of AI. |
| Ethical guidance for students on responsible use of AI. |
| Ethics and Regulation. |
| Clear regulations. |

According to some of the teachers' responses in a preliminary questionnaire, some teachers pointed out how important clear boundaries in AI used are. And with a more general reinforcement of ethics and regulations governing the use of these technologies was an emphasis on the need for ethics and for ethical guidance for students in the responsible use of AI. They also demanded for clear regulations, showing that teachers want a guideline which can offer them the certainty and direction needed to integrate AI in the classroom. The researcher use preliminary questionnaire data as a reality check first, before dives into the main data, which is the data from interviews and FGD.

Moreover, this depiction of condition is corroborated by individual interviews and FGD from the four focal teachers. It is disclosed that they operate without clear guidelines especially when there is not a direction given by the top school authorities or the higher

authorities. They are confronted by urgent questions on the boundaries of AI usage, the ethical aspects and academic integrity that have to be safeguarded, and how to manage with student work that has been developed with the aid of AI or generative AI without any reference to the incumbent institutional policies. However, some of the teachers reported that at times, they end up depending on the personal interpretations and their personal standards which can even differ from person to person, hence leads to inconsistent implementation of this at the school level. This was seen during discussions with teachers in the FGD:

Maybe I will add a little bit...it's about the guidance. Yes, guidance. How is a good guidance so that we can maximize the use of this AI without violating boundaries like maybe copyright, maybe morals, and so on. It's not there yet. (Mr. Mahfud, Mathematics Teacher, FGD, April 15, 2025).

I would also like to add. Guidance, there is none yet, right? (*checking with other teachers*). Yes. So we have been running according to the standard... maybe our own standard. So there is less physical similarity in its use. (Mr. Ivan, Indonesian Language Teacher, FGD, April 15, 2025).

Additionally, some teachers during interview also stated the same issue:

Because AI is still a new technology. Indeed, in terms of curriculum or in terms of standard guidelines, there is no such thing yet. So there are really many standards. According to A, this is good, and so on, and so on. So the challenge is indeed how do we choose and sort out which AI tools are most suitable for such learning. The second thing is of course, apart from the fact that there are no standards or rules or policies in schools. (Mr. Rafi, English Teacher, interview, April 15, 2025).

.... As I recall, there is no such thing as a specific usage guide or any specific rules regarding the use of this AI. (Mrs. Eny, English Teacher, interview, April 15, 2025).

From these FGD and interview data, it can be inferred that teachers in general agreed that clear guidelines are needed: to establish boundaries, and also to guide teachers, especially how AI can be integrated responsibly and positively in the learning ecosystem, said Mr. Rafi who also pointed out the need to define and establish policies, since AI has many negative impacts: "...then what kind of policy to deal with the negative impact of AI. I think it needs to be clearly defined and spread" (Mr. Rafi, ICT Teacher, FGD, April 15, 2025). This statement underscores that teachers' awareness of the risks and negative impacts of AI reinforces the urgency for clear institutional guidelines. Without such a framework, teachers lack a strong hand to ensure that the use of generative AI truly supports educational goals in a safe and constructive manner. Besides lacking a formal guideline or regulation, there is another major hurdle hindering the utilization of generative AI, which is the perceived lack of capacity among the teaches themselves which will be the primary topic covered in the following theme.

4.1.5.3 Teachers' Capacity Gap for Effective AI Implementation

Another barrier in the high school teachers' ability to successfully implement generative AI, aside from external factors like institutional support, are teachers' own issues of capacity regarding their ability to apply it dynamically within the context of teaching and learning. This gap encompasses a wide range of issues, including lack of AI knowledge and skills, also the extra time and effort it takes to learn and implement these new technologies into current teaching. The preliminary questionnaire results from the open-ended questions then revealed initial insights of this situation:

Table 4.16 Teachers' Answers Regarding Their Challenges Faced on Their Capacity Gap

| What are the biggest challenges you face in using AI tools to support teaching? |
|--|
| Lack of knowledge, the use of AI is only limited to the use of making learning materials |
| Opportunity & willingness to continue learning new platforms, especially for teaching |
| Limited time to design a teaching material |
| Lack of AI trainings |

The initial questionnaire yields data that will give an overview or a point of entry into the multiple challenges of teachers in relation to their capacity gap in the use of AI. In response to what they see as the most significant difficulties in utilizing AI tools to assist in teaching, the responses of the teachers reveal a number of important barriers. Such obstacles also involve perceived lack of technical knowledge, resulting in using AI only to generate learning content. Also, the time constraints noted by teachers as another important practical limitation. Conversely, there also arise issues pertaining to the possibility and interest in learning new platforms further and a recognition of an overall deficiency in AI training. All these first reactions suggest that the capacity problem the teachers face is not one-dimensional but rather encompasses knowledge, time, and inspiration dimensions.

Moreover, some teachers indicated that they felt their own technical skills and knowledge in relation to AI or generative AI need to be improved, which was uncovered from the FGD and individual interviews:

For me, I feel like I am not doing enough, maybe I am only 3 out of 10. For example, yesterday there was training on making book chapters with the ChatGPT team. But the training explained how we can make a book chapter collaborating with this many people to write a book. That is also something new for me in ChatGPT 4.0. Then also how ChatGPT 4.0 can generate images for certain advertising models. So I think that is also really new points on how to produce consistent image programs for example in ChatGPT and so on. And I think because it is constantly evolving, so the knowledge I got today is like water in a glass with many holes. No

matter how much knowledge we get, it will continue to feel lacking. Because we have 25 thousands or millions of new knowledge born at the same time. (Mr. Rafi, ICT teacher, FGD, 15 April 2025).

... Maybe what is lacking for me is... what I lack knowledge is like what I told you earlier. For instance, I want to find an AI that can make posters based on drafts. Maybe I need to explore more... (Mrs. Eny, English teacher, interview, 14 April 2025).

... If I have a percentage, maybe I am still at the 50-60 level. Because the more I explore, the more I read, it turns out that so far all I know is just the skin of it. I still need to read more, and utilize more. And honestly, the AI that I have used so far is more for myself. So I have not used it to help my students learn. Maybe just asking to make learning materials. Like for example, today I want to learn about inequality (in mathematics) then the condition of the children is like this. How do I want my students to learn... It is just limited to that. (Mr. Mahfud, Mathematics teacher, interview, 14 April 2025).

Then, although from the utilization aspect of this thesis research (see section 4.1.2.3) already provide insights into how teachers create prompts when using it to assist teaching or learning, however, there is one teacher who acknowledge that he still struggles with how to formulate or create prompts that actually generate AI outputs that address the learning needs in the way he intended. This can be seen in the following excerpts of his statement:

The obstacle is actually how to translate what I want so that it is understood by the generative AI. In simple language, how to do the right prompting... How to communicate with it. So I want to go this way, then how do I get the machine to understand that? That's the challenge. Sometimes it is hard for me to express what I want. I have already given this prompt, but the machine reads it or interprets it the other way. That's the challenge. (Mr. Mahfud, Mathematics teacher, interview, 14 April 2025).

Furthermore, the perceived demands of time and effort to learn, experiment and adapt generative AI into teaching routines was a challenge that was quite obvious from the interviews. To this, a teacher admitted:

For this AI technology, because it is very fast developing, it is very difficult to keep up with so many AI models that are updated almost every two weeks, especially since many of these are paid, of course. So indeed we are only limited to trying which features suit our needs and can be incised for free of course. So it's like that. (Mr. Rafi, ICT teacher, interview, 14 April 2025).

He then added:

...Because technology is quite disruptive, so it abolishes or eliminates many old habits and offers new solutions or methods that are more productive. Usually, the application takes time I think, so for instance, I am just trying to make an AI avatar, where the avatar will clone the movements and voice of this person, the creator, but I am still exploring this, not yet in the implementation stage. This requires a lot of time to do experiments. (Mr. Rafi, ICT teacher, interview, 14 April 2025).

Moreover, with current workloads, teachers also admitted that they had a hard time finding dedicated time to be able to explore more AI tools, design new materials with new AI tool, or just merely testing out new generative AI tools. Because, this process demands heavy time investment, from initial familiarization to reaching a level of proficiency where true effective and innovative AI implementation can happen.

This, therefore, brings to the one main obstacle of use of this technology in the school environment; the gap between the potential of generative AI and the actual capacity of teachers to make use of this to their optimum. Therefore, in response to this perceived capacity gap, there is frequent reference by some of the teachers with regards to the need for continuous and relevant professional development on AI and the latter, in particular, that is organized and facilitated by school.

In my opinion, maybe the thing that is necessary from the school is that there should be professional training so that us can rely more on AI instead of wasting time that can actually be used for other things instead of struggling. So yes, it is very lacking officially professionally, especially teachers at our school get training on AI, which we should be able to.... so that we don't get defeated by the children who also use AI. (Mrs. Eny, English teacher, interview, 14 April 2025).

Another teacher added:

As far as I know, there is none (professional development on AI). What is really needed is like training for teachers specifically. But we need it professionally, meaning, we need people specialized in the field of AI to continue to provide training to teachers who can answer every question and can provide innovations and new things. So far there is none. It's necessary because it's a waste that there are friends who still can't utilize AI even though it will greatly relieve energy and free up time for other things. (Mr. Mahfud, Mathematics teacher, FGD, 15 April 2025).

And lastly, this is also confirmed by the open-ended question in the preliminary questionnaire results, in which the teachers mentioned the need for more AI trainings often:

Table 4.17 Example of the Teachers' Answers Regarding the Need of Training (Professional Development) in Using AI

| What do you think is needed to make the use of AI in learning more effective? |
|---|
| Various trainings on the use of AI for more insights |
| Teacher training related to the use of AI and cyber security |
| Teachers are given practical training on how to use AI appropriately |
| Training |

Teacher training that includes competence in the use of adaptive platforms in each learning material, competence in accuracy of information obtained from AI, etc.

Lastly, beyond the need for capacity building in general technical and pedagogical terms, then rises a more urgent matter, given the complicated and often contentious aspect of AI, which is ethics. In terms of this, the next theme will focus on the different ethical conundrums in which teachers struggle with academic integrity when generative AI is widely used, especially in school.

4.1.5.4 Teachers' Dilemma in Maintaining Students' Academic Integrity

This theme became the most important issue, as well as the concluding theme of the third set of research questions of this thesis research. The most fundamental and widespread concern voiced by high school teachers in this thesis research was the issue of ethical dilemmas in maintaining the academic integrity in the era of AI or the era of generative AI. Deep confusion surrounding originality, honesty and the essence of the learning process itself has been stirred by the ability of generative AI to create content that nearly looks like human work.

Though the items in the preliminary questionnaire were not directly designed to capture the specific dilemma academic integrity (from students' side) that the teachers felt, however, this can be indicated from the open-ended answers. Responding to the question about what would help to use AI more effectively, one teacher pointed to the fact that students need "ethical guidance on how to use AI responsibly". The requirement to provide explicit ethical instructions manifested in this statement implies that teachers may feel the threat of students using AI improperly and experiencing academic dishonesty as a consequence. The complete extent and depth of this ethical dilemma as one of the fundamental problems that teachers faced was then discussed in detail using the findings from FGD and individual interview as it repeatedly underscored how teachers engage with these important aspects.

First, teachers believe that they must not only teach content but also pass on to students digital ethical values for interacting with AI technology. The view of the responsibility of society is not solely an individualised undertaking but it has a root at institutional values. The identification of academic dishonesty within the school system finds an added meaning, per se, when referred to the Learner Profile of the school itself as an official document expressing the developmental end goal of students becoming a self-nurtured person who is to be identified as a responsible, independent as well as a critical thinker. Such a product of generative AI that works as a shortcut implicitly contradicts these

institutionalised values, hence creating a pedagogical and moral dilemma among teachers in two ways. To address them, teachers use diverse interventions aimed at responsible use of digital technologies. This is evidenced from the following statements by some teachers:

(In this context) Students are allowed to use AI as a supporting tool only. The way to do this is to give them time to use AI and discuss it with me. After that, I will direct them on how to solve it based on the ideas they get. This applies to both written and product assignments. (Mr. Ivan, Indonesian Language teacher, interview, 14 April 2025).

I usually give direct examples to them. For example, showing that the material I created was assisted by generative AI and stating that it uses AI, etc. (Mr. Mahfud, Mathematics teacher, interview, 14 April 2025).

Secondly, these ethical concerns led to a real threat to academic integrity, specifically related to the potential for massive use of AI by students, but were immediately swallowed raw, without double-checking the truth. But before getting into that, there is an interesting paradox of the use of generative AI by students in this school. One of the teachers said and admitted that the use of generative AI has been quite cultured in this school. Not least, for 12th grade students, whose use is already at the stage of making the final paper, which even those students used the Systematic Literature Review (SLR) research method:

It is even evident from the final paper done by 12th graders, that they used the SLR (Systematic Literature Review) method. So they reviewed hundreds of articles or journals with AI. Yes, that's one small indicator of how AI is used in this school. (Mr. Ivan, Mathematics teacher, interview, 14 April 2025).

This shows the positive potential that students can use AI as a powerful tool for complex academic tasks. However, at the same time, one teacher also revealed if there is also irresponsible use of AI by students. This is as expressed by Mr. Rafi:

Indeed, I see that there are also many students who make final papers or research only based on AI, without understanding the process or doing the stages that they should do in conducting research like that. (Mr. Rafi, ICT teacher, interview, 14 April 2025).

In addition to AI being widely used by students, which in this example context is to create final papers, other uses by students are also often used to do daily digital assignments, as expressed by Mrs. Eny:

I already do not trust my students nowadays. So if I tell them to type, especially when the computer has internet... unless the internet is turned off, and then they write, or type, I do not trust them anymore. Because not only they always use ChatGPT, but they also always use Google Translate. I don't see children now with high integrity, so automatically if they do not use Google Translate, they will use ChatGPT. Meaning, they do not use their own knowledge and skills. (Mrs. Eny, English teacher, interview, 14 April 2025).

And further, she also added, that earlier during lesson time (before the interview was conducted), she found her students secretly “sneaking” using ChatGPT in her class. In fact, she instructed her students to write first manually instead of directly using a computer.

This issue just happened this morning, I said: “*write as much as you can on the paper*”, because later the next step I will ask them to ask for feedback from ChatGPT, but my plan is for later. After they have done the grammar and structure points, then like I said earlier, “*enter your writing*” (to AI), this is the prompt, the rubric, read the feedback. I just asked them to type it, then check it on grammarly. But uh, apparently I caught ... there were students who opened ChatGPT, then I asked: “*What are you doing opening ChatGPT?*” “*Why am I not allowed, maam?*” “*Yes, because I just said it's not allowed. It is not time yet.*” So yes, as a teacher, I have to be in full control. (Mrs. Eny, English teacher, interview, 14 April 2025).

Moreover, the difficulty in detecting works produced or significantly assisted by AI is also a troubling practical dilemma faced by the teachers. This is as evidenced from Mr. Ivan’s statement below:

So, in my opinion, the biggest risks are to creativity and integrity. With integrity, the issue is that it is hard (for students) to say, *‘I got this from this specific source.’* If it comes from an AI, whatever that AI is, there's no element of plagiarism that you can legally take action against. Legally, you cannot really say someone's rights have been violated in the usual way. But, it really boils down to the moral issue: it is simply not their own original work. And that is something that us, as high school teachers already seeing happen among students. (Mr. Ivan, ICT Teacher, FGD, 15 April 2025).

Teachers feel that the line between using AI as a legitimate learning tool and misusing it to take shortcuts is becoming thinner and harder to identify. Morally and honesty-wise, it is a problem because students may pass off AI work as their own hard work when it is not. This is a form of dishonesty or lack of integrity, although it may be difficult to legally prosecute as traditional plagiarism. In addition, the findings also indicates that there is a duality in the use of AI by students at the school: there is the potential for sophisticated use that supports complex academic tasks, but at the same time there is a risk of irresponsible use that neglects essential learning and understanding.

Therefore, to deal with these ethical dilemmas and integrity threats, there is a strong need for control over the use of AI on the part of teachers as one of the mitigation mechanisms. Especially, since these students are still at the secondary education level. Although in practice and reality there are still many students who are ‘sneaky’, but, at least, teachers also still try to control the use of AI. This is as expressed by the following teachers:

For me, if I am the supervisor, because in this school there is a final paper where one teacher can be a supervisor or can be an examiner. I will first calibrate their writing with the understanding they have when the students can explain well, both the various concepts of practice or the methods they use, then they are considered to have understood not only the

AI. However, for certain students, this is still a struggle. Meaning, they need more efforts so that they do not merely copy and paste from AI, but they really understand how an educational process is carried out. So it must be the teacher himself who is active to explore, recalibrate the results of the research they do with the understanding or mastery they have. And yes, this school is already open in terms of AI use. (Mr. Rafi, ICT teacher, interview, 14 April 2025).

Similar to Mr. Rafi, Mrs. Eny also controls her students, but it is more likely to be done practically and strictly:

So for me technically, if I ask them to do something like this, typing, I arrange their sitting position all facing the wall so that I can see all their screens. Just like in an internet cafe, so everything is arranged ... they are facing the wall, so I can look to the left and right, I can see what's on the monitor just in case they open ChatGPT, or maybe they open a game like that. So that's one of the things, if we don't have full control when working on it, that's what teachers are worried about. But there are ways...so that they are more controlled. Maybe there are times where once or twice, they would open it, but after I went around and saw, no one opened ChatGPT Windows, they only open related tools as I instructed. So yes, the control is really full, and it's tiring. It's tiring, because we have to go around the class, non-stop, and monitor constantly. We can't sit holding a cellphone, we can't play cellphones in front of the class. But by that way, children can learn to use, at least use technology responsibly. This kind of control is the hardest thing to do, but I have to do it anyway. (Mrs. Eny, English teacher, interview, 14 April 2025).

