AI-POWERED DIFFERENTIATED FLIPPED CLASSROOM DESIGN THINKING: FOSTERING DIGITAL LITERACY, CREATIVE THINKING, AND SELF-EFFICACY

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Abstract

The integration of Artificial Intelligence (AI) into the Flipped Classroom Design Thinking model offers a promising approach to enhance digital literacy, creative thinking skills, and self-efficacy among university students. This hypothetical model proposes a student-centered learning environment that combines independent learning with collaborative interactions. The model's syntax involves out-of-class activities such as mind mapping, observation, brainstorming using AI, prototype development, and testing, followed by in-class activities like presentations, evaluations, discussions, and wrap-up sessions. The model's effectiveness is supported by various learning theories, including constructivism, cognitivism, social cognitive theory, Vygotsky's sociocultural theory, transformative learning theory, and connectivism. The integration of AI tools further empowers students to explore innovative solutions, receive personalized feedback, and engage in collaborative learning experiences. By fostering digital literacy, creative thinking, and self-efficacy, this model has the potential to equip students with essential skills for success in the 21st century. It also promotes a deeper understanding of concepts, problem-solving abilities, collaboration, communication skills, motivation, critical thinking, and overall academic achievement. The proposed model represents a significant step towards leveraging AI's potential to create transformative learning experiences that prepare students for the challenges and opportunities of the digital age.

Keywords: AI, Flipped Classroom, Design Thinking, Digital Literacy, Creative Thinking, Self-Efficacy.

1 INTRODUCTION

Artificial Intelligence (AI) is the key technology driving the fourth industrial revolution, also known as Industry 4.0. AI, along with the Internet of Things and big data, plays a crucial role in this phase of the industry's transformation (Jun, 2018). The fusion of digital technology with the physical world is a hallmark of Industry 4.0, and AI is accelerating this revolution (Bühler et al., 2022). Advances in AI, particularly in the medical field, are closely related to the start of the fourth industrial revolution (Nam et al., 2019). In addition, AI is not only impacting the industrial landscape, but also impacting social structures. AI is considered the driving force

behind the Fourth Industrial Revolution, which affects various aspects of society (Mahomed, 2018). As progress progresses towards the social revolution 5.0, AI is expected to continue to play a transformative role. The development of a new generation of AI is seen as a force that can increase national strength and promote sustainable economic growth (Li, 2021). In addition, the ethical and social dimensions of AI systems are increasingly recognized as important considerations in various social domains, including health and social services (Isbanner et al., 2022).

Generative AI in higher education has the potential to revolutionize the learning process, increase creativity, and improve information processing. Generative Artificial Intelligence (AI) plays a crucial role in higher education by offering transformative potential in improving learning, creativity, and information processing (Wrench & Elmoudden, 2024). The application of AI in teaching and learning is a technological revolution that is expected to change the structure of higher education globally (Popenici & Kerr, 2017). AI technology has the potential to reshape and overhaul higher education, playing a crucial role in the transformation of this sector (Priya Gupta & Bhaskar, 2020).

However, ethical considerations, including the prevention of unethical practices such as cheating, and their impact on the workforce, need to be considered to ensure responsible and effective integration of AI in higher education. Generative AI has the capacity to generate responses to questions, which can interfere with higher education if used unethically, such as in cheating scenarios during exams and assignments (Tenakwah et al., 2023). In addition, the use of generative AI in education raises ethical issues, including the potential for unethical or dishonest use by students and the potential for the eviction of human labor by technology (Qadir, 2023). Despite the opportunities that AI offers to support teaching and learning, its development for higher education has ethical implications and risks that need to be carefully considered (Pedró, 2020). Generative AI mastery should involve digital literacy as a foundational skill that empowers individuals to interact responsibly with AI technology, critically assess the information generated by AI systems, and proficiently navigate the digital landscape in a variety of contexts, including educational and professional settings.

Mastery of generative AI includes digital literacy as an essential component. Digital literacy, defined as the ability to understand and utilize information in a variety of formats, is essential for individuals to navigate the digital landscape effectively (Hilyana et al., 2023). In the realm

of generative AI, digital literacy plays a crucial role in promoting the responsible use and understanding of information generated by AI systems (Krügel et al., 2022). Especially in the context of the COVID-19 pandemic, digital skills are essential for accessing and processing information (Fathia et al., 2022).

The incorporation of generative AI in higher education underscores the importance of digital literacy for students and professionals to utilize AI responsibly and critically evaluate the impact of advanced technology on society (Dianova & Schultz, 2023). As AI literacy becomes increasingly important in various fields and industries, digital literacy is becoming interrelated with the understanding and application of AI technology (Boscardin et al., 2024). The establishment of transdisciplinary digital literacy education is critical in preparing individuals to effectively and ethically engage with generative AI (Dianova & Schultz, 2023).

In addition, introducing AI literacy as part of the curriculum to help students understand the digital world, data-driven systems, bias in models, and other important elements for digital literacy in the AI era (Kesici, 2022; Kreinsen & Schulz, 2023) which discusses the effects of digital literacy on creative thinking dispositions. According to this study, digital literacy has an important role in influencing a person's creative thinking disposition (Kesici, 2022). This study shows that individuals who have good digital literacy tend to have a better creative thinking disposition. Therefore, the development of digital literacy can positively affect a person's ability to think creatively (Kesici, 2022). The mediation role of lifelong learning in the relationship between digital literacy and creative thinking disposition (Kesici, 2022; Naveed et al., 2023). This shows that continuous learning through digital literacy plays an important role in improving creative thinking skills that are very important for students.

Creative thinking skills are very important for students because these skills are very important for solving problems in various contexts (Moh. A. Rahman et al., 2020). These skills allow students to explore their potential, think divergently, and develop innovative solutions to complex problems. Creative thinking is closely linked to educational outcomes, fostering deep conceptual understanding and enhancing students' talents in subjects such as mathematics (Qadri et al., 2019). Creative thinking is essential for innovation, development, and progress, in line with the demands of a rapidly changing world. Additionally, creative thinking skills are associated with increased collaboration, problem-solving, and technological readiness, which are essential competencies for success in the modern world of work (Fideli & Aliazas, 2022).

The development of creative thinking is influenced by various factors, including teaching methods, learning environments, and individual characteristics (Ratnaningsih, 2017; Sekarini et al., 2020). In addition to creative thinking skills and literacy, the important thing to improve during learning is self-efficacy.

Self-efficacy plays an important role in student development and academic success. Self-efficacy is very important in motivating students to use effective learning strategies, and highlights the importance of self-efficacy in encouraging academic performance (Zimmerman, 2000). Other research further shows positive outcomes related to self-efficacy, especially in non-traditional fields, underlining its role in shaping students' educational and career trajectories (Marra et al., 2009). Additionally, self-efficacy can create a feedback loop where higher initial self-efficacy leads to improved performance, strengthening self-confidence, while lower self-efficacy can lead to decreased performance, perpetuating a cycle of diminished self-confidence (Marshman et al., 2018).

Self-efficacy is very important in improving students' abilities and grades, as highlighted by (Ernawati et al., 2022). By improving self-efficacy, students can effectively overcome challenges and achieve success in complex problem-solving tasks. In addition, self-efficacy has been associated with a variety of motivational outcomes, influencing student engagement, task choice, effort, and perseverance (Beatty et al., 2020; Rini & Purwanti, 2021). The positive impact of self-efficacy on student success is further emphasized by (Beatty et al., 2020), which states that self-efficacy increases motivation, perseverance, and ultimately leads to academic achievement.