From those answers, it can be implied that implementing these controls is not without its own challenges. The dilemma facing teachers is whether or not to grant students learning autonomy given the need to guarantee integrity and the constrained time and resources for examining the quality and the substance of every student's uses of AI. Therefore, while teacher control is seen as essential, its implementation in daily practice is still an area of struggle that requires guidance of AI, support, and strategy development.

4.1.7 Summary of Findings on High School Teachers' Challenge Upon AI/Generative AI Utilization (RQ 3)

Research results indicate that teachers using generative AI in high school encounter a multi layered set of difficulties in its use for teaching. Accessibility constraints, along with suboptimal supporting infrastructure (i.e., limited devices and unstable internet connections), form the main fundamental and external challenges that directly hinder the effective usage of AI. Moreover, the school institution lacks clear guidelines and policy on the use of AI which is yet another barrier for teachers to set boundaries and good work practices of such use.

Moreover, there are challenges on the teachers internal side, mainly due to gaps in their capacity to apply the effective AI. Issues connected to these include AI literacy, as well

as technical and pedagogical skills still to be developed and the tremendous time and effort investment required to learn and integrate these new technologies in teaching and learning routines. The most troubling core challenge of all is the ethical dilemma of maintaining academic integrity. However, the issue of AI-assisted plagiarism that teachers face, the challenge of how to assess originality of student work and the responsibility of instilling ethical use of AI exacerbate the dilemma of what a teacher is in this age of digital era.

4.2 Discussion

This section will further discuss the results of the findings of this research and discuss them with the theoretical lens, as well as previous studies. Each discussion will be discussed coherently according to the results that have been presented in the findings section, which in each research question consists of several main/key themes. Discussion will theoretically pivoted based on Long & Magerko (2020b) framework and the AI-TPACK framework by Ning et al. (2024).

4.2.1 Discussions on High School Teachers' Perception About Generative AI (RQ1)

From the findings, the many facets of high school teachers' perceptions regarding the existence, and the potentials of generative AI in the context of teaching were revealed. More than just a view between accepting or rejecting, however, this thesis research reveals a view that is rich in nuance, awareness, hopes, and cautions in the use of generative AI. This discussion section aims to interpret more deeply the meaning behind these findings, relate them to broader conditions in Indonesia, and review them through the lens of the theoretical framework of the AI Literacy framework and AI-TPACK framework.

4.2.1.1 Generative AI as a Potentially Transformative Technology

Openness to Use Generative AI

This thesis research's initial findings indicate that high school teachers have a cautious optimism toward generative AI. More than just a new technology, generative AI is perceived to have significant transformative power, where this is in line with what has been stated in the introduction part of this thesis research according to Zainal & Mohd Matore (2024), that generative AI really has transformative power, especially in education. The base for this perception is the openness of the teachers which is manifested in their attitude of acceptance, acknowledgement, and willingness to embrace the presence of AI or generative AI. This attitude is based on the first impression that AI or generative AI is a tool that has the potential to help their work especially in terms of teaching. The discussion of these findings will explore the implications of this openness attitude.

This open attitude and initial perception that AI, especially generative AI, is a helpful tool, as found among high school teachers in this study, is a crucial foundation for the development of AI Literacy as proposed by Long & Magerko (2020b), where AI literacy is defined as a collection of abilities that prepares people to critically evaluate AI; communicate and cooperate with AI effectively; and use AI as a tool in digital environments, homes, and workplaces. Furthermore, the openness of teachers to accept and acknowledge AI technology itself is the first step that allows teachers to start interacting and developing those competencies. Annuš (2024) supports this fact with an explanation that the openness of teachers is a key requirement or facilitating factor that enables them to explore and successfully integrate artificial intelligence into their teaching methods. Simply put, teachers may feel reticent to participate in the learning process required to become literate in AI or even generative AI without understanding and openness, which in this case is a positive attitude regarding ‘What is AI?’, ‘What can AI do?’ and ‘How should AI be used?’. Like what is in the competencies recognized in the framework of Long & Magerko (2020b). Generally, teachers who are positive towards AI will be encouraged to introduce AI related content into their classroom (Polak et al., 2022). Thus, the results of this previous study corroborate this, because it is necessary for this positive disposition to be established in order to continue to engage with the AI technologies.

From the AI-TPACK framework perspective, although the AI-TPACK framework proposed by Ning et al. (2024) describes the knowledge domains needed by teachers, however, it does not specifically discuss the dispositions needed at the beginning which then will lead those teachers to build those knowledge domains. On the other hand, the findings of Annuš (2024)’s study also point towards a ‘positive development’, in that teachers are open to AI, and this openness is a way forward in convincing them to embolden themselves to explore the ‘roads’ and ‘directions’ to integrate technology. When taking these two ideas into account, the process ‘seeking ways and directions’ may be viewable as a gateway to establish teachers’ AI-Technological Knowledge (AI-TK). This urge to explore, in turn, leads them to explore how AI technology can be effectively used with their current Content knowledge (CK) and Pedagogical Knowledge (PK) (Raygan & Moradkhani, 2022; Tondeur et al., 2020; Voithofer et al., 2019 cited in Yue et al., 2024). In other words, this forms the core of the process of integrating this and hence, the development of the AI Technological Content Knowledge (AI TCK), AI Technological Pedagogical Knowledge (AI TPK) and finally the AI TPACK as a whole. In other words, this is consistent with the study by Govender & Maharaj (2005), that underscores the significance of an initial positive user attitude as one of the basic elements on which depends the new technology adoption success.

Educators need to have positive attitudes toward information technology for it to be incorporated in their classrooms and to avoid resistance.

Moreover, the synthesis of these findings shows that the initial positive attitude and openness of these teachers are not without foundation. Likewise, the study by Williyani et al. (2024) shows how teachers in Indonesia worked with AI in the development of learning content and they see concretely how generative AI helps them to ease some aspects of their work or open up some new possibilities of the teaching. Meanwhile, the impression that AI is a "helpful tool" becomes an "entry point" for them not to immediately reject it, but to try to understand further. The openness shown by high school teachers in this thesis research is interesting to contextualize with the educational landscape in Indonesia. This is in line with the national narrative and the government's urge in accelerating digital transformation in the sectors, especially education, as reported the official website of the Ministry of Primary and Secondary Education (Kemendikdasmen, 2025), on one side. At this stage, design of policies that focus on innovation and allow the use of technology could facilitate better climate for teachers to be open to AI.

On the contrary, this tendency should also be seen in the light of reality, for instance, there would be limitations in technological access and infrastructure among schools, or among regions, along with the difference in teachers' general digital readiness (UNESCO, 2023). The openness demonstrated may be more appropriate for the environment of private background of this thesis research site and the other school contexts in Indonesia may not have the same availability and initial support in promoting openness. Therefore, though this openness is a positive quality, there is a need for special attention to the issues on equal accessibility and teachers' capacity development nation wide (UNESCO, 2023).

Critical Attitudes Towards Generative AI

Another important finding is that apart from the positive way that teachers were found to view generative AI, high school teachers in this thesis research were not only receptive and open to generative AI, but they also developed a critical attitude towards generative AI. In two aspects, these attitudes were demonstrated: (1) critical commenting on the output generated by AI, and (2) criticism of generative AI system itself as imperfect and sometimes makes mistakes/errors. It is not rejection of technology, but to the contrary, only a sign of a more reflective attitude. This discussion seeks to explain how this critical attitude may be seen as an integral part of AI literacy and as a prerequisite to successful implementation of AI – TPACK. The four main participants of this research, which is the teachers (regardless of gender, age, subject taught, or teaching experiences), all stated that it is imperative to re-check or cross-check the output of generative AI as it tends to make

mistakes or errors. This can be seen from their answers on how they recount their experiences of finding misinformations from generative AI, or how they complain about generative AI's limitations in understanding complex contexts, which is the basis of their critical attitudes. Moreover, this shows that teachers are already aware of how generative AI works and the quality of output produced by generative AI regardless of what generative AI tool used.

Viewed from the perspective of Long & Magerko (2020)'s AI Literacy framework, these teachers' critical attitude is a clear indication of a level of AI literacy that is emerging. According to Long & Magerko, they explicitly define AI literacy to be a set of competencies that allow people to do things, such as, 'critically evaluate AI technologies' (p. 7). Results of this thesis research offer empirical evidence of these competencies in practice. In the case of teacher's critique on the AI generated outputs, they are simply using Competency 13 (Critically Interpreting Data); the understanding that data or results from algorithms cannot just be taken as it comes (Long & Magerko, 2020). From this instance, it is visible that they do not 'fall' into the Eliza effect, which is a misconception in that one thinks AI systems are more intelligent than what they are (humans) (Switzky, 2020). Second, teachers are very aware of the output of the AI which, most of the time, contains many errors. This is in line with research conducted by Chomphooyod et al. (2023), in which they suggest that some AI systems are limited and not every output of AI is fine to consume (p.9). Teachers have to double check to the results which suit to their needs.

Secondly, when teachers criticized the rudimentary generative AI system, teachers showed that they possessed Competency 5 (AI's Strengths & Weaknesses) (Long & Magerko, 2020). They were able to find places where AI still is not as great as human capabilities. This corresponds well with previous research on the fact that trust in AI assisted decision making is determined by context in multiple aspects and various stakeholders (Vereschak et al., 2024). Understand and develop tools for human and machine 'teaming', and participant in critical oversight to foster human and AI collaboration (Barmer et al., 2021). Additionally, Pangrazio & Selwyn (2019) also point out through the concept of critical digital literacy, that the simple use of digital tools over and over, needs to be followed by critical awareness of their accuracy, appropriateness and potential bias. This perspective matches the gradual surfacing of a more critical position among teachers in this thesis research.

In Ning et al. (2024)'s framework, however, the critical attitude of teachers in evaluating AI technology is not explicitly mentioned as crucial dimension to implement the AI-TPACK. This critical stance is a lens that helps to augment all the knowledge domains in AI-TPACK instead, which means that teachers will not only be able to deal technically

but also morally and pedagogically with the technical aspects, according to Karataş & Ataç (2024). This critical attitude corroborates with Melisa et al. (2025)'s study, where through reflection, individuals can critically consider in depth how AI, such as ChatGPT for example, shapes their mindset, influences their decision-making, and changes the way they access and process information. Moreover, teachers with a critical view about AI adoption are better at incorporating it into teaching as AI is supposed to support instead of replace human teachers (Chan & Tsi, 2023). In that scope, critical attitudes of teachers have a role in the evaluation of teachers whether an AI tool can help teachers do effective and ethical teaching or not, so that teachers can decide more wisely in the use of technology (Karataş & Ataç, 2024).

In the Indonesian context, where introducing new technology usually comes attached with strong 'hype' and rapid/massive adoption, the critical attitude taken by these teachers should be viewed positively. This is a sign of professionalism and caution, where teachers are not just following trends, but they reflect on what is good and bad for technology in their students' learning context. In the midst of the swift flow of information and the potential for misinformation that is also amplified by AI, the ability of teachers to be critical becomes an important trait to maintain the quality of education, this can be strengthened by combining AI and media literacy (Academy & Kouzov, 2019; Washington, 2023). The key implications related to the emergence of a critical stance among teachers towards the sustainable integration of generative AI in education are important as they clearly demonstrate the potential for the use of generative AI in education. This emphasizes the importance of thriving in having a critical attitude, which becomes essential to allowing the educators to effectively utilizing the AI tools in a pedagogically honest manner (van den Berg & du Plessis, 2023, pp. 9–10). In addition, it should drive the design of professional development programs (which comprise of digital, media, or AI literacy) and institutional programs to promote responsible use of AI in teaching practices.

4.2.1.2 Generative AI as a Double-Edged Sword

Knowledge About AI and Generative AI

As a continuation of the previous theme that emerged in the findings, this theme is a continuation of how the teachers' openness and critical attitude eventually led them to an attitude where they could recognize the benefits and risks of generative AI tools. AI, which in the context of this research is generative AI that has both benefits and risks, like a double-edged sword. In this theme, not only teachers' knowledge of the benefits and risks of generative AI is discussed, but it also includes how they first learned about the types of AI, as well as the various generative AI tools. This is important, given that if someone wants to

‘evaluate’ the benefits or risks of an AI tool, then logically, they must first recognize (at least have knowledge about) the AI tool.

Summarizing a few of the findings, it was found that two-thirds of the teachers that participated in this research had better knowledge, understanding, and were able to name specific AI tools directly compared to when asked about types of AI in general. However, this is understandable, given that teachers fall into the category of non-technical audiences. Several studies have noted that teachers do not understand the basic mechanisms of how AI works and are unable to engage with complex technical details (Ding et al., 2024; Papenkordt, 2024). This is why they may not know technical terms or technical details related to AI, for example, as simple as mentioning what types of AI are. It is also found that teachers are more likely to directly mention the names/brands of AI tools because they are closely connected with their daily work. In other words, the key reason is the practicality and familiarity of specific tools for their daily teaching where this is in line with the study conducted by Delello et al. (2025). In addition, results from the preliminary questionnaire also indicated an interesting variation in responses when looking at demographics, such as gender. In the preliminary questionnaire results, the results showed that female teachers were more likely to directly mention the name of the AI tool instead of the types of AI, even though the question was asked to mention the types of AI. This is in line with previous research, where women reported lower levels of knowledge about AI systems and technologies at work compared to their male counterparts (Borwein et al., 2024 cited in Russo et al., 2025). Further interpretation of this phenomenon, however, needs caution as it needs further data to avoid over simplification.

Then, talking about teachers' knowledge related to generative AI, the results show that the results are quite diverse. The four focal teachers participating in this study have demonstrated good technical knowledge of what generative AI can do. This shows their level of familiarity, as discussed in the previous theme, namely that because they are quite ‘open’ to AI and generative AI, they have indeed used it for their daily needs. From the perspective of AI Literacy framework by Long & Magerko (2020), the technical knowledge demonstrated by teachers is the first step in building various AI Literacy competencies. This describes a natural path towards literacy. Moreover, Long & Magerko define AI literacy as the ability to use AI tools in practice in the context of work. These findings, as presented in this thesis, are empirical examples of how open attitudes as affective prerequisites, can bring about the development of practical competencies elaborated within the framework.

From the perspective of AI-TPACK (Ning et al., 2024), this technical knowledge that teachers develop through practical use can be seen as the foundation of the AI-

Technological Knowledge (AI-TK) domain. In the AI-TPACK framework, AI-Technological Knowledge (AI-TK) is positioned as one of the core knowledge ‘pillars’ that teachers should possess (Ning et al., 2024, p. 14). However, AI-TK is not a monolithic domain; it is built on a multiphase foundation of AI knowledge. This foundation firstly includes basic conceptual understanding, such as the ability to recognize and differentiate AI from other technologies, and understand its strengths and weaknesses, which is strongly supported by the AI literacy framework by Long & Magerko (2020). Secondly, this foundation is reinforced by an understanding of operational principles, algorithms, and how AI technologies work in general (Allen & Kendeou, 2024).

Finally, the foundation must be contextualized in the educational landscape, where teachers need to understand the potential of specific applications such as personalized learning, chatbots, and automated assessment systems (Annuš, 2024). Therefore, the robust AI-TK in the AI-TPACK model is actually a manifestation of mastering these multiple layers of foundational knowledge, which without a teacher's technological knowledge will be insufficient to support effective pedagogical practices in the AI era. Thus, these findings suggest that teachers are building the foundational components that will serve as prerequisites for the development of more complex AI-TPACK competencies, which will be discussed in more depth in the utilization section of the discussion (in research question 2).

Benefits and Risks of Gen AI

Generative AI is found to be viewed by teachers as a ‘double-edged sword’, something that has great potential but also some real risks. This perspective is one that is mature and reflective. The result of this perception does not stop whether it is good or bad. There was also an interesting awareness of this paradigm shift, where using AI is actually not an exercise in laziness, but an activity which requires new critical thinking skills. Simply put, teachers believe that generative AI is innovation with value, both for creating teaching materials effectively and for engaging creativity. But they are also aware of the same risks of dependence, of becoming addicted, or of losing some creativity when it is misused. Furthermore, amidst all the opposition, there is a strong counter-argument that in order to effectively use AI, it requires critical thinking skills to create prompts, contradicting the assumption of using AI being a passive or lazy activity.

Through the lens of Long & Magerko (2020)’s AI literacy framework, teachers’ abilities to think about both how generative AI can be used to make teaching more efficient and more inclusive and, at the same time, its potential dangers, are a direct demonstration of competency 5 (AI’s Strength & Weaknesses) which means those that are AI literate can determine what types of problems AI does and does not do well at solving (p.4). This finding

corroborates with Pinski & Benlian (2024)'s study that literacy in AI helps an individual to understand the capabilities and limitations of AI technologies (p.11). Moreover, an understanding of the paradox that AI can also promote and obviate creativity reflect such a balanced, critical evaluation of its strengths and limitations understanding, being the main point of AI literacy, which is to be able to critically evaluate technology. As it turns out, this is consistent with Liang (2023)'s study where being literate in AI means recognizing AI's strengths and weakness, and realizing how it can both amplify and undermine creativity.