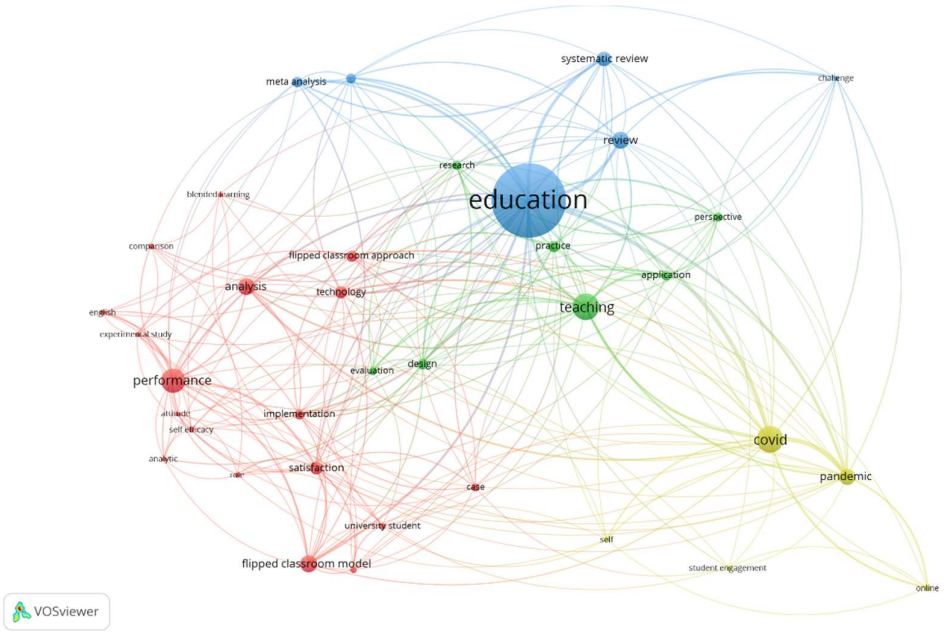

Figure 1 Flipped Clasroom Bibliography (2019-2023)

Source: VOSViewer Analysis

Figure 1.1 shows a bibliography of 1000 references from the last five years of Scopus data (2019-2023) with the keyword "Flipped Classroom" using Harzing's Publish Or Perish. Based on the data, it was found: (1) There were three articles or 0.3% of flipped classroom articles related to literacy, including artificial intelligence (AI) literacy (Kong, 2021; Laupichler, 2022) and information literacy (Humrickhouse, 2021); (2) there are four or 0.4% of flipped classroom articles related to creative thinking (Ariani, 2022; Hung, 2023; Rodríguez, 2019; Widyaningrum, 2020); (3) there are thirteen or 1.3% of flipped classroom articles related to self-efficacy (Algarni, 2023; Belgium, 2023; Boateng, 2022; Chang, 2022; González-Gómez, 2022; Hsiao, 2023; Jin, 2020; Latorre-Cosculluela, 2022; Lin, 2019; Namaziandost, 2020; Sun, 2022; Zhao, 2021; Zheng, 2020); and (4) there are four or 0.4% of flipped classroom articles related to AI (Huang, 2023; Peng, 2022; Shan, 2021; Wu, 2021). This means that there are still few studies that examine the influence of flipped clasroom on digital literacy, creative thinking skills, and self-efficacy. Also, there is still little research that integrates AI into flipped classroom learning. Although there have been studies related to the flipped clasroom model related to digital literacy variables, creative thinking skills, and self-efficacy, the research was carried out partially, while in this study it was researched simultaneously. In addition, the research methods used previously were mostly experiments, case studies, meta-analysis, and

systematic reviews while in this study it was model development. This research aims to develop a syntax model and a hypothetical model of Flipped Classroom learning based on Design Thinking supported by AI.

2 METHODOLOGY

This research is part of a development research that adapts the first phase of the R&D model proposed by Plomp (2013). This first phase is preliminary research, which aims to identify needs, analyze the context, and develop a conceptual framework as the basis for the preparation of a hypothetical model. The steps in this phase are shown in the adapted flowchart. This preliminary research consists of two main components: needs and context analysis, as well as literature study and conceptual framework development. The stages in this phase are described as follows (Figure 1).

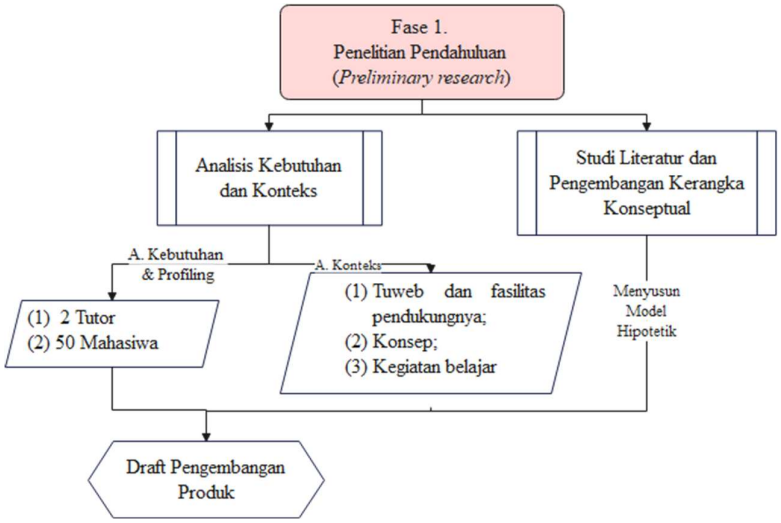

Figure 1. Research Procedure

Adapted from: (Plomp, 2013)