Next, it is the view of a paradigm shift of the role of quick formulation skills that deals directly with competency 10 (Human Role in AI). The literate here according to the AI literacy framework, should understand that the programming, model selection and the refinement of the AI system itself is important and must be done through humans (Long & Magerko, 2020b, p. 6). The work of Pinhanez et al. (2023) is also in line, as humans are critical in terms of programming, selecting models & refining AI systems to make them context aware, support human-machine teaming, and provide proper oversight. Additionally, the teachers also believe that creating prompts needs critical thinking skills which point out how the usage of AI involves humans at its core. Accordingly, a study revealed that making AI text generators work effectively to boost critical thinking relies on creating suitable and tailored prompts (Essien et al., 2024; Khosravi et al., 2022). Critical thinking skills are of paramount importance since users may deal with 'black box' AI. The AI decision making process is opaque to the end user and therefore is termed black box (Gillani et al., 2023). Essentially, "Black-box" means that without the access of the AI and probing it to figure out why it makes decisions it does (Bathae, 2018, p. 27). This leads to worries that educators and learners may, in fact, use AI without fully grasping how the system works or the biases that may be ingrained in them.

To overcome this problem, AI literacy is more than being technically able to use AI systems; it includes being critically able to perceive the social and ethical implications of the flaws in these technologies (Kong et al., 2024). The result of this is also reflected in study that show how active engagement in interpreting AI outputs can not only enable users to rely on the results of AI systems, but are more likely to evaluate the validity and usefulness of AI outputs for the educational context (Gillani et al., 2023). Additionally, research in Explainable AI (XAI) demonstrates the significance of transparency of AI systems for the users, so that they can comprehend the logic grounded upon which these decisions are derived (Khosravi et al., 2022). By making a more open approach to AI systems, teachers and students can interact with these systems in a more effective way, not 'push a button and you are done', but gain critical skills to assess and use AI in its proper place. Overall, creating

good prompts is an active, and not a passive form of AI literacy. It points out that intelligent use of AI including critical thinking and understanding of how AI produces output.

From the AI-TPACK framework perspective, this phenomenon is not explicitly mentioned in the framework either. This phenomenon, however, is connected with the AI-TK (AI Technological Knowledge) domain. Ning et al. (2024) described AI-TK as educators' comprehension and application of available AI technologies, understanding, being familiar with, available visible and tangible AI platforms, tools, products, or other educational resources etc., and acquiring pedagogic approaches to use AI in educational contexts such as its literacy. In the present day of generative AI, contextualizing this should encompass knowing the generative AI itself and that is, more than just basic technical skills. The core of AI-TK lies in teacher consciousness of the pros and cons of the technology. As presented in the results of this thesis research, on the benefits side, teachers know that AI, if it is well used, can be an innovative tool for teaching materials development, including creating lesson plans and doing assessments. To support this, Celik (2023) who stated that the more knowledge teachers have with regard to AI based tools (which is AI-TK in this regard), the more possible for a teacher to understand the usefulness of AI since teachers are more knowledgeable regarding AI based technologies.

Yet, a 'mature' AI-TK needs to be aware of the risks of AI, like AI hindering students' creativity and making students dependent on it by replacing independent work process. The above is backed up by the study done by Said et al. (2023) that indicates knowledge and confidence on the part of people regarding AI also influences their view of the risk and benefits of AI, beyond simply possessing technical knowledge. Besides, an application of AI-TK advanced to the most sophisticated on the results of this thesis research, is a paradigm shift: supposing laziness of AI users in the further is, maybe, incorrect. Formulating good prompts to generate outputs solving with desired learning outcomes is a skill of critical and analytical thinking where trying, evaluating, and refining, are the core ideas of critical and analytical thinking in prompting (Knoth et al., 2024). In a prompt, teachers embed content knowledge (CK) to provide a specification of their pedagogical objectives (PK) and the technology has to deliver results to them. Thus, being able to craft good prompts is not a purely technical but rather, it is a practice in AI-TPACK. This mirrors the claims made in the general TPACK studies like Koehler et al. (2013) who mentioned that effective use of technology in education is not about the tools, but teachers' wisdom in using their knowledge, as stated in their study that there is no 'one best way' when it comes to integrating technology into a curriculum. Instead, efforts at integration should be creatively designed or structured for particular subject matter ideas in particular classroom contexts.

Additionally, in the utilization section (research question 2, see: 4.1.4.3) further in depth discussion of teachers' prompting will be covered.

4.2.1.3 Generative AI Should Remain under Human Control

Following the previous themes' discussion on the potentials, benefits, and associated risks of generative AI, the findings in this theme resulted in the one core belief among high school teachers: AI, and especially generative AI, must always be under human control. Instead, this is a proactive professional stance that indicates how the relationship of educators with technology is proactive. The findings of this thesis research consistently demonstrated that teachers perceive humans to be the ultimate 'controller' with an opinion of AI or generative AI as an entity that serves human purposes, not otherwise. Teachers play an active role as selectors, limiters, and guides in the use of AI to obtain educational goals and values. This stems from the belief on the role of human intelligence as irreplaceable and will always be needed, it is therefore the belief in human control providing the basis for better, safer, and responsible use of AI, particularly generative AI. Such a fundamental belief by the teachers implies a question: Why did teachers hold such a firm opinion about the human control to AI?

The key reason being that the belief in human control goes beyond the simple defensive position; it is reflective of the ongoing state of AI literacy. It is seen not just qualitatively, but one that is also prominently brought out by the findings derived from the initial questionnaire. The results indicated that a large proportion of teachers agreed or strongly agreed with the proposition, "*I recognize that humans are accountable for AI biases,*" and most were also confident in their ability to explain the effects of AI on society. These results from the first questionnaire analysis give testament to the fact that teachers' critical perspectives are founded on a solid understanding. In the AI Literacy framework by Long & Magerko (2020b), the understanding that bias in AI comes from humans is a reflection of Competency 13 (Critically Interpreting Data). The ability to explain the social impact of AI also shows literacy that goes beyond mere technical use, in line with a study conducted by (Walter, 2024), that AI literacy is identified as crucial, encompassing an understanding of AI technologies and their broader societal impacts.

The second reason this belief in human control is so tenacious is that it is the rational reaction to the imperfections and risks of generative AI that they have diagnosed. As revealed in the previous themes as well, teachers are well aware of the potential for AI or generative AI to produce inaccurate information, be misused to threaten academic integrity, and create dependency. Therefore, this desire for full control is a professional risk mitigation strategy.

Primarily, the teachers in this research are high school teachers, who teach high school students, who are teens and still need help and constant supervision using generative AI technologies. The study done by Okocha et al. (2023), explains that this happens due to their developmental stage, adolescents' brains adapt easily, allowing technology to influence their memory, feelings, and social skills. When viewed through the lens of Long & Magerko (2020)'s AI Literacy framework, the teachers' belief in human control is connected to many key aspects of AI literacy.

Another important justification is teachers must choose, restrict, and direct students due to the connection with Competency 5 (AI's Strengths & Weaknesses) and Competency 16 (Ethics). AI literate individuals are aware that AI has limitations and that dealing with its ethics depends on people. Similar to past findings, the two skills seen in these results indicate that, by adding the correct knowledge, skills, and ethical mindset, people can safely use AI and help maintain its positivity in society (Asrifan et al., 2024; Velandar et al., 2024). Teachers feel the need to be 'gatekeepers' of quality and ethics to ensure that the presence of generative AI does not compromise essential learning processes. These findings are in line with a study by Yang et al.,(2024, pp. 8–9), where educators need to focus on the learning process rather than the end product, because the end product produced by AI may not reflect students' true understanding. Essentially, teachers are 'gatekeepers' of effort and skill development value for the skills to retain value for effort and critical thought by making sure AI becomes a tool for enhancement, not replacement. Similarly, a study by Samala et al. (2025) also found that teachers view AI as a tool that has to be controlled by human oversight, because the risk of imperfections and ethical concerns is still very high.

Then, why do the teachers think human intelligence is valuable and cannot be replaced? This is related to Competency 2 (Understanding Intelligence), where they can perceive the differences between the narrow calculation found in machines and the wider perspective and principles of humanism Long & Magerko (2020). The teachers in this thesis research reasoned that human intelligence remains more superior than artificial intelligence, mainly because it includes emotions and spirituality. Many studies have confirmed that current AI systems, such as large language models (LLM), are unable to understand emotions attributed to people. It is because AI cannot experience or be aware of itself that it lacks true understanding of emotions (Picca, 2024). Then, though AI can help with spiritual activities and understanding by analyzing information, it lacks the personal spiritual and existential experiences and knowledge that humans have (Calderero Hernández, 2021; Kumar & Uchoi, 2025). This is also in line with the finding that teachers believe that the role of teachers is irreplaceable, especially in the aspect of teaching spiritual values.

Also, the belief that people “need to be in control” and their “brains should lead the way” reflects Competency 10 (Human Role in AI), which is about the important part people play in programming, selecting models, and governing AI. According to this idea, AI cannot be seen as an independent actor that figures things out by itself, since human actors are always involved. A number of studies show that people must get involved, review, and manage AI systems to resolve ethical, legal, and social worries. Ways to appeal and fix AI decisions are necessary to support users’ freedom and ensure their fundamental rights are respected (Fanni et al., 2020, 2023). This is in line that trust in human control is thus an important foundation guiding teachers to better, safer and more responsible use of generative AI, especially in school environments. This belief in human control as the foundation of today’s wise use of generative AI also forms teachers’ expectation where the development of AI will go in the future.

Lastly, viewed through the lens of AI-TPACK framework Ning et al. (2024), what justifies the role of teachers as being ‘controllers’? This idea, though not specifically mentioned in the framework, is required by the teachers if they use technology in the classroom. Using the AI-TPACK framework, the principle of human control shows itself as a result of fully understanding the AI-Technological Pedagogical Knowledge (AI-TPK) domain. AI-TPK enables teachers to effectively use AI within teaching so that the major goals and values of education are met (Ning et al., 2024). Since interaction between people and thinking skills are essential and irreplaceable in education, especially for emotion and creativity, Chan & Tsi (2023) believe teachers are needed in education the most. For this reason, when a teacher implements AI-TPK, he/she acts as someone who ensures that AI is managed safely and properly, without seeing technology as more powerful than humans. For example, researchers found in the study by Kasepalu et al. (2022) that teachers can use suggestions from AI assistants to guide students during collaborative work, which teachers appreciated and put to use. Overall, teachers have to take charge to guide the integration of these three key areas in an intelligent way. Therefore, according to TPACK Koehler et al. (2013), the effectiveness of technology comes from the teacher’s teaching strategies rather than the level of technology.

4.2.1.4 Generative AI as an Evolving Technology

Following the previous theme’s discussion about belief in human control as the foundation of today’s wise use of generative AI also forms teachers’ expectation where the development of AI will go in the future. The results indicate that their expectations are highly practical and are deeply entrenched in their day to day professional requirements and also

that they differ according to the subject context of the subjects they teach. These anticipations do not merely constitute a desire list, but it also shows their increased knowledge of the potential and shortcomings of AI. The main point is: Why do teachers possess such expectations, and what does it imply to our comprehending of their AI literacy and competence?

First, why do language (Mr. Ivan & Mrs. Eny) and mathematics (Mr. Mahfud) teachers envision an AI that will be able to deal with more complex inputs like handwriting and have fewer “receptive problems”? This is since their subjects are quite frequently handling non-standardized or digitally un-structured student work (for instance: hand-written essays, scribbles of mathematical procedures). The fact that the current AI can not recognize this type of input is an actual obstacle to their applying AI to important processes like formative assessment or even offering individualized feedback. In terms of mathematics or numbers-related subject, this complies with a study done by Kortemeyer et al. (2024) where in their work they attempted to evaluate handwriting in a thermodynamics examination. The most difficult part is the Optical Character Recognition (OCR) technology which is supposed to change the handwriting into a computer readable text. This is complicated by the fact that handwritten mathematical expression is more complicated to tackle. Besides, the expectations of these teachers are conditioned by the practical necessity to establish the contact between the digital environment of AI and the reality of the classroom.

Second, what are the reasons that language teachers (Mr. Ivan & Mrs. Eny) desire an integrated AI rather than a stand-alone app? The reason is because the current language teaching methodology already frequently incorporates the usage of a range of digital platforms (for example: in the form of reading, writing, or listening activities). This is in line with the research conducted by Yuan (2025) for instance, where the research did not only substantiate the fact that numerous digital platforms are utilized in language teaching, but also supplied the evidence of the users (learners), that an integrated platform where several tools, e.g., dictionaries, note-takers, etc., are incorporated into a single one, would be favored, since it is more practical (time-saving) and does not interfere with the concentration and the learning process. Finally, the teachers found it ineffective to have to open and close various applications that were not integrated, which might disrupt the learning process. This capability of envisioning superior AI applications that can meet their requirements more adequately is a prime instance of Competency 6 (Imagine Future AI) in the view of the AI literacy framework introduced by Long & Magerko (2020) which states that teachers are not merely passive consumers, but also framers who also consider how technology ought to evolve. It corresponds to a study by Ho (2019), in which the principles enlisted by Ho are

also highly applicable in education. Assuming that the ‘patients and service providers’ in the argument by Ho are interchanged with students and teachers, then this argument is still in line. The teacher is the one who understands the dynamics, challenges and contextual needs of the classroom in the best way possible. Thus, teachers must be visionnaire which actively consider and contribute to the way the technology ought to develop.

And, last but not least, why should Indonesian (Mr. Ivan) and Mathematics (Mr. Mahfud) teachers in particular require an AI that understands more contextual and local (like for instance, Indonesia or Bogor)? This is because they know that relevance of content is vital in effective learning. Local context makes math story problems more meaningful, and Indonesian teaching is locally-based in terms of culture and context. The shortcoming of the existing AI or generative AI which tends to generate unspecific or westernized content evolved into a functional issue that obligated them to carry out considerable manual modifications. This is also as revealed by a study conducted by Agarwal et al. (2024), in which they discovered that Western-centric generative AI models homogenize writing to western standards and reduce the distinctions that make cultural expression unique. Likewise, Kuteeva & Andersson (2024) also support it, where AI have no agency, metacognition, familiarity with the local context, and absence of the contextual information. Such a critical awareness is evidenced by the demand to make AI more contextualized and localized. This complies with the Competency 13 (Critically Interpreting Data) and Design Consideration 3 (Contextualizing Data) because the teachers are able to critically understand that AI biases and limitations frequently lie in its training data, and they require more representative datasets (Long & Magerko, 2020).

From the lens of AI-TPACK framework by Ning et al. (2024). Such expectations correspond to their practical needs to have the capabilities of using pedagogical and content knowledge in a technology-facilitated setting. As the example of the study by Dantas et al. (2022) demonstrates, high expectations of teachers regarding the enhancement of adaptive and personalized learning by AI technologies are accompanied by the limitations expressed by the teachers with references to technical support and the necessity of pedagogical knowledge as Swedish teachers in their study note the necessity to establish ties between ICT and research on pedagogy and didactics that will enable them to teach more effectively or ties between technical and educational decisions. Moreover, as example, the wish that AI could process more complex input like handwriting recognition and be more adaptive to the requirements of assessment demonstrates the need for development in the AI-TPK domain.

This implies that teachers possess some concept of the intended pedagogical strategies (PK) but feel that the present technology is inadequate to facilitate such

incorporation. This is supported by a study conducted by Memarian & Doleck (2024), where although it does not specifically highlight that this is part of AI-TPK, the desire of practitioners (teachers) for AI to be more sophisticated (able to handle multimodal data) in their study is a reflection of the need for the AI-TPK domain. Likewise, when language teachers expect improved AI receptive skills, the necessity of AI-TCK becomes apparent, in which the technology should be capable of properly handling their domain-specific contents (Ning et al., 2024). The findings of the study conducted by Chan & Tang (2024) for instance, showed that English teachers require AI that not only comprehends the linguistic meaning, but also can offer contextualised feedback based on the local curriculum. It indicates that the AI potentials cannot be merely technical and should be adapted to the content and features of the field.

4.2.2 Discussions on High School Teachers' Generative AI Utilization (RQ2)

The results of the use of generative AI by high school teachers in the thesis study reflect a trend of pragmatic and adaptive pattern. The key area of utilizing generative AI is its application in preparing teaching materials, whereas the use of its capabilities in the student learning and assessment sphere remains rather tentatively, and is more exploratory in nature. Such practices, including attempts of teachers to constantly develop their own skills, indicate a complicated process of professional adjustment. Thus, the next section will interpret the meaning of these patterns of use in the theory of AI Literacy and AI-TPACK and explain what impact these patterns will have on professional development of teachers in this era of AI.

4.2.2.1 Various Generative AI Tools Utilization for Teaching

The results indicate that the use of generative AI by teachers is not only homogenous; instead, it is described as the growth of understanding and a more tactical application of numerous AI tools. What was earlier mentioned as one of the factors that spurred their perceptions, their technological knowledge can now be understood as a 'drive' which governs their course of actions as the way they operate. The same knowledge helps them to be an active learner to select and appropriately use various AI tools that reflect their personal teaching needs. Through the preliminary questionnaire, it was indicated that some teachers could mention some of the tools such as ChatGPT, Gemini, and Magic School. Moreover, data collected via interviews and FGDs gave a more elaborative story.

The teachers are actually going past the use of a 'one tool fits all', and beginning to chose specific platforms with slight variations in purpose like the aforementioned (for

instance: functionality: conversational, simplicity of use, and even gaining a ‘second opinion’). The most advanced practice was the capability to utilize a variety of the generative AI tools within a workflow to produce a single pedagogical output.