2.1 Needs and Context Analysis

There is this stage, the researcher identifies learning needs and analyzes the context that involves tutors and students as the main actors in the educational process. The profiling of needs is done by engaging 2 tutors to understand the relevant approaches in supporting AI-assisted personalized Flipped Classroom-based learning. In addition, 50 students were used as the subject of analysis to determine their specific needs in digital learning, especially related to digital literacy, creative thinking, and self-efficacy. This approach aims to identify the challenges and opportunities faced by tutors and students in adopting technology-based learning

methods. The results of this needs profiling help develop a design that suits the characteristics and needs of the two actors.

In addition, a context analysis was carried out to understand the infrastructure and approaches that support AI-based learning models and Flipped Classroom. The researcher reviewed the tutoring website and other supporting facilities available to support the learning process, ensuring that the technology used was in accordance with the learning needs. The analysis also includes theoretical concepts that support learning differentiation, Flipped Classroom integration, and the application of Design Thinking. Furthermore, researchers mapped out relevant learning activities, including the use of AI to personalize materials and support project-based learning strategies. The information from this needs and context analysis is the basis for compiling a product development draft in the form of a more effective hypothetical learning model.

3. Literature Studies and Development of Conceptual Frameworks

At this stage, the research focuses on a thorough literature review to identify relevant theories, concepts, and learning models to support the development of hypothetical learning models. Researchers collected various scientific references from journals, textbooks, and conference papers related to the concept of Flipped Classroom, Design Thinking, AI in education, as well as its relationship to digital literacy, creative thinking, and self-efficacy. A study of Flipped Classroom highlights the effectiveness of this method in encouraging active and independent learning, while Design Thinking in education helps develop creative and collaborative skills. Additionally, the literature on AI emphasizes the role of these technologies in personalizing learning and data-driven support to strengthen individual student learning processes.

The results of the literature review are then used to compile a conceptual framework that underlies the development of the learning model. This framework integrates key elements of Flipped Classroom and Design Thinking supported by AI's ability to differentiate learning according to student needs. In this framework, the learning syntax is designed to involve the stages of independent exploration, collaboration in the classroom, and the application of Design Thinking to solve creative problems. With the support of AI, learning becomes more directed and in accordance with the level of ability and needs of each student, which in turn is expected to be able to improve digital literacy, creative thinking, and self-efficacy.

4. Product Development Draft

The results of the needs and context analysis and literature study are then used to prepare a draft product development in the form of a hypothetical learning model. The model includes a learning stage syntax that leverages AI for personalization and is focused on improving digital literacy, creative thinking skills, and self-efficacy.

3 FINDINGS AND DISCUSSION

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3.1 Preliminary Research Results

The needs analysis was carried out through interviews and questionnaires by 41 students related to tuweb experience, tuweb facilitation, AI, digital literacy, creative thinking skills, self-efficacy, and student learning needs. A summary of the interview results is shown in Table 1.

Table 1. Summary of Interview Results Related to Digital Literacy, Creative Thinking, and Self-Efficacy

Variable	Current Conditions	Challenge
Digital Literacy	Basic understanding, difficulty in evaluating & using information	Limited access to internet/technology Lack of training Relying on unverified sources Difficulty distinguishing information
Creative Thinking	Learning/tutorials focus on memorization, little exploration and lack of creativity, still dominated by tutor explanations	A culture of learning that inhibits risk, one-way, is dominated by tutors Regular tasks do not encourage thinking outside the box. Lack of confidence Fear of failure & criticism Choosing a comfort zone
Self-Efficacy	Low, especially during complex challenges	- Isolation due to lack of interaction - The mindset of "as long as the task is done" - Limited resources & support - Previous failed experience

Table 1 shows that there is a significant need to improve digital literacy, creative thinking skills, and self-efficacy of Open University students. The development of innovative and technology-integrated learning models, such as those proposed, can be an effective solution to address these

challenges and prepare students for success in the digital age. Table 2 is the result of the analysis of student learning needs.