The most interesting and insightful detail in this discovery lies not only in the fact that the teachers choose other tools, but why and how they actively and strategically consider and even mix them, showing a cognizant, rational attitude to the use of technology. The best example is the workflow of Mrs. Eny, which involved the creation of the substance of a poster through Gemini, followed by the creation of the visual representations with Microsoft Copilot. Within the context of the AI Literacy framework (Long & Magerko, 2020), such choice of strategies is a vivid example of Competency 5 (AI s Strengths & Weaknesses). It implies that they do not simply use tools, but also select and criticize tools with regard to the affordances they have. For instance, Mr. Ivan likes conversational AIs to generate quiz questions, and Mr. Mahfud prefers to use ChatGPT and generate a second opinion with Gemini, a practical expression of the affordances of each tool. This is in line with the studies which emphasize that capability of users to critically evaluate the capacity of AI and make informed decisions is important (Aracri et al., 2023; Ng et al., 2025). Similar but in different context, the study conducted by Zhong et al. (2024) deploy various AI tools which best fit each phase, and address the shortcoming of one tool and another, specifically to design a product.

Moreover, the essence of the action of AI-TPACK is the practical illustration provided by the teachers (Ning et al., 2024). The areas of knowledge that the teachers apply in making a decision are dynamic in interacting with one another. What are their reasons behind making these particular choices? This is because they are always (and maybe even subconsciously) integrating their knowledge. When Mr. Mahfud, a Mathematics teacher, uses Magic School specifically to create story problems, he is applying his AI-Technological Content Knowledge (AI-TCK), because he understands that Magic School AI’s trait is specifically tailored for teaching and overall school needs (Tilak et al., 2024), unlike the common Large Language Model (LLM) generative AIs (such as ChatGPT) which are more for general purposes (Badr, 2024). Similarly, when Mr. Ivan, an Indonesian language teacher chose Gemini AI as his ‘daily driver’, this action also falls under the AI-TCK category, since he knows that Gemini could provide external links to the sources he need (for instance: in the demonstration session, he demonstrated his needs to look about the definiton of ‘drama’). This can be supported by the findings from Ahmed & Islam (2024), that the main characteristic of Gemini AI incorporates Retrieval-Augmented Generation (RAG), that gives the model an opportunity to find pertinent outside passages and produced grounded replies.

Meaning, Gemini AI has the capability to browse the internet directly and cite the answers given.

In addition, by creating a sequence of steps used to design a teaching poster, Mrs. Eny is illustrating an excellent level of AI-Technological Pedagogical Knowledge (AI-TPK) with her ability to organize several AI resources in order to reach a particular educational goal. This fully corresponds to the framework proposed by Ning et al. (2024), according to which AI-TPACK is characterized as an intuition about the existing "complex interrelations and synergistic effects" of knowledge domains. The teachers do not only apply AI; they are also collaborating with AI. Teachers' familiarities with various generative AI tools that eventually translate into its actual use for teaching, learning, and assessment will be discussed in the next theme.

4.2.2.2 Generative AI Utilization for Teaching, Learning, and Assessment

A major and practical pattern in the use of generative AI by high school teachers were disclosed from the findings. There is a 'gradient' in the utilization of generative AI for teaching, learning, and assessment which is quite specific: the strongest and most assured usage is in the domain of teaching preparation, then becoming more experimental and diverse in the domain of student-facing learning, and most minimal is in the domain of assessment. This 'gradient' is not without meaning; it gives a detailed account of the professional thinking of the teachers having to deal with powerful yet this flawed technology. The discussion in this section will attempt to address this concept and explain what is behind these particular patterns of utilization and consider it through the AI Literacy framework perspective and the AI-TPACK framework perspective to answer such questions as: Why are teachers so confident that they can use generative AI to carry out such tasks as the preparation of teaching materials, but become uncertain and cautious when it comes to using generative AI tools to assessing students?

This obvious 'gradient' of confidence (ranging from the hesitant attitude until confident attitude), and application is the interesting aspect here which provides insights to the evolving abilities of the teachers, as well as how they evaluated the technology itself. Through the lens of the AI Literacy framework (Long & Magerko, 2020), this trend is the manifestation of the advanced use of foundational literacies. The development of teaching materials with the use of generative AI counts as a safe practice in which a teacher can easily capitalize on the strengths of generative AI (for instance: speed and generation of ideas) by simply countering its weaknesses (for instance: inaccuracy) through a simple review and editing. It is an implementation of Competency 5 (strengths and weaknesses). Further, this

concept is supported by Chen et al. (2023), and this called 'human-in-the-loop' approach, the objective of which is to guarantee the safe and efficient utilization of generative AI to create instructional materials among teachers. Then, critical attitudes of teachers come to surface when the stakes are higher like in the case of student assessment. However, when there is a higher stake at hand, such as student assessment, the critical faculty of the teachers is in the forefront. That reluctance is a direct expression of greater-developed literacy competency: Competency 16 (Ethics). The statement expressed by Mr. Ivan, that generative AI is frequently inaccurate even at solving problems, not to mention for assessment, is telling of how well he understands the ethical issues presented by applying a tool one may consider yet unreliable in general to the field of evaluation. This aligns with the fact that although teachers were optimistic about the possibility of application of generative AI, the problem of academic dishonesty and the reliability of AI poses a significant challenge. The reservation that the teachers embrace, consequently is a sign of execution of most important and important aspects of literacy (Giannakos et al., 2024; Ng et al., 2025).

The different uses can be directly associated with the ever-growing complexity of the integration of the domains of knowledge of the TPACK through the AI-TPACK framework (Ning et al., 2024). The various degrees of use translate to the some degrees of difficulty in synthesizing the TPACK domain of knowledge:

Teaching Preparations

This mainly entails the combination of AI-Technological Knowledge (AI-TK) into content knowledge (CK) to produce AI- Technologica content knowledge (AI- TCK). Compared to the other two (for learning and assessment), this is not too complex: the teacher applies the expertise he/she has in AI tools in order to create or edit the content applicable to his/her topic. It is suggested by the fact that in the study conducted by Xie & Luo (2025), the competence of teachers in the AI-TCK domain was a bit higher as opposed to the AI-TPK domain. It implies that the ability to incorporate the usage of AI in content preparation is somewhat simpler to conquer. This is also supported by the fact that teaching preparations using generative AI has all been demonstrated by the four participants in this thesis research.

Learning Activities

Incorporation of AI in pedagogical practice requires a highly proficient degree of AI-Technological Pedagogical Knowledge (AI-TPK). Instead of focusing on production of content, educators need to design robust learning experience where they can allow students to interact meaningfully with AI. This is corroborated by Kim et al. (2022), which offer direct

evidence of expert teachers that introducing AI in the classroom is not only about the use of tools, but It involves a change in mindset toward designing complex learning activities through collaboration. In their context of study, strong AI-TPK is inherent in such a process of ‘experience engineering’ where students and AI co-construct learning processes. Such implementation of generative AI use in fostering student’s creativity in assignments performed by Mr. Rafi is an evident demonstration of such enactment of this AI-TPK.

Assessment

This necessitates the most advanced and combined version of AI-TPACK. AI-based assessment should be reliable in terms of technology (AI-TK), content fairness (AI-TCK), as well as pedagogically significant (AI-TPK). It also aligns with the intelligent TPACK framework discussed by Ren & Wu (2025), which places particular emphasis on the importance of ethically and goal-oriented curricula, including assessment, to the sustainable introduction of AI into the work of educational institutions. The lack of adequate experience in using generative AI in assessment practice by educators can be explained by the unwillingness to trust technology or insufficient AI-TPACK competence development. This is supported by Ciampa et al. (2025), in which their research revealed that The use of AI in K-12 student assessment practices is still in early stages, with educators exploring its potential to enhance assessment while facing challenges. Lastly, the fact that Mrs. Eny insisted on being the last verifier clearly underlined the postulation that knowledge integrated in the hands of the human factor can not be ignored in making pedagogical choices at greater stakes. This is also in line with what have been covered in the previous section of discussion (see 4.2.1.3), acknowledging the necessity of teacher supervision in education using the application of AI (Yang et al., 2024).

Overall, generative AI is experienced as such professional consideration and validation in practice by teachers who can draw on their technology, content and pedagogy knowledge, and apply it in an integrated manner to address situations with generative AI. The next discussion therefore will describe how these three knowledge domains are applied by teachers in the cases of using generative AI in the context of their teaching activities.

4.2.2.3 Technological, Content, and Pedagogical Knowledge Application

Having critically recognized the generative AI as a support tool that requires validation based on the findings by the high school teachers in this thesis research, the next important step is to apply and integrate their knowledge domains of technology, content, and pedagogy on their day to day teaching activities with the generative AI. The results on this

theme provide sufficient evidence that the use of generative AI by teachers in this research has not settled at the technical, but it has reached the level of critical thinking about their professional practice. Evidence from structured observation, interview, and FGD data shows the manner in which the three most significant domains of teacher knowledge are actively employed and intertwined in the process of dealing with AI: technology, content, and pedagogy. Engaging practices like structured, detailed prompts creation and critical validation of generative AI results can be seen as an indicator of the successful effort of integrating this knowledge, which implies transitioning beyond as the consumers of the tools, to being the creators of AI-assisted learning experience. Then why don't these teachers merely use generative AI, but go to such detail and careful integration strategies? There are a number of theoretical and practical interpretations to answer this.

Based on the view of AI Literacy framework (Long & Magerko, 2020), teachers' actions to constantly filter, edit, and approve AI outputs shows cross-competency development. This is a distinct application of Competency 5 (knowing the strengths and weaknesses of AI) and Competency 13 (Critically Interpreting Data), since they understand that the output supplied by an AI is not necessarily the whole truth. In addition, by adopting the role of a content quality and pedagogical appropriateness 'gatekeeper', they demonstrate Competency 10 (Human Role in AI), which is the realization of the key human responsibility in guiding and authorizing AI systems. This is substantiated by other studies (Giannakos et al., 2024; Ng et al., 2025) which affirm the necessity of having critical evaluation by teachers of the AI-generated contents to guarantee its accuracy and applicability since teachers have expertise and knowledge of the content to evaluate, which have already been addressed, and are often mentioned in former themes (see 4.2.1.2, 4.2.1.3).

Then, before moving on to the second lens, AI-TPACK, the researcher also analyzed the prompting techniques they used with the IDEA framework by (Park & Choo, 2024) to make them more robust. This framework is selected as a complement to the AI Literacy framework and the AI-TPACK framework because it offers an in-action representation of the abilities of utilising the AI tools efficiently and evaluating the outputs of AI that should be acquired by teachers in a classroom setting. The structure has four major components they are; (1) Include basic PARTS: namely making sure prompts are built with elements of persona, purpose, audience, style, and output format; (2) Develop with CLEAR prompts: that is, create prompts that are concise, logical, explicit, contextual and limited; (3) Evaluate and REFINE: by evaluating AI outputs and refining prompts iteratively; and (4) Apply with Accountability, namely using AI ethically and responsibly.

From the results of the researcher's analysis of the prompting techniques carried out by the four teachers during demonstration session in the structured observation. The following results were obtained:

Table 4.18 Analysis of The Focal Teachers' Prompting Techniques Using IDEA Framework

| Teacher | Prompting Technique Analysis with IDEA Framework |
|----------------|---|
| Mr. Rafi | A great familiarity with the prompt structure was shown by Mr. Rafi who directly listed the components of Persona (the teacher who designed the question), Aim (to design Higher Order Thinking Skills (HOTS) questions in form of a detective story)), Recipients (8 th grade students), Theme (the style of the question in the form of a game), and Structure (the question and answer format). This indicates the intense application of the Include essential PARTS aspect. The prompt given by Mr. Rafi according to the CLEAR aspect is not only explicit, logical — not to mention restraining enough, since it gives limits to the format and type of questions. Nevertheless, it is not possible to observe the evaluation and revision of the output and, therefore, the aspect of REFINE has not yet emerged. Overall, Mr. Rafi's prompting technique is technical and systematic. He used Magic School AI (free version) during the demonstration. |
| Mr. Ivan | Mr. Ivan employed a rather detailed way of description. He refers the Recipients (11 th grade), describes Aim (coming up with questions containing particular answer variants), and gave information on Structure of the answers (amount of answer variants, kinds of mistakes, etc.). Persona and Theme was not clearly discussed. Overall, Mr. Ivan's prompt is CLEAR, meaning it is quite clear and limiting, outlining the format and product of expected output. He used ChatGPT (free version) during the demonstration. |
| Mrs. Eny | Prompts created by Mrs. Eny were relying on school templates, and clearly contained such elements as the Aim (creation of full teaching materials), Recipients (high school students), Theme (use of posters, rhetoric, and styles), and Structure (the form of teaching materials, module output). She did not compose the prompts according to her free will, yet she created them with the adherence to the certain construction, which reinforce PARTS dimension. Her immediate prompt is also clear, rational and dynamic because it goes with the submission of the school policies. Overall, the prompting strategy of Mrs. Eny proves to be combined with curriculum (such as national |

| | |
|------------|--|
| | curriculum, Cambridge curriculum) and local context. She used Gemini (free version) during the demonstration. |
| Mr. Mahfud | Mr. Mahfud did not use free text but a form-based prompt builder. He systematically entered PARTS elements in his input of grade level, number of questions, topic, and story problem style. Due to the interface of the AI that he used (Magic School AI), the AI required to be Concise, Logical and Restrictive; thus the result on this were very precise, the AI operates within narrow parameters. |

The analysis result indicates that a majority of teachers have been successful in technically and contextually constructing AI prompts. The difference in prompting styles seems to be affected by some aspect like the subject they taught, and familiarity with AI. Such results are consistent with the framework suggested by Mollick & Mollick (2024), where efficient prompt building is not a manifestation of technical competence, but rather a representation of content and pedagogical proficiency on the part of the teacher. Here, teachers such as Mr. Mahfud (mathematics) whose approach is more structural represent an applied efficiency character trait in the profession of mathematics, and Mr. Rafi (ICT) on his nature of narrating and the need to construct High Order Thinking Skills (HOTS) questions represent a creative and reflective application of AI. Chavez et al. (2024) also confirms this finding, as they discovered that the approaches of teachers representing ICT, Science, and Language disciplines differ regarding the specifications of the observed disciplines in terms of employing AI. Moreover, although during the demonstration some teachers did not show how they evaluated the AI output, some teachers such as Mrs. Eny showed how she evaluated the generative AI output. During the demonstration session, Mrs. Eny rephrased some of the keywords until the results were sufficiently in line with what she wanted. What Mrs. Eny did is in line with Velásquez-Henao et al. (2023 cited in Park & Choo, 2024), that substitution of words or reformation of the prompt may have varying consequences and may assist the users to discover discrepancies between various answers.

In addition, in utilizing various generative AI tools, teachers also showed awareness of the difference in capabilities between freeware and premium services. The decision of whether to use the free or paid version translates directly in the way they approach the tool and what to expect in terms of the final ‘product’. It is not a mere perception that premium versions frequently provide a better set of features or quality, but the studies in other areas tend to confirm it. The high quality provided by premium version is not a mere perception but it also has empirical evidence. In this example, a comparative study conducted by Lee et al., p. (2024, p. 6), which assessed ChatGPT 3.5 (free) and ChatGPT 4.0 (paid), has shown

that both versions were fully capable of providing answers that are easy to understand; however, the paid one was much more precise and adaptive to different complexity changes in the answers. Research results like these give background to the teaching practice of the teachers in this thesis research. When a teacher uses the free version, this could imply that he/she has to take more time checking on accuracy and doing manual editing on the output, which could be minimized when a teacher uses the premium version (McGee & Sadler, 2024). This may also explain why some teachers developed a ‘tool-chaining’ strategy (as Mrs. Eny did), or used several different AI tools interchangeably (as Mr. Mahfud did) as a way to maximize the freely available features of the free AI tool.

Then through the lens of AI-TPACK (Ning et al., 2024), it is a reflection of the essence of the framework itself. Intuitively, these teachers realize that AI Technology Knowledge (AI-TK) should not exist in isolation in order to accomplish successful pedagogical objectives as proposed by Oved & Alt (2025) in their study. Examples of simultaneous AI-TK, Content Knowledge (CK), and Pedagogical Knowledge (PK) would be the prompts made by Mr. Rafi, such as specifying the requirements to high order thinking skills, and a format of a detective story to present the binary conversion material. It corroborates with the argument of Ning et al. (2024) of complex interrelationships and synergistic effects between knowledge domains that in practice is achieved by the design of the prompts. Besides, the outcomes regarding teacher critical validation of AI outputs can be interpreted in a deeper sense in the context of disciplinary literacy (Picasso et al., 2024). As an example, when Mrs. Eny criticizes the understanding of rhetorical devices by AI, teachers do not just fill in the gap in knowledge, but also determine whether the output of AI is correct in the conventions and peculiarities of its field. Therefore, the appropriate use of AI-TCK by teachers in the case, is not just the application of AI in writing the texts, but the application of AI as an assistant (Mishra et al., 2023).

Moreover, the practices of using utilization, as undertaken in the context of the thesis research in which generative AI is mainly used by teachers to efficiently prepare the teaching content, is especially of interest in contrast to the overall government vision. The Ministry of Education, in an academic paper published in February 2025 (Mu Lahdi et al., 2025), considered that AI would be included in the curriculum in terms of forming student skills, which would include computational thinking, analyzing data, and understanding ethics. This foresight converts the AI not as an instrument of educators, but also as an item and medium of students.

There is a certain gap between this vision of policy and the actual practice in the field. Currently, teachers are still at the stage of utilizing AI for teaching, with little of them

actually using AI as a medium for teaching and learning (one of it was demonstrated by Mr. Rafi in the previous themes), while the government's vision is for teachers to be able to teach about and through AI. However, Such a gap is not a failure, but a reflection of natural process of adoption. It is common sense that, in order to develop multi-dimensional learning experiences in students, according to the future curriculum, teachers will have to learn how to be comfortable with AI as a personal tool (developing their AI-TK and AI-TCK) first. Overall, to achieve an idealized effect and responsibility in the use of AI, it is necessary to master the AI technology and to develop other professional skills which are related to generative AI. Therefore, the topics of the next theme are: how teachers improve their competencies.

4.2.2.4 Improvements of Professional Skills in Generative AI

Previously concluded in the last theme that the proper and responsible integration of AI requires a mastery of the technology and professional skills, it is also imperative to discuss how teachers in the thesis research attempt to enhance their competencies. This is indicated in the findings as a proactive and to a great extent self-initiated professional development. Instead of hoping that formal support will be provided, teachers took strong initiatives to provide them via informal means, which was mostly believed to be inadequate. It was mainly a process of personal, manual discovery in the form of trials and errors, more importantly, also an active culture of sharing of practical knowledge and approaches involving learning between peers. Thus, this discussion will delve deeper into the importance of informal activities, explore the reasons why it is becoming the primary way, and determine what effect the formal approach of teacher professional development in the era of AI will have.

But before that, there is an interesting insight into how the mindset of the teachers to learn AI is based on a mature and philosophical awareness, as expressed by Mr. Mahfud, that if a teacher stops learning, then it is better not to teach. It is this spirit of enthusiasm for teachers to continue learning that ultimately leads them to be able and have to 'walk side by side together' with this rapidly developing AI technology. Relevant to this, then Mr. Ivan emphasized the awareness of the importance of AI literacy owned by teachers. Because according to him, if the teachers are not AI literate, then how will the students be? If seen from the lens of the AI literacy framework Long & Magerko (2020), Mr. Mahfud's commitment is included in the Design Consideration 9 (identity, values, backgrounds) where the value of 'lifelong learner' becomes the main driver to master AI. Then, the opinion expressed by Mr. Ivan is included in Competency 16 (Ethics), in which he shows a deep understanding of the social impact of AI in education. He does not just think of himself, but

about student literacy as well. This is a thinking that is higher than simply being technical to the extent of being professional and ethical, in line with Stolpe & Hallström (2024), that what AI literacy in technology education focused on is the technological scientific knowledge and socio-ethical understanding.

Moving on, the most distinct findings in this regard is not a paradox, but an explanation of what is so outstanding in the choice in favor of informal, peer-to-peer learning instead of formal external professional development. The practical trials and errors approach of explaining AI implemented by Mrs. Eny, as seen through the lens of AI Literacy (Long & Magerko, 2020), is one of the direct and effective ways that result in the development of fundamental competencies in the area of knowing the strengths and weaknesses of an AI specifically within Competency 5. This informal peer-to-peer sharing identified by both Mr. Rafi and Mr. Mahfud is a part of defining a Low-Barrier to Entry (Design Consideration 15); it may be faster, trusted more, and what being learned is more directly applicable to current problems than a scheduling or visit of a formal external training.

From the AI-TPACK perspective, the professional awareness and the intrinsic motivation of these teachers is the 'fuel' that is needed to support the process. It will be enabled by the spirit of never-ending learning as Mr. Mahfud referred. Without it, a teacher may simply remain at the basic level of AI-TK mastery having never developed profound integration of AI-TPACK. The significance of motivation (interest and the sense of the necessity of the subject significance) alongside positive attitude is also the common feature of other literatures on the TPACK based professional development of teachers, such as studies conducted by Yue et al. (2024) and Max et al. (2023).

Moreover, the choice of the teachers to initiate informal competency developments is also reasonable in the perspective of the AI-TPACK framework (Ning et al., 2024). It has been reported that the process of developing a package of integrated knowledge such as TPACK (in which the principle is the same with AI-TPACK) is very contextual and practice-based (Swallow & Olofson, 2017). Informal peer sharing enables teachers to ask very specific questions in which they directly tap the intersection of technology, pedagogy, and content (for instance: How do you use this AI tool on this particular topic in Indonesian language?) and will help build the teachers AI-TCK and AI-TPK. It corresponds with results of studies such as conducted by Ng et al. (2025), who observe that to integrate generative AI into teaching, teachers require practical use cases and assistance. Additionally, the involvement of the teacher in informal networks is a practical approach to filling the existing gap between a formal AI training experience and classroom practice requirements such as studies conducted by Tan et al. (2025), and by Dogan et al. (2025). It was confirmed as well

by both studies that collaborative and social learning, which is part of informal networks, is an important component of building complex and situational AI-TPACK knowledge.

The sheer dependence on this informal initiatives of AI or generative AI competency, although indicative of the initiative of the teachers, has its implications. It indicates that though teachers are taking the initiative to advance their competencies, this could be intermittent and is subject to the availability of proactive colleagues in the institution. To be effective however, these formal trainings should not be generic. It ought to also augment and formalize the natural learning process that was already occurring, by supplying background knowledge and higher-order pedagogy which the teachers might not learn independently. The concrete issues connected to the absence of the formal professional development with which may explain the aforementioned over-reliance on the informal techniques will be the subject of more detailed discussion in ‘challenges’ section (see 4.2.3.3).

Altogether, hence, the practices of utilization identified in this thesis research can be regarded as a decisive prerequisite or starting point. The bottom-up process of developing the basic capacity of the teachers is underway before the national vision according to official guideline on the use of AI by Mu’ti et al. (2025) can materialize. Naturally, a path to a wider adoption of curriculum is not going to be easy and is challenged by numerous obstacles, which are going to be addressed in the following section.

4.2.3 Discussions on High School Teachers’ Challenge Upon AI/Generative AI Utilization (RQ3)

The results concerning the third research question have managed to pinpoint that the issues surrounding the inability of high school teachers to use generative AI are multi-layered and include both external factors like infrastructure, absence of guidance, as well as internal challenges connected to teacher capacity, and last but not least, highly complicated ethical dilemmas that the teachers felt towards the students. This list of challenges is not merely a list of technical obstacles, but it is quite a representative of the friction that occurs between technological innovation and the reality of the existing education ecosystem. As a result, the discussion below will explore more the definition and origin of these challenges, place them in the AI literacy perspective, and draw implications of more successful and responsible AI integration endeavors in the future.

4.2.3.1 Accessibility and Supporting Facility Constraints

As technology develops, it will also need supporting facilities and infrastructure in such a way that this technology itself can be operated. When the facilities and infrastructure

in an institution have not been or are not purported to be adequate, then this could present a problem. Accessibility and support infrastructure were the following fundamental issues mentioned by teachers in their daily experience of incorporating generative AI on their daily academic activities. Based on the preliminary questionnaire's answers and in subsequent conversations held during FGDs and interviews, teachers stated that their willingness to subject themselves to experimenting with different AI tools was, at times, thwarted by the realities of a ground-based technical situations. As an example, Mrs. Eny and some other teachers as well described incidences of unstable Wi-Fi coverage across the school area. Issues with hardware were also mentioned, for instance, hardware specifications might not yet maximally optimized to support newer and more computationally intensive generative AI applications like what Mr. Mahfud, Mr. Rafi, and other teachers mentioned as well. This leads to technical delays and limitations in the process of preparing and implementing them in the classroom. It is commendable to note that this does not only apply in this case only, but it is a major obstacle that most learning institutions in Indonesia, even global, can often encounter to implement emerging technologies that have high connectivity and computing power requirements (Fitriansyah et al., 2020; Funda et al., 2024).

The most interesting finding is the awareness of why these infrastructure limitations are not only the inconvenience, but an essential barrier to the professional development of teachers in the age of AI. In the context of AI Literacy framework (Long & Magerko, 2020), poor infrastructure sets an excessively high threshold to the learning, which is the complete opposite of the Design Consideration 15 (Low Barrier to Entry). The establishment of AI literacy is dependent on the process of exploration and experimenting, as Mrs. Eny stated. When a tool is slower than is expected, or otherwise not available due to a poor connection, it creates frustration and this condition deters the experimentation that teachers need in order to learn the Strengths & Weaknesses of an AI (Competency 5) or to become expert users. Simply put, weak infrastructure puts an end to the organic learning process before it starts. This is supported by (Barrett et al., 2019), where the report also shows that reliable infrastructure encompassing the access to electricity, the reliable internet connection, and school buildings that are healthy and safe are a necessary prerequisite to equitable and effective schooling. This finding directly relates to the current thesis research, where teachers listed the lack of technical resources (for instance: unreliable Wi-Fi connection and less-powerful devices) as one of the key factors that would prevent the utilization of generative AI tools. In these circumstances, this become more than a logistic hassle, serving as institutional barriers that limit both the possibility and ambition of pedagogical experimentation within the institutions (Ng et al., 2025).

Though the data on this theme did not indicate full-fledged integration of pedagogy, and though this matter is not explicitly stated within the framework, the AI-TPACK framework nevertheless still applicable as a model of reflections that reveals the trends in development of the teachers and the cross-roads of technology, pedagogy, and content in their visions and practices. The physical condition of reliable infrastructure is the actual precondition of addressing any of the knowledge areas (Zhan et al., 2024; S. Zhao & Song, 2021). When such technology itself is not reliably accessible to a teacher, then that teacher will have AI-Technological Knowledge (AI-TK) that is irrelevant. Meaning, it restricts the AI-Technological Pedagogical Knowledge (AI-TPK). A teacher might enjoy creating a new pedagogical plan regarding applying AI in the classroom, yet the idea becomes impossible if the Wi-Fi is not stable in their classrooms, for instance. This observation is an empirical justification that the context aspect of the TPACK framework is not a passive backdrop, but an active gatekeeper; an unfavorable technological context may hinder the dissemination of the teacher's well-designed knowledge. Thus, an institution must ensure its technological (technical) readiness (Barrett et al., 2019; Zhao & Song, 2021).

Notably, this infrastructure challenge has elicited adjusting of strategies among teachers. As an example the findings revealed that other teachers would: 1) prefer to set AI-based material outside the school where there is stable internet connection, 2) or they would collaborate within the computer labs that are ideal, 3) or even simply using their personal hotspots to tether to the computer. It demonstrates that efforts are being made at a proactive level to break the boundaries. This is supported by Aljemely (2024), in which the systematic review highlights the fact that limited access to AI tools and the internet connection in institutions is one of the major barriers to the implementation of AI in schools. To counter such infrastructural disadvantages, teachers shape up through self-initiated problem solving strategies that provide an alternative to cover to such limitations, thus depicting the essence of making training and resource deployment adaptive and context sensitive in educational institutions.

This thesis research proves, especially on school leaders to focus on the school infrastructure's upgrade, so that it can better facilitate of both teacher and student competencies development in the AI era. Even the most advanced professional development programs will not be delivered in the most successful way without an overall strong technical infrastructure (Aljemely, 2024; Fitriansyah et al., 2020; Obioma, 2023). Theoretically, the solution is consistent with the theoretical framework of AI-TPACK according to which the contextual dimension, encompassing the infrastructure context, critically determines, and in

some contexts limits teacher ability to translate his or her knowledge into instructional practices.

4.2.3.2 Absence of Guidelines for AI Use in the Institution

A lack of formal institutional guidelines or policies regarding the use of generative AI was recognised by teachers as one of the most important systemic challenges. This was true in accordance with the initial data from the preliminary questionnaire, where the need of definite boundaries and regulations was remarkably high, and with the data from interviews and FGDs, where confusion and variability of practice were discovered. Such regulatory gap is bound to send the teachers into exploring this new found land using their interpretations and standards. The most distinctive insight from this finding is the fact of non-uniform and personalized standard or variability of practices amongst teachers that may end up causing confusion among students too. This is stated by Mr. Ivan, that since each teacher is left to use their own standards, the AI use might be different between teachers in the school. That was supported by Mr. Rafi, who emphasized how all teachers may have various preferences and standards of what AI tools are considered to be good since nothing is formally regulated yet. Their own experiences will then greatly affect these individualized standards as well as the subject taught, the level of their AI literacy, and their pedagogical intentions.

One question that appear is, why did the urgency of these guidelines and regulation come forth firmly by the teachers in this thesis research? The findings show that the implications of the necessity of a formal framework are the most salient to those teachers who have been actively exposed to, and have utilized generative AI in their daily academic practices. This makes sense, because based on direct experiences of use, be it positive or troublesome, teachers can observe the complexities, risks, and ethical gray areas that cannot be managed solely based on individual interpretations or standards.

Even though this is not directly referred within the AI literacy framework by Long & Magerko (2020), upon review, the need of teachers to be provided with ethical and regulatory guidance shows that they are becoming increasingly literate. These teachers have attained a level of understanding of the “How Should AI Be Used?” competency where they have heard about problems including copyright and morality (as stated by Mr. Mahfud), also about the necessity of accountability. This critical awareness is what causes them to view the policy vacuum as a problem. The urgency of having formal guidelines would not be as off the hook, because teachers who do not (or have not) had a direct experience of using generative AI in their teaching practice may not struggle with this dilemma to the same extent.

Although this challenge is not explicitly stated in the AI-TPACK framework, however. According to the AI-TPACK view (Ning et al., 2024), the lack of guidance makes the institutional situation unstable, so it does not allow teachers to use the available knowledge directly. A teacher can come to a brilliant AI-TPK (AI Technology Pedagogical Knowledge) concept, but they are not ready to execute it because they do not know whether it concerns the values of the school or it is ethically possible. Interestingly, Mr. Rafi, the most experienced ICT teacher in terms of technology, was the one who uttered aloud the need to make policies to handle the negative effects of AI or generative AI. This may be understood as the more the technical knowledgeable one is (AI-TK), the more they are aware of the need to implement a policy framework to take care of risks and this is an important element of the responsible AI-TPACK implementation. The relationship is highly supported by the use of a study carried out by Yee & You (2020) as an example. In their study which surveyed the employment experts who are a population with high technical expertise on the technology (AI-TK) found that awareness of the risk is directly related to the demand of regulation and demonstrated the strong awareness of AI threats like computer hacks and manipulation of information.

Such a demand of explicit rules corresponds to the research of Ng et al. (2025), who stated that the teachers directly asked to provide clear policies and guidelines that would assist in dealing with the AI integration challenges. The requests of these teachers may be understood as the reaction to the wider policy vacuum, which was revealed by Schiff (2022), who discovered that national policymakers tend to ignore the ethical and practical consequences of AI in education. This policy vacuum in this thesis research according to Ng et al. (2025) translates to intervention at the meso level, that is, interventional level of a school institution. Following the socio-ecological model they embrace, the particular level entails the significant role of school leaders in defining inner policies and rules. The tasks associated with this meso level are the formulation of clear policies within schools, formulation of codes of ethical conduct of the AI application, and the provision of resources and technological assistance to teachers needed. Consequently, the policy-void apparent to educators in the thesis research arises due to the fact that at the level of the school (meso) teachers are not provided with clear rules, even though they urgently need them in order to plan to cope with classroom challenges (micro level).

These findings then leave the following practical conclusion: school leaders must take immediate steps to develop the guidelines on the collaborative use of generative AI. The policy vacuum at the school level further hurried up this need, as the overall national policy remains as mere formulation, as far as the “Academic Paper on Coding and AI” formulated

by Ministry of Primary and Secondary Education Republic of Indonesia written as a blueprint, and not an immediately enforceable regulation (Mu'ti et al., 2025). That is why the sense of urgency of rules is strongest among those teachers who have had a direct contact with AI or generative AI: a first-hand experience informs them about the complexities and ethical risks that cannot be addressed on an individual basis. Interestingly, teachers' offered solution of collaborative and flexible guidelines is closely related to the guideline (formulated by Ministry of Primary and Secondary Education Republic of Indonesia), which also insisted on the significance of multi-stakeholder partnerships and flexible and phased implementation depending on the school readiness (Mu'ti et al., 2025). Without local efforts supported by such principles, the attempts of teachers to develop literacy and AI-TPACK will remain isolated, uneven, and uncertain.

4.2.3.3 Teachers' Capacity Gap for Effective AI Implementation

The discourse of this theme revolved around the reality that a gap remains in the ability of teachers to use generative AI. Such capacity shortfall can be also well-explained with references to the situation in the field of this thesis research's site. The culture of the school is open to the digital innovation which is also reflected in the findings where it was important to note that top-down systematic strategy of high-level technology integration is not yet fully formed. As it was mentioned in the previous themes, the technology limitation which was repeatedly mentioned by teachers were the limitations in the technological infrastructure like inadequate network connections and inadequate computer specifications. Even though teachers have demonstrated their receptivity and have begun experimenting with generative AI, the results of the initial questionnaire, interviews, and FGDs all indicated the presence of a perceived gap in capacity, which creates a major issue when it comes to the actual application of generative AI. This divide is reflected in some critical areas: 1) the necessity of further exploration of AI or AI tools, 2) the challenges of developing prompts, 3) the time-consuming requirement of learning and adapting to new AI or generative AI tools, and 4) the absence of official and appropriate professional development endeavors.

The capacity issues of teachers highlighted in the AI Literacy by Long & Magerko (2020) become a manifestation of a natural process when it comes to the understanding of the AI-literate journey. Why do teachers need to explore more generative AI tools, and yet, why are some teachers still having difficulties with prompting? This is because AI literacy requires more than superficial knowledge of how to use it, but rather insights into what happens 'behind the curtain' (Matthews & Bartley, 2025). The inability of teachers to achieve the desired result using prompts means that there is a gap in their competency in the "How Does AI Work?" area. In order to be capable of providing useful prompts, a user

should possess a mental model of how AI acts on information and makes decisions (Competency 8: Decision-Making) and how it knowledge represents (Competency 7: Representations). This challenge indicates that their literacy on this still progressing.

The time issue that is an essential part of learning and applying generative AI should be considered in two perspectives that complement each other. On the one hand, it does not happen immediately to develop all elements of AI literacy proposed by Long & Magerko (2020), It is an intricate collection of skills which encompasses technical knowledge, critical analysis ability as well as ethical consideration which by itself takes time to mature. Tibor (2024) supports the discussion that AI literacy is not a thing that can be learned overnight since it is an evolutionary approach that requires time to master. The reason is that the concept of AI literacy relies on data literacy as its primary element. Tibor supports this point by indicating that even the definition and implementation of the concept of AI literacy itself is currently in its early forms and has yet to be finalized.

However, a more immediate cause that is experienced by teachers directly is the little practical time that they get because of the heavy workload. Thus, the actual dilemma here is the collision between the necessity to acquire a new intricate competency, and the actual state of teaching profession which does not provide much time and space on explorations and self-improvements. That is, regardless of how motivated to learn a teacher may be, the time demands of the teaching and administrative activities will turn into practical yet concrete obstacle, complicating, and slowing down the process of building their AI capacities (Dos Santos, 2024). This fact is actually a bit of a paradox, because on the one hand, the use of generative AI aims to make things easier and efficient, but at the same time, to use generative AI itself requires thorough literacy so it clearly takes time. Apart from insufficient time to explore problems, teachers also felt overwhelmed about the rapid advancement of generative AI or AI in general, making it difficult for them to keep up the ‘trend’ with. This was stated by Mr. Rafi, and his concerns aligns well with Huang et al. (2021 cited in Hava & Babayiğit, 2024), that teachers might feel bewildered by the technicalities involved in AI and that they might require greater assurance on how to effectively incorporate AI to their teaching methods.

Although there have been initiatives among teachers to learn together in informal way (for instance: by sharing with their colleagues) as indicated in the utilization results (RQ2), the development of a high demand of more formal training highlights the difficulty of attaining AI literacy in an equal and profound manner. This requirement of guided assistance is very much applicable to the Design Consideration 15 (Low Barrier to Entry) of Long and Magerko (2020). Such a request can be understood not as an indication of

insufficient effort of teachers, but quite the opposite: as an acknowledgement on their part that the barrier to entry to more sophisticated AI or generative AI usage remains high, and their informal learning should be backed up, and buttressed by more formal professional development. To be effective however, these formal trainings should not be generic. It ought to also augment and formalize the natural learning process that was already occurring, by supplying background knowledge and higher-order pedagogy which the teachers might not learn independently. As a matter of fact, it is the duty of the institution to enable this to happen; according to Hava & Babayiğit (2024), the educational administrators need to ensure that they give enough time, funds, and other resources in order to carry out a thorough professional development. One of the professional developments can be in the form of workshops aiming to equip teachers with ideas, various insights of AI tools, and how it can be used for the benefit of students. Such workshops may also suggest practical approaches of how teachers can use AI technologies in different settings (Hava & Babayiğit, 2024).

From the perspective of the AI-TPACK framework Ning et al. (2024), why is the application of AI complicated and requires extra time? This is since the successful implementation does not merely hinge on the AI Technology Knowledge (AI-TK), but rather requires sophisticated interactions with Pedagogy knowledge (PK) and Content Knowledge (CK) (Celik, 2023). The hardness of creating a good prompt is the explicit instance of the challenge on the AI-TK level. But, the enormous volume of time, implied to be spent in “applying to learning”, points to a more fundamental problem in building AI-Technological Pedagogical Knowledge (AI-TPK) and AI-Technological Content Knowledge (AI-TCK). Integrating the understanding of AI tools with the suitable teachings methods and subject-specific content is an intense process that demands time, contemplation, and trial-and-error experimentation (Tammets & Ley, 2023).

This is even more fascinating considering that a policy vacuum has been found in this school in which this thesis study has been carried out, and comparing this with the policy course at the national level. The Ministry of Education published an academic paper on a visionary implementation of AI into the student curriculum and proposed it focuses on ethics and critical thinking in February 2025 (Mu'ti et al., 2025). Nevertheless, the emphasis on the student competencies implicitly presupposes the preparation of the frontline teachers. Moreover, the case study findings of this thesis study demonstrate the contrasting truth, according to which the lack of school-centric guidance causes confusion and inhomogeneity in the implementation that threatens to impede the successful transition of the national vision among the school system.

Lastly, the capacity gap may be viewed as a barrier to the process of combining different knowledge domains of teachers. Also, the fact that teachers have expressed the need to improve their professional development is especially pertinent. The role of a TPACK-based professional development approach to prepare teachers to have integrated AI competencies is specifically discussed in the studies such as Celik (2023), Park et al. (2023), Hava & Babayiğit (2024). The barriers expressed by teachers in this thesis research regarding the absence of relevant professional development by the institution points to the existing gap between the necessity of developing AI-TPACK and the existing support.

4.2.3.4 Teachers' Dilemma in Maintaining Students' Academic Integrity

The results of the thesis research on this topic continue to prove that the moral complexities, especially those in upholding the academic honesty of students, are the most essential and alarming issues that educators face in the age of generative AI. Generative AI goes beyond the field of technicality to raise serious questions of originality, honesty and the epitome of learning itself (Enriquez et al., 2024). The findings from this thesis research show contradiction in the sense that on the one hand AI supports advanced academic work; but its use is engaged in irresponsible practices on the other hand. Meaning, there is a paradox here. Essentially, the teachers have been left with a dilemma between inculcating digital moral principles but at the same time attempting to regulate its application in the profession.

One of the unique findings is how the issue of academic integrity is no longer a mere detection of plagiarism, but rather a deeper issue regarding the loss of the value of learning and honesty among the students. Why is this issue becomes fundamental? It is not about the final result or output problem according to the view of teachers expressed by Mr. Rafi and Mrs. Eny, but the process that is overlooked by the students instead. Once students are able to generate a final paper or a daily assignment merely on the basis of generative AI without knowing how it works, then the principle of education such as intellectual effort, acquisition of critical thinking skills, and the feeling of pride over the product of the students' own effort can be threatened. This is in line with the studies done by Steele (2023) and Dron (2023), as it indicate the fact that the education principles can be put at risk through reliance on generative AI. Those are the inability to quantify the intellectual output of the students, the suppression of critical thinking abilities in the passive adoption of generative AI, and the reality that it may be challenging to place borders between the original writing of students and automatically generated text, leading to plagiarism issues.

Furthermore, the concern expressed by teachers like Mrs. Eny and Mr. Rafi regarding students' tendency to 'blindly accept' generative AI results is actually an important indicator. This does not only point to a possible lack in student proficiency in this

competency, which is Competency 13 (Critically Interpreting Data) of Long & Magerko (2020), but more importantly, this shows a certain degree of critical literacy and pedagogical self-consciousness in the teachers themselves. Some studies also underpin the relevance of this competency when interacting with generative AI systems that are typically biased, hallucinating, or misinformed. Indicatively, a study by Augenstein et al. (2023), suggests AI literacy programs to combat the danger posed by AI capability in producing false or misleading content and states the need to educate users on how Large Language Models (LLM) works and not to merely accept the answers provided by the AI, as it can be programmed to spout misinformation in a surprisingly convincing voice. Similarly, Bruno et al. (2023) implicitly underlines why this competency is important for users, namely to avoid ‘cognitive mirage’ generated by AI. Cognitive mirage here is a scenario whereby AI causes what is referred to as a hallucination (information that is not factual or true) in such a smooth and natural manner, that the user just assumes that the information presented is factual (Bruno et al., 2023).

In addition, another interesting finding also comes from the fact revealed by Mrs. Eny, where she no longer trusts her students nowadays, and says that her students have no integrity. She often sees this because many of her students are ‘sneaking’ to use generative AI in English learning. What is the reasoning behind this action of students? A potential explanation of such a behavior consists in the unwillingness of the students to apply intellectual effort which is supported by the instantaneous culture. Moreover, it might be expected that students are more inclined towards final grades instead of embracing and appreciating the learning process. Even though this thesis research did not examine directly the motivations of the students according to their own point of view (since the scope of this thesis research was the teachers only), However, the observations expressed by Mrs. Eny show a strong alignment with Dron (2023). When students focus too much on extrinsic motivations such as grades, they will tend to look for ‘shortcuts’, which could explain the observed ‘sneaking’ behavior by Mrs. Eny.

The behavior of the students as what Mrs. Eny told and their involvement with instant technologies, which in this context referred to generative AI, can also be analyzed on the basis of a developmental psychology. The characteristic features of high school age, in particular, are empirically recognized tendencies to boundary testing and the preference of rapid ways of solving problems that may be regarded as potentially impulsive. Meeus et al. (2021) provide the evidence of a discrepancy in development of maturity of the cognitive control system (related to executive functional and self-regulation) and the socio-emotional reactivity system (that fosters sensation seeking and short-term reward). During this period

of development, sensory seeking exceeds the inhibitory control in most cases of teenagers between 12 and 17 years, thus increasing their exposure to risk taking behavior and high rate of adopting short term (instant) solutions.

In addition, according to the findings of Hauser (2019), the individual sensation seeking reaches its peak at the age of 19, whereas the maturation of the self-control skills is delayed and the peak of this individual trait occurs at the age between 23 and 26 years old. Such process of development could explain why teenagers tend to ignore the bigger pictures and focus on immediate benefits (Leuker & van den Bos, 2016), which is significant when it comes to access to generative technologies like AI. Therefore, the attractiveness of a shortcut provided by the generative AI could be particularly significant among people who have not yet reached an advanced level of development of ability to judge long-term results. This is in fact, also in line with what Mrs. Eny state during the FGD session: *“But students are in their teens... biologically and physiologically their brains have not developed perfectly yet. Even if they are 21, let’s say, their brains will still in a development process actually. Until they are over 25 years old, they can probably be fully responsible. So of course that is a very high risk, right? (referring to her students using generative AI as a shortcut)”*.

To overcome this, Mrs. Eny has implemented her own ways to supervise her students, although it may be very practical in action. This corresponds to Competency 5 (AI Strengths and Weaknesses) in the framework of Long & Magerko (2020) which implies that individuals should be capable of critically evaluating the effect, drawbacks, and ethical aspects of AI utilization, as well as misuses thereof (for instance: plagiarism, academic fraud), which might jeopardize the integrity of the learning process. With this capability, teachers and students will be better informed of the dangers of a dishonest use of generative AI and have the capability to take actions to preserve honesty and academic integrity in teaching-learning process. Thus, keeping track of and critically evaluating the generative AI use in the classroom, just like Mrs. Eny did practically (surveiling her students, even managed their seats to be observable by her), is an aspect of maintaining integrity. Although these findings are not explicitly stated within the AI literacy framework, however these findings fill in this gap. Thus it can be inferred and further reinforced that AI literacy should not be limited to technical knowledge only, but should also relate to values, trust, and learning habits in reality (Tadimalla & Maher, 2024).

Switching to the AI-TPACK framework lens point of view, the fact that teachers were able to recognize this practice as an issue shows that they do not merely regard AI as a technical tool, but also proactively consider its pedagogical implications, which is the key to

reflective use of AI-TPACK (Ning et al., 2024). Such literacy disparity among the students, in its turn, poses challenges to the development and enactment of AI-TPACK by teachers (Ning et al., 2024). This entails the recalibration of teachers AI-Technological Pedagogical Knowledge (AI-TPK). The proper use of AI-TPK has ceased to be a question of how it is possible to make learning interesting with the help of AI, but also how it is possible to create activities and assessments that would pedagogically reduce integrity risk factors, and on the contrary, would contribute to the development of critical literacy among students. As evidenced in previous studies, it is highlighted that the pedagogical aspect needs to be switched to the process of learning rather than the product as AI-generated products might not be representative of the actual student knowledge (Yang et al., 2024, p. 9).

Also, the activities of the teacher, like the ones shown by Mrs. Eny, who invented a method of monitoring her students, can be regarded as a practical implementation of AI-TPACK use. She also applies her content, pedagogical and technological knowledge to solve complex contextual problems, which is exactly what Celik (2023) suggests the requirement of an ethical dimension in the professional knowledge of teachers in the AI era. This implies that the task of teachers within the AI-TPACK framework has now been broadened: they should now also act as facilitators of critical and ethical literacy which, in turn, requires a certain pedagogical wisdom that even AI itself cannot perform and once again confirms the significance of the human control in AI.

These teachers also experience ethical dilemmas that are consistent with issues identified on the policy level. The academic paper created by the ministry (Mu'ti et al., 2025) also indicates that it is significant to educate learners on how to apply AI responsibly to safeguard academic integrity. This implies that the issue has been determined on the top-down basis. The results of this thesis research however, show the extent to which the other side to this story is: the way in which the teachers who are at the receiving end of this policy, have not been given consistent guidance, training or approach to staying with such integrity. It places teachers in a complicated situation as they are supposed to teach students in accordance with the national vision, yet they need to operate with fewer resources and institutional backing.

Overall, teachers who get to the stage of having concerns and actively experiencing ethical dilemmas related to student integrity are practicing this critical and ethical evaluation competency. They not only accept the technology as it is, but also consider its implications deeply. The emergence of this ethical dilemma is also evidence that the teachers in the thesis research are in the process of becoming more literate, reflective, and responsible practitioners in dealing with the complexities of AI or even generative AI in education.

CHAPTER V

CONCLUSION

This qualitative case study thesis research seeks to understand an in-depth explanation of how high school teachers in one of the privately run schools in Bogor perceive, utilize, and encounter challenges in the use of generative AI in their teaching activities. Using data analysis findings of initial questionnaires, observations, individual interviews, and Focus Group Discussions (FGDs), this study gave a number of important conclusions which appropriately answer the three research questions which had been posed.

5.1 Conclusion

Based on the first research question, namely “*how do high school teachers perceive generative AI in its use for teaching?*”, leads to the conclusion that there is no single perception of generative AI and its potential application to the teaching needs of high school teachers, but it is diversified and complicated. Theoretically, the results of the investigation of the perceptions of high school teachers in the present research seem to contribute significantly in showing and offering an actual picture of the current AI Literacy framework. This thesis research demonstrates the implementation of abstract skills, like possession of the ability to critically assess AI technology (Long & Magerko, 2020) in everyday activity through the two views given by the teachers who perceive generative AI as a double-edged sword, which is both transformational and also risky at the same time. This perception is based on an attitude which is welcoming but yet with caution. Most fundamentally is the solid belief that AI or generative AI should be stagnated as a tool, controlled by humans, that teachers have inconceivable role of professional judgment and knowledge. It equally highlights the fact that the creation of AI-TPACK by Ning et al. (2024) is inseparable with the process of developing ethical and critical awareness, which is the fundamental of AI Literacy. Last but not least, the way in which teachers view generative AI among themselves means considering it as a constantly developing technology that influences their hopes and expectations about the future of AI or generative AI development that will be more closely connected with educational requirements.

Next, in the second research question: “*How do high school teachers utilize generative AI in its use for teaching?*” the conclusion would be that the teaching application of generative AI is practical, flexible, and still more concerned with the efficiency of teaching preparation activities. In the theoretical context, these results characterize the areas in which the teaching ability of the teachers strongly relies on the AI literacy foundations by Long & Magerko (2020) that they have acquired. The most prevalent use of generative AI here is to

speed up the process and to enrich the production of teaching materials and tools, including lesson plans, worksheets, and questions. By doing so, the teachers intensively exercise their Technology, Content, and Pedagogical Knowledge. The AI-TPACK framework (Ning et al., 2024) is represented in the possibility to choose various generative AI tools to different tasks and suitable prompting strategies. In the meantime, the use to directly support the learning processes of students is still exploratory, and in the assessment scope, it is performed with extra cautions, and in limited amount. The process of learning and enhancing the skills of AI or generative AI mostly occurs to a great extent through informal means, which include exploration (trial and error) of oneself, also peer-to-peer interactions, and exchange of experiences.

Moving on to the third research question: *“What challenges do high school teachers face when using generative AI for teaching?”* Issues that teachers have with implementing generative AI are connected to each other. The basic external challenges were identified, including the constraint on infrastructure as well as lack of encouraging policies or official rules formulated by institutions. Moreover, teachers have some serious internal problems as well, such as capacity deficit, not only in a technical-pedagogical sense, but also in time and effort, that could be offered to learning due to the heavy workloads that teachers have. But the biggest one and the most important might be the serious ethical question, especially regarding upholding the academic integrity of the students in the face of the conveniences provided by the generative AI. The actual necessity of solving this ethical issue shows the critical evaluation and ethical skills that lie at the basis of AI literacy, as described by Long & Magerko (2020).

Additionally, the lack of institutional guidelines and infrastructural limitations are just some of the possible ecosystem specific obstacles in the way of development and application of individual competencies (both AI literacy and AI-TPACK), which is a unique theoretical contribution of this thesis research. It also implies that theoretical frameworks on AI competencies of teachers should pay more direct attention to discussing the support ecosystem within the broader context of the institutional level since without an efficient support ecosystem, any individual competencies, even the highly developed and clever ones cannot be developed correctly and efficiently used.

5.2 Limitations of The Research

In the midst of the exploration of artificial intelligence (AI) literacy of high school teachers in Bogor, there are several limitations that could affect the findings of this thesis research. As AI technology, particularly generative AI is developing frequently, and as it

continues to mature and come into use at breakneck speed, there is a potential that the results of this study are likely to be quickly obsolete. Second, the findings are limited by the unique educational and cultural setting of Bogor only. Results from the study may be particularly useful to understanding the local situation, however the experiences of teachers in the context of Bogor may be different from teachers in other regions or countries, facing different challenges and opportunities.

Next is regarding the generalizability of the results. Since the research falls into the qualitative research, the findings are specifically contextualized and may not have broad applicability. The sample size and sample diversity would affect the comprehensiveness of the study; a small or less diverse sample could represent an inaccurate portrayal of high school teachers, as a larger sample would. Therefore, a valuable preliminary recommendation for future research is to engage in mixed methods. Mixing the qualitative and the quantitative methods will give a comprehensive understanding of the topic. The qualitative part can give rich insights embedded within specific context; the quantitative part helps generalize and statistically validate. An integrated approach such as this can help overcome the shortcomings of the stand alone approaches, and result in more solid and effective research output.

5.3 Future Directions of The Research

The exceptionality and swiftly advancing age of generative AI make it possible that future research would highly benefit by creating or implementing generative AI-specific theoretical frameworks. Even though the AI Literacy and the AI-TPACK frameworks in this thesis research gave a profound background, however, they were designed prior to the recent proliferation of generative AI. The rationale behind this is the fact that generative AI cannot be perceived as yet another improved iteration of older AI but a new technological paradigm. As the studies conducted by Ng et al. (2025) and Zhang & Magerko (2025) emphasize, generative AI has specific features: it is extremely interactive, illustrates more sophisticated contextual knowledge, and can produce complicated new information. These special characteristics, which are quite unlike the previous AI systems, require a new and more accurate framework to understand the competencies that are required in order to make its use effective and responsible in ways that it is used to this date. Accordingly, it is proposed in further studies to apply a generative AI focused framework that will directly consider the kinds of competence a teacher and a student should have to engage with this technology safely and carefully. Such a more specific framework will enable a more severe and contextual examination of the new phenomena caused by the age of generative AI.

In addition, since this thesis research is about exploring the AI literacy from the side of teachers, one of the key areas of future research can be to investigate the issue of AI/generative AI literacy directly through the lens of the students. As noted in the findings (particularly under the challenge section), much of the anxieties and predicaments of the teachers are anchored on what the teachers observe in direct practical situations as the behavior of high school students in the use of generative AI. As such, it would be beneficial to conduct additional research on what motivates students, their views, and how they use generative AI in 'de facto' to give a contextual 'opposite side of the coin', so that a more comprehensive idea of teacher-student-AI dynamics in the learning ecosystem can be accomplished.

5.4 Implications of the Research

Moreover, following the results of this research and in accordance with the direction in the national policy identified in the academic paper of the ministry on AI learning, multiple implications are developed. The next important step to be taken in achieving the national vision to equip students with AI literacy is to compose professional development guidelines and plans that will highly address teachers. This study reveals that until and unless teachers are given clear abilities first before providing pedagogical methods and ethical models, at-risk student-oriented policies will not be effectively applied in the classrooms. Hence, teachers need to be trained in AI and not only generic training, but also specific and based on the context. Second, educational institutions should make prompt preparations of definite rules on how teachers and students can use AI. Third, students must be provided with AI literacy, to which the priority must be given, and it is better aligned and embedded within the curriculum. Lastly, the implications of the findings also relate to technology developers since the teachers require more integrative, varied, and subject-specific appropriate AI tools.

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APPENDICES

Appendix 1. Items in the preliminary questionnaire adapted from Chiu et al., (2024). The language used was Indonesian

| No | Domains | Aspect | Original Items | Translated Items (Indonesian) |
|----|---|-------------|---|---|
| 1 | AI Knowledge (AIK): The capacity to discern between AI-based tools and traditional ones is crucial for maximizing efficiency and productivity. With a keen understanding of AI, teachers not only create compelling content using AI but also articulate its fundamental principles and applications. | perception | I can distinguish whether a tool is AI-based or not. | Saya bisa membedakan apakah suatu alat berbasis AI atau tidak. |
| 2 | | utilization | I can create content with AI. | Saya bisa menggunakan AI untuk membuat konten, seperti materi pembelajaran atau presentasi. |
| 3 | | perception | I can explain what AI is. | Saya bisa menjelaskan apa itu AI. |
| 4 | | utilization | I know how to choose the right AI tools to effectively complete a task. | Saya paham bagaimana memilih alat berbasis AI yang sesuai agar tugas bisa diselesaikan dengan efektif. |
| | Open-ended questions | perception | Apa saja jenis-jenis AI yang Bapak/ibu guru ketahui? Mohon untuk menjelaskan jenis-jenis AI yang diketahui secara singkat. | |
| | Open-ended questions | perception | Apakah Bapak/Ibu Guru mengetahui apa yang dimaksud dengan Generative AI? Mohon untuk menjelaskan secara singkat, baik definisinya maupun contoh alat (<i>tools</i>) dari generative AI yang Anda ketahui. | |
| 5 | AI Pedagogy (AIP): The capacity to select AI tools significantly enhances teaching practices, enriching both the content delivered and student learning | utilization | I can choose an AI tool to use in my classroom that enhances what I teach, how I teach, and what students learn. | Saya bisa memilih alat AI untuk digunakan di kelas yang membantu meningkatkan apa yang saya ajarkan, cara saya mengajar, dan apa yang dipelajari siswa. |
| 6 | | utilization | I can choose an AI tool that enhances my teaching subject content for a lesson. | Saya bisa memilih alat AI yang memperkaya materi pelajaran yang saya ajarkan. |
| 7 | | utilization | I can teach lessons that appropriately combine my | Saya bisa mengajar dengan menggabungkan materi |

| | | | | |
|----|--|-------------|---|--|
| | experiences. By carefully choosing AI applications that align with the subject matter of each lesson, teachers can create a more engaging and interactive classroom environment. | | teaching subject, AI tools, and teaching approaches. | pelajaran, alat AI, dan cara mengajar secara tepat. |
| 8 | | utilization | I can help others coordinate the use of subject content, AI tools, and teaching approaches. | Saya bisa membantu orang lain mengatur penggunaan materi pelajaran, alat AI, dan cara mengajar. |
| 9 | AI assessment (AIA) | utilization | I can use AI tool to foster assessment for learning. | Saya bisa menggunakan alat AI untuk mendukung penilaian dalam pembelajaran. |
| 10 | | utilization | I can design an assessment approach to improve student learning in an AI-based environment (e.g., learning with ChatGPT). | Saya bisa merancang cara penilaian untuk meningkatkan pembelajaran siswa di lingkungan berbasis AI (misalnya, belajar dengan ChatGPT). |
| 11 | | utilization | I can assess student learning in an AI-based environment. | Saya bisa menilai pembelajaran siswa di lingkungan berbasis AI. |
| 12 | | utilization | I can choose an AI tool to foster student self-assessment. | Saya bisa memilih alat bantu AI untuk mendorong penilaian mandiri siswa. |
| 13 | AI Ethics (AIE) | perception | I can ensure my health and well-being while using AI tools. | Saya dapat memastikan kesehatan dan kesejahteraan (<i>well-being</i>) saya saat menggunakan alat bantu AI. |
| 14 | | perception | I can teach students ethics. | Saya dapat mengajarkan etika (penggunaan AI) kepada siswa. |
| 15 | | utilization | I teach students how to behave safely and responsibly when learning with AI tools. | Saya mengajarkan siswa cara menggunakan alat bantu AI dengan aman dan bertanggung jawab. |
| 16 | | utilization | I can protect sensitive content from AI tools (e.g., exams, students' grades and personal data). | Saya dapat melindungi konten sensitif dari alat bantu AI (misalnya ujian, nilai siswa, dan data pribadi). |
| 17 | Human-centered Education (HCE) | perception | I can assess the benefits of an AI tool. | Saya bisa menilai manfaat dari sebuah alat bantu AI. |
| 18 | | perception | I can assess the risks of an AI tool. | Saya bisa menilai risiko dari sebuah alat bantu AI. |

| | | | | |
|----|---|-------------|--|---|
| 19 | | perception | I recognise human is responsible for AI bias. | Saya menyadari bahwa manusia bertanggung jawab atas bias dalam AI. |
| 20 | | perception | I can explain how AI impact our society. | Saya bisa menjelaskan bagaimana AI berdampak pada masyarakat kita. |
| 21 | Professional Engagement (PEN) | utilization | I can use different websites and search strategies to find and select a range of different AI tools. | Saya bisa mencari dan memilih berbagai alat AI dengan menggunakan situs web dan strategi pencarian yang berbeda. |
| 22 | | utilization | I actively look for continuous professional development activities (regarding AI tools) outside my educational organization. | Saya aktif mencari kegiatan pengembangan profesional (terkait penggunaan alat bantu AI) di luar organisasi pendidikan saya. |
| 23 | | utilization | I actively share my AI teaching experience with other colleagues within and out side my educational organization. | Saya aktif berbagi pengalaman mengajar menggunakan AI dengan rekan-rekan di dalam dan di luar sekolah saya. |
| 24 | | utilization | I love to help my colleagues design learning activities with AI. | Saya merasa antusias untuk membantu teman sejawat dalam merancang aktivitas belajar yang memanfaatkan teknologi AI. |
| 25 | Challenge (open ended question) | challenge | Open-ended questions: 1. Apa tantangan terbesar yang Anda hadapi dalam menggunakan AI untuk mendukung pengajaran? 2. Menurut Anda, apa yang dibutuhkan agar penggunaan AI dalam pembelajaran lebih efektif? | |

Appendix 2. Semi-Structured Interview Guide. The language used was Indonesian.

Semi-Structure Interview Guide versi shortened (40-Minute Version)

Tujuan: Mengeksplorasi praktik guru dalam menggunakan generative AI untuk pengajaran, termasuk persepsi, pemanfaatan, tantangan, dan dampaknya.

1. Demonstrasi & Observasi (15 Menit)

(Fokus pada tindakan nyata, bukan wawancara verbal)

1. "Bisa tunjukkan satu contoh aktivitas pengajaran di mana Anda menggunakan generative AI (misal: membuat soal/rubrik penilaian)? Alat AI apa yang dipilih dan mengapa?"
 - o Observasi: Catat:
 - Alat AI yang digunakan (e.g., ChatGPT, MagicSchool).
 - Contoh *prompt* yang diberikan.
 - Hasil output AI (minta izin untuk melihat contoh sebelumnya jika ada).
2. "Bisa jelaskan bagaimana Anda mengevaluasi hasil dari AI ini? Apa yang biasanya Anda perbaiki?"

2. Persepsi & Pengalaman (5 Menit)

1. "Bagaimana Anda menilai tingkat pengetahuan Anda saat ini mengenai teknologi AI, dan bagaimana pengetahuan mengenai alat AI ini memengaruhi kemampuan Anda untuk menggunakan tool ini saat mengajar?"

3. Pertanyaan Utilization (20 Menit)

(Fokus pada kompetensi pedagogis dan contoh konkret)

A. Integrasi AI dalam Pembelajaran

1. "Bisa beri contoh bagaimana AI membantu Anda menjelaskan materi pelajaran ini? Apakah ada strategi khusus yang terbentuk berkat AI?"
 - o *Follow-up*:
 - "Bagaimana Anda memutuskan di materi/topik apa AI bisa digunakan?"
 - "Apakah AI pernah memberikan ide baru yang mengubah cara mengajar Anda?"
2. "Bagaimana Anda menggunakan AI untuk meningkatkan keterlibatan siswa? Misal: membuat diskusi lebih interaktif atau tugas lebih kreatif?"

B. Asesmen dengan AI

3. "Jika menggunakan AI untuk menilai tugas, bisa tunjukkan contohnya? Bagaimana Anda memastikan penilaiannya adil/akurat?"

- *Follow-up*:
 - o "Pernah menemukan kesalahan dalam penilaian AI? Bagaimana menanganinya?"

C. Pengembangan Profesional

4. "sejauh mana Pengalaman berbagi dengan rekan tentang AI memengaruhi cara Anda memanfaatkannya untuk mengajar?"

3. Tantangan Singkat (5 Menit)

(Prioritaskan hambatan praktis)

1. "Apa hambatan terbesar saat menggunakan AI untuk pengajaran? Misal: keterbatasan alat, waktu, atau kebijakan sekolah?"
 - o *Follow-up*: "Bagaimana Anda mengatasinya?"

4. Penutup (5 Menit)

1. "Apa saran Anda untuk guru yang masih ragu menggunakan AI?"

FGD Guide New

Pertanyaan Umum tentang Persepsi AI

1. Dari mana bapak/ibu guru sekalian mendapatkan informasi atau pengetahuan tentang generative AI? Bisa diceritakan juga pengalaman pertama kali menggunakan generative AI dalam kegiatan mengajar
2. Menurut bapak/ibu guru sekalian, apa saja keuntungan dan kekurangan menggunakan generative AI dalam pengajaran?
3. Apakah bapak/ibu guru sekalian percaya bahwa AI suatu saat nanti bisa menggantikan peran guru di kelas? Mari berdiskusi

Human-Centered Education

4. Bagaimana menurut bapak/ibu guru sekalian, apakah ada risiko dalam menggunakan generative AI di ruang kelas? Apa yang perlu diperhatikan agar AI tetap dapat digunakan secara efektif?

Pemanfaatan AI dalam Pengajaran

5. Di antara berbagai alat atau metode AI yang bapak/ibu guru sekalian gunakan, mana yang paling membantu dalam kegiatan mengajar? Apa alasan memilihnya?
6. Jika bapak/ibu guru sekalian memiliki kebebasan penuh untuk memilih teknologi atau alat AI, apa yang ingin bapak/ibu guru sekalian coba atau gunakan lebih banyak di kelas?
7. Menurut bapak/ibu guru sekalian, di area/aspek mana AI masih perlu ditingkatkan agar lebih berguna untuk pengajaran?

Tantangan

7. Bagaimana Anda memastikan bahwa penggunaan AI tetap mendukung proses pembelajaran yang berpusat pada siswa? (5 menit)
8. Bagaimana pendapat bapak/ibu guru sekalian mengenai kesiapan sumber daya (baik SDM maupun sumber daya sarana prasarana) dalam penggunaan AI dalam dunia pendidikan?
9. Apakah Anda khawatir tentang ketergantungan pada generative AI? Bagaimana Anda mengatasinya? (5 menit)

Appendix 4. Formal Informed Consent for Participants to Join the Research (template). The language used was Indonesian.

PERSETUJUAN PARTISIPASI PENELITIAN UNTUK GURU

Judul Tesis:

Exploring the Artificial Intelligence (AI) Literacy of High School Teachers in Bogor: Perceptions, Utilization, and Challenges in Leveraging Generative AI for Teaching

Researcher: Nabila Nindya Alifia Putri

Asal Institusi: Fakultas Ilmu Pendidikan, Universitas Islam International Indonesia

Formulir persetujuan ini memungkinkan peserta untuk mengikuti protokol evaluasi penelitian. Dokumen ini berisi informasi penting tentang penelitian bersama dengan kemungkinan fitur partisipasi. Anda memiliki kebebasan penuh untuk memutuskan apakah akan mengambil bagian dari penelitian atau tidak. Harap evaluasi informasinya dengan cermat. Jangan menahan diri untuk mengajukan pertanyaan sebelum membuat keputusan untuk berpartisipasi atau menolak. Formulir tersebut memerlukan tanda tangan Anda, jadi Anda akan menerima duplikatnya setelah menandatangani jika Anda setuju untuk bergabung dengan penelitian.

Tujuan Penelitian:

Penelitian tesis ini berupaya menyelidiki bagaimana guru sekolah menengah memandang, dan memanfaatkan teknologi AI generatif untuk pendidikan, beserta kesulitan implementasi yang mereka alami. Penelitian ini bertujuan untuk mengumpulkan informasi berharga tentang interaksi guru dengan teknologi AI generatif dan hambatan yang mereka hadapi untuk meningkatkan strategi integrasi sistem pendidikan. Guru adalah subjek penting dari penelitian ini.

Proses Pengambilan Data:

Pemilihan partisipan:

Peserta penelitian ini akan ditentukan oleh studi dasar (hasil kuesioner awal). Oleh karena itu, semua guru SMA harus mengisi kuesioner awal terlebih dahulu. Di bawah ini adalah mekanisme pengumpulan data dalam penelitian skripsi ini:

1. Kuesioner Pendahuluan

Kuesioner pendahuluan dalam penelitian ini memiliki tujuan yang berbeda dari eksperimen ilmiah pada umumnya karena tidak berfungsi sebagai pengumpul angka atau pembuat kesimpulan umum. Metode ini berfungsi untuk memperoleh detail demografis mendasar seperti paparan peserta terhadap teknologi AI secara umum (yang juga akan mencakup AI generatif), serta pengalaman terkait mereka sebelum wawancara aktual dan sesi diskusi kelompok fokus (FGD).

Durasi: Maret – April 2025

2. Observasi Terstruktur dan Wawancara Semi-Terstruktur

Observasi terstruktur akan dilakukan untuk melihat bagaimana guru berinteraksi dengan AI, dan memanfaatkan AI. Guru harus mendemonstrasikan bagaimana mereka menggunakan AI dalam penggunaan sehari-hari, terutama dalam kaitannya dengan proses belajar atau mengajar. Sebagai kelanjutan dari observasi terstruktur, pada tahap ini, wawancara akan

dilakukan untuk mendapatkan data yang lebih mendalam dan bernuansa, dengan fokus pada pengalaman spesifik guru dalam memanfaatkan AI generatif untuk pembelajaran.

Durasi: maksimal 45 menit, dilaksanakan pada Bulan April 2025

Wawancara akan dilakukan pada April 2025 dengan menyelesaikan prosedur di atas.

3. *Focus Group Discussion (FGD)*

Metode ini akan mendapatkan perspektif dan pengalaman umum yang akan diperoleh melalui diskusi yang terdiri dari beberapa topik yang berkaitan dengan praktik guru dalam menggunakan AI generatif dalam pengajaran dan pembelajaran, tantangan yang dihadapi, masa depan AI, dan membahas tentang kelebihan dan kekurangan AI generatif. Pengalaman dan perspektif masing-masing guru yang akan terbukti melalui diskusi antar guru akan menjadi temuan otentik dan unik untuk penelitian tesis ini.

Durasi: maksimal 75 menit, dilaksanakan pada Bulan April 2025

Risiko dan Manfaat:

Ada risiko yang mungkin timbul dari jumlah jam yang dihabiskan untuk berpartisipasi dalam proses pengumpulan data dan dedikasi guru seperti yang disebutkan di atas. Di antara manfaatnya adalah kesempatan untuk berpartisipasi dalam penelitian yang akan berpotensi memberikan saran terhadap kebijakan dan peningkatan pedoman AI yang ada di sekolah tingkat menengah.

Hak Peserta:

Partisipasi sepenuhnya bersifat sukarela dan Anda dapat menarik diri kapan saja jika Anda merasa tidak nyaman atau merasa kewalahan.

Kontak dan Pertanyaan:

Jika ada pertanyaan, kekhawatiran, atau keluhan tentang penelitian, Anda dapat menghubungi Nabila Nindya Alifia Putri (081775242784).

INSTRUMEN PENELITIAN FORMULIR PERSETUJUAN YANG DIINFORMASIKAN UNTUK GURU (Surat Persetujuan untuk Menjadi Responden)

Yang bertanda tangan di bawah ini

Nama :

Alamat :

Lembaga :

Setelah mendapatkan penjelasan yang memadai dan memadai, serta mengetahui manfaat penelitian berjudul "*Exploring the Artificial Intelligence (AI) Literacy of High School Teachers in Bogor: Perceptions, Utilization, and Challenges in Leveraging Generative AI for Teaching*", dengan ini saya menyatakan bahwa saya bersedia/tidak mau*)

untuk terlibat sebagai subjek penelitian, bahwa jika sewaktu-waktu saya merasa dirugikan dalam bentuk apapun saya berhak untuk membatalkan persetujuan ini.

Saya secara sadar memberikan persetujuan untuk berpartisipasi dalam penelitian ini tanpa paksaan dari pihak manapun, dan informasi yang diperoleh dapat digunakan secara etis untuk tujuan penelitian ini

Bogor, 2025

(Nama Partisipan)

*) : tolong **tebalkan yang diperlukan**

Appendix 5. Member Checking Form (template)

FORMULIR MEMBER CHECKING WAWANCARA

Judul Penelitian : **Exploring the Artificial Intelligence (AI) Literacy of High School Teachers in Bogor: Perceptions, Utilization, and Challenges in Leveraging Generative AI for Teaching**

Nama Peneliti : Nabila Nindya Alifia Putri

Inisial Partisipan :

Tanggal Wawancara : 14 April 2025 (*online*)

Dokumen ini merupakan bagian dari prosedur *member checking*, dan diberikan kepada partisipan untuk meninjau transkrip hasil wawancara mereka. Tujuannya adalah untuk memastikan bahwa data yang ditranskrip oleh peneliti telah sesuai dan mencerminkan makna yang dimaksudkan oleh partisipan.

Transkrip Wawancara:

.....

Pertanyaan untuk Partisipan:

1. Apakah transkrip wawancara ini secara keseluruhan sudah sesuai dengan apa yang Anda sampaikan dalam wawancara?

- Ya

- Tidak

2. Jika tidak, mohon tuliskan koreksi atau klarifikasi Anda:

.....

3. Apakah Anda ingin menambahkan informasi atau pandangan lain yang belum sempat disampaikan saat wawancara?

.....

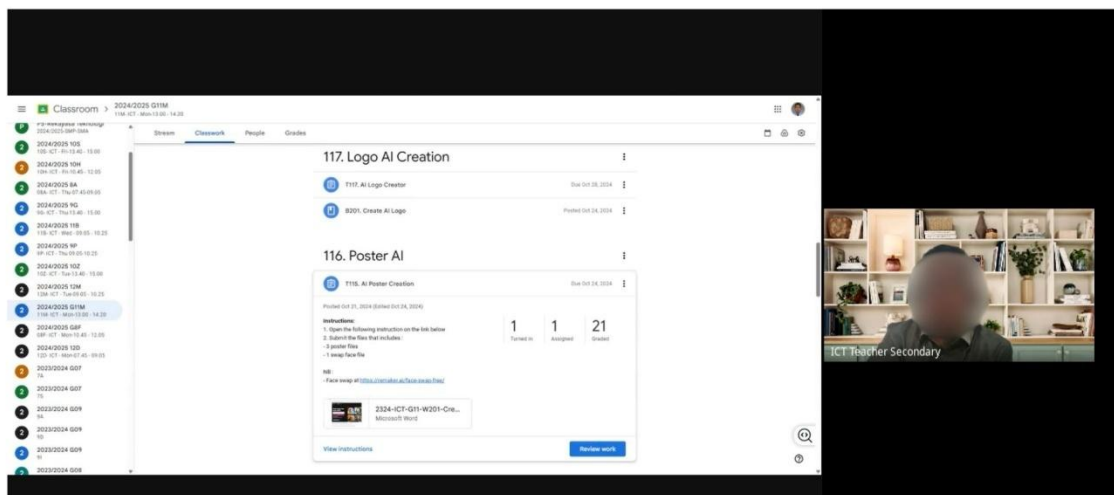
Tanda Tangan Partisipan

Saya yang bertanda tangan di bawah ini adalah Informan Ke-1 dengan kode dan inisial Dengan ini, Saya menyatakan bahwa data yang diperoleh peneliti atas nama Nabila Nindya Alifia Putri dengan NIM 04212310009 dalam penelitiannya yang berjudul *“Exploring the Artificial Intelligence (AI) Literacy of High School Teachers in Bogor: Perceptions, Utilization, and Challenges in Leveraging Generative AI for Teaching”* adalah benar berasal dari saya dan sesuai dengan fakta yang terjadi di lapangan.

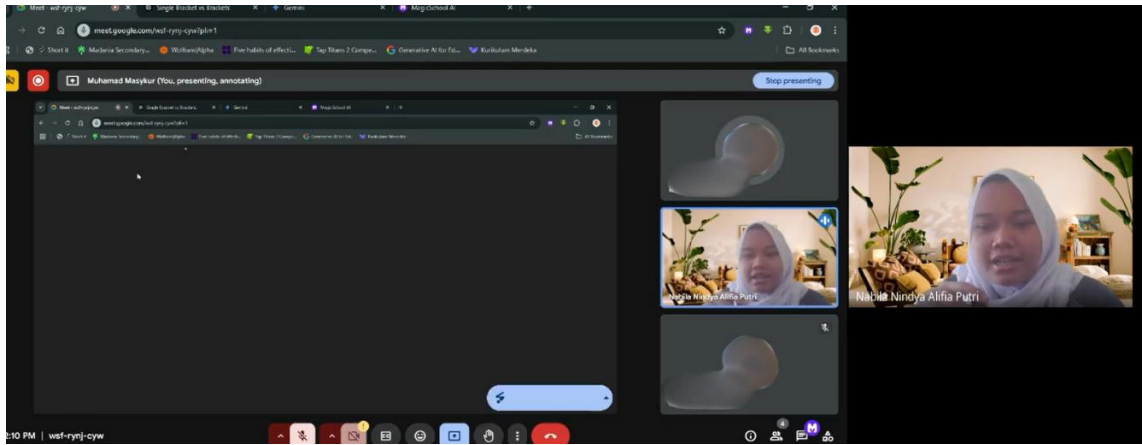
Bogor, Mei 2025

Partisipan

Appendix 6. Evidence of the Structured Observation Process



Appendix 7. Evidence of the Semi-Structured Interview Process



Appendix 8. Evidence of the FGD Process



Appendix 9. Permit Letter to Conduct Thesis Research



Kementerian Agama Republik Indonesia
Universitas Islam Internasional Indonesia
Jalan Raya Bogor KM. 33.5
Cisalak, Sukmajaya, Depok, Jawa Barat 1641E
secretariat@uii.ac.id
www.uii.ac.id

Depok, 07 Februari 2025

Nomor : 038/Dek.FIP/UIII/UM.02/2/2025
Lampiran : -
Hal : Permohonan Izin Penelitian

Kepada Yth.
Kepala Sekolah

Assalamu'alaikum Wr. Wb.,

Dengan ini kami menyatakan bahwa mahasiswa di bawah ini:

Nama : Nabila Nindya Alifia Putri
NIM : 04212310009
Fakultas : Fakultas Ilmu Pendidikan
Program Studi : Magister Ilmu Pendidikan

sedang melakukan penelitian untuk tesis dengan rincian sebagai berikut:

Judul Tesis : *Exploring the Artificial Intelligence (AI) Literacy of High School Teachers in Bogor: Perceptions, Utilization, and Challenges in Leveraging Generative AI for Teaching*
Lokasi Penelitian : [Redacted]
Waktu Penelitian : 2 bulan

Kami memohon bantuan Ibu/Bapak untuk memberikan izin penelitian kepada mahasiswa tersebut. Data penelitian hanya akan digunakan untuk tujuan akademis dan tidak akan digunakan untuk tujuan lain.

Demikian kami sampaikan, atas perhatian dan kerja sama Ibu/Bapak kami ucapkan terima kasih.

Wassalamu'alaikum Wr. Wb.,

Hormat kami,
Dekan Fakultas Ilmu Pendidikan



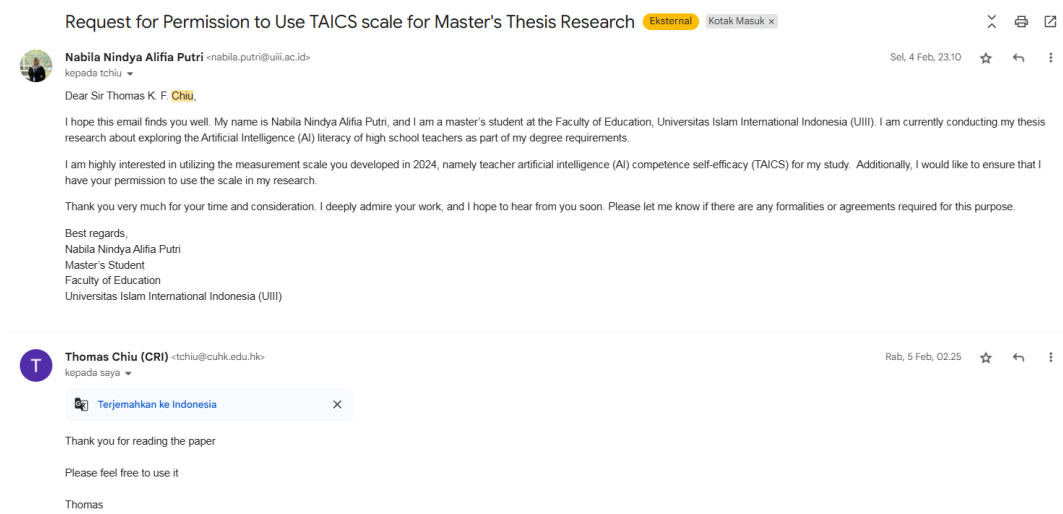
Prof. Nina Nurmila, PhD



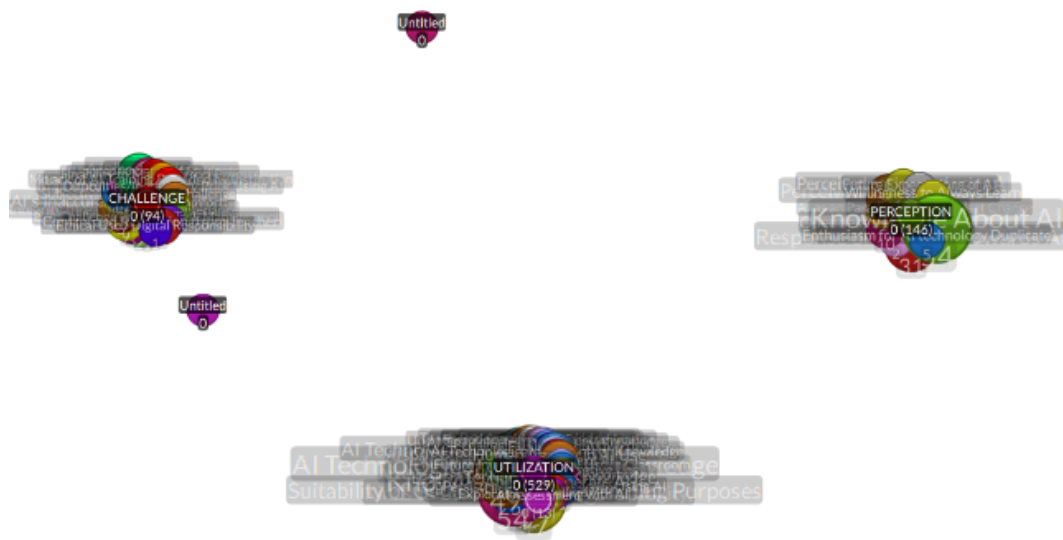
Dokumen ini telah ditandatangani secara elektronik menggunakan sertifikat elektronik yang telah diterbitkan oleh Balai Sertifikasi Elektronik (BSrE), Badan Sandi dan Siber Negara.

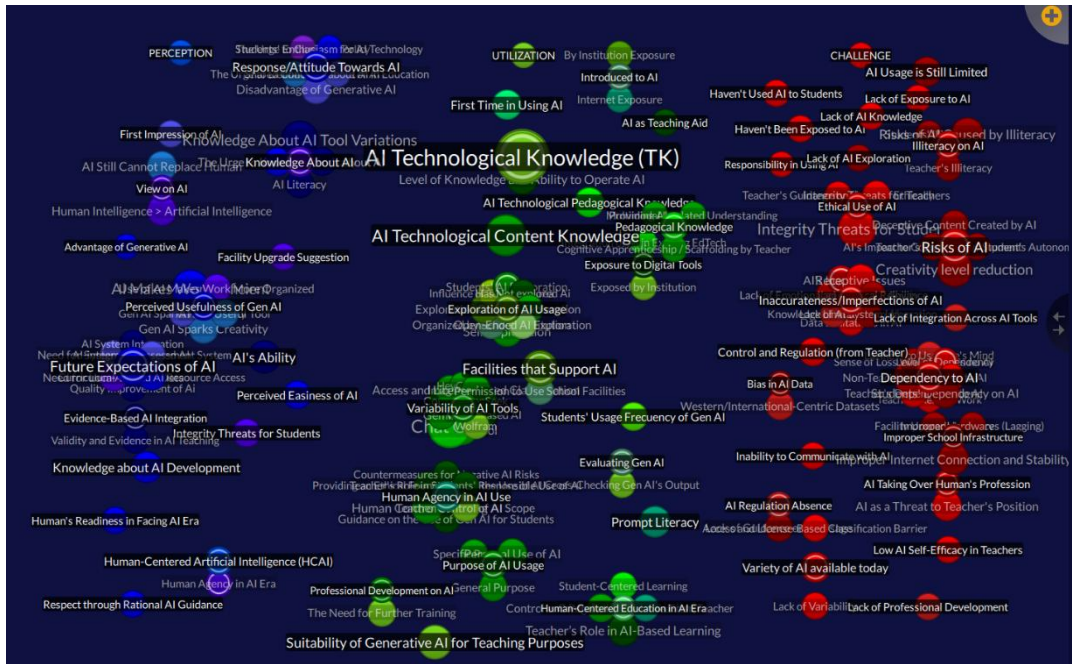


Appendix 10 Permission Email to Adapt the Questionnaire to The Scale Developer



Appendix 11. Thematic Coding Process





Appendix 12. Table of Thesis Research Timeline

| Thesis Research Activities Log | Month | | | | | | | |
|---|-------|---|---|---|---|---|---|---|
| | 12 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| Initial conceptualizing of thesis topic and ideas for thesis proposal | | | | | | | | |
| Research permit letter preparation, and questionnaire preparation | | | | | | | | |
| Make research permit letter to the school foundation, for data collection | | | | | | | | |
| Questionnaire distribution as a baseline for next data collection | | | | | | | | |
| Questionnaire results analysis | | | | | | | | |
| Structured observation, interviews, and FGD with teachers | | | | | | | | |
| Transcription and coding the interview results | | | | | | | | |
| Data analysis, writing the results and discussions | | | | | | | | |
| Finalization of the thesis research | | | | | | | | |

Appendix 13 Statement of Generative AI And AI-Supported Technologies Used in The Writing Process

This statement confirms the use of Artificial Intelligence (AI) tools by the student and researcher Nabila Nindya Alifia Putri during the development of the thesis, "Exploring the Artificial Intelligence (AI) Literacy of High School Teachers in Bogor: Perceptions, Utilizations, and Challenges in Leveraging Generative AI for Teaching". In addition to these, specifically, ChatGPT, Gemini, and Elicit all acted as aids during the initial conceptualisation phase by brainstorming research avenues and assisting as a search tool to identify related academic papers; for instance, prior studies and core theories of the main topic: AI literacy. Moreover, ChatGPT and DeepSeek were also aids to help in translating the adapted scale for preliminary questionnaire. Most importantly, the outputs and recommendations of AI were very stringently human reviewed. Ideas were assessed critically, sources discovered by AI were confirmed to be accurate and relevant independently before inclusion in the thesis, original work, critical thinking, synthesis, and written composition were the responsibility of the researcher for the academic integrity and originality of this thesis.