Table 2. Results of Maahasiswa Learning Needs Analysis

Aspects	Current Conditions	Expectations & Needs
Learning Style	Diverse (visual, auditory, kinesthetic)	A learning approach that accommodates a wide range of preferences
Learning Format	Diverse preferences (video, text, discussion)	Flexible learning model with a variety of collaborative formats & activities
Role of Tutor/facilitator	Tutor as material presenter, assignor (1, 2, 3), and assessor	Personalized guidance, constructive feedback, motivation, inclusive & supportive learning environment

Table 2 shows the need for flexible and adaptive learning models, which can accommodate diverse learning styles and student preferences. In addition, the role of facilitators needs to be improved to provide more personalized support and encourage active student involvement in the learning process. Table 3 relates to the initial view of AI (more details can be seen in Appendix 1).

Table 3 Initial Views on AI

Aspects	Current Conditions	Challenge
Understanding AI	Limited, overview	Lack of specific knowledge about AI applications in learning
Concerns & Obstacles	There is, especially the question of human roles and ethics	- The potential of AI to replace tutors/facilitators - Uncertainty of ethical integration of AI - Limited access to technology & infrastructure - Lack of training & capacity building

The results in Table 3 show that while there is great potential in the use of AI to improve learning, there are still challenges in terms of understanding, adoption, and implementation. Therefore, there is a need for systematic efforts to improve AI literacy, address concerns, and develop the necessary infrastructure and capacity to effectively integrate AI in learning. A summary of student feedback based on the results of the distribution of google form questionnaires related to the previous tuweb flipped classroom activities is shown in Table 4.

Table 4 Summary of Feedback on Previous Tuweb Flipped Classroom Implementation

Category	Feedback
Positive Effects	- Flexibility and accessibility: can be followed from anywhere, saving time and distance, encouraging learning independence. - Good interaction and communication: the tutor is patient and clear, the learning atmosphere is active and comfortable, building communication between friends. - Interesting and useful material: concepts are easy to understand, lots of new knowledge and experiences, relevant to learning, improve skills. - Increase motivation and independence in learning. - An engaging learning experience. - Good delivery of material and media. - Provides a deeper understanding.
Challenges/Obstacles	- Unstable internet connection: network interruptions, poor audio/video quality, disconnection from webinars. - Technical problem with the device: the microphone does not work. - Lack of interaction: interaction is less optimal than face-to-face. - Lack of technological ability: difficulty following the material.
Suggestion	- Maintain and improve quality. - Reduce the workload. - Improves internet connection. - Adding variety and interaction: real practice, ice breaking, group discussions, innovation, use of media such as videos. - Periodic evaluation and feedback. - Schedule adjustments for more flexibility. - Increased tutor engagement: more material from the tutor. - The use of MFIs in other courses.

A flipped classroom model solution that integrates AI-assisted design thinking steps to improve digital literacy, creative thinking skills, and student self-efficacy through *out-class* and *in-class activities.* The AI-assisted Flipped Clasroom Design Thinking syntax design process is specified in Table 4.5.

Table 4.5 AI-Assisted Flipped Clasroom Design Thinking Syntax Design Process

Advanced tables...

Learning Components		**Syntax of the *Flipped Classroom Learning Model Prototype Design thinking assisted by artificial intelligence (AI)***
Model Micro Flipped Classroom	***Design thinking***	
Out Class Tutors provide short videos and study assignments to students.	1. *Mpathise* (Mpati) 2. *Define* 3. *ideate* (generate ideas) 4. *Prototype* (Prototipe) 5. *Test* (Uji Coba).	***Out Class*** 1) Students individually study the Module and listen to a short video (*Whiteboard Animation).* 2) Students individually create *a Mind Map* based on the identification of essential concepts. 2. *Mpathise* (Mpati) 3. *Define* 4. *Ideate* (Generate Ideas) with *AI-assisted* brainstorming 5. *Prototype* by Developing prototype alternatives with AI 6. *Test* (Uji Coba) Prototipe
In class Students do the rest of the learning activities and work on certain tasks facilitated by the tutor.		***In class*** *1) Presentation* *2) Evaluation* *3) Q&A and Discussion* *4) Cover*

We explain the syntax in the context of the Science Learning Course in Elementary School visually in Figure 2.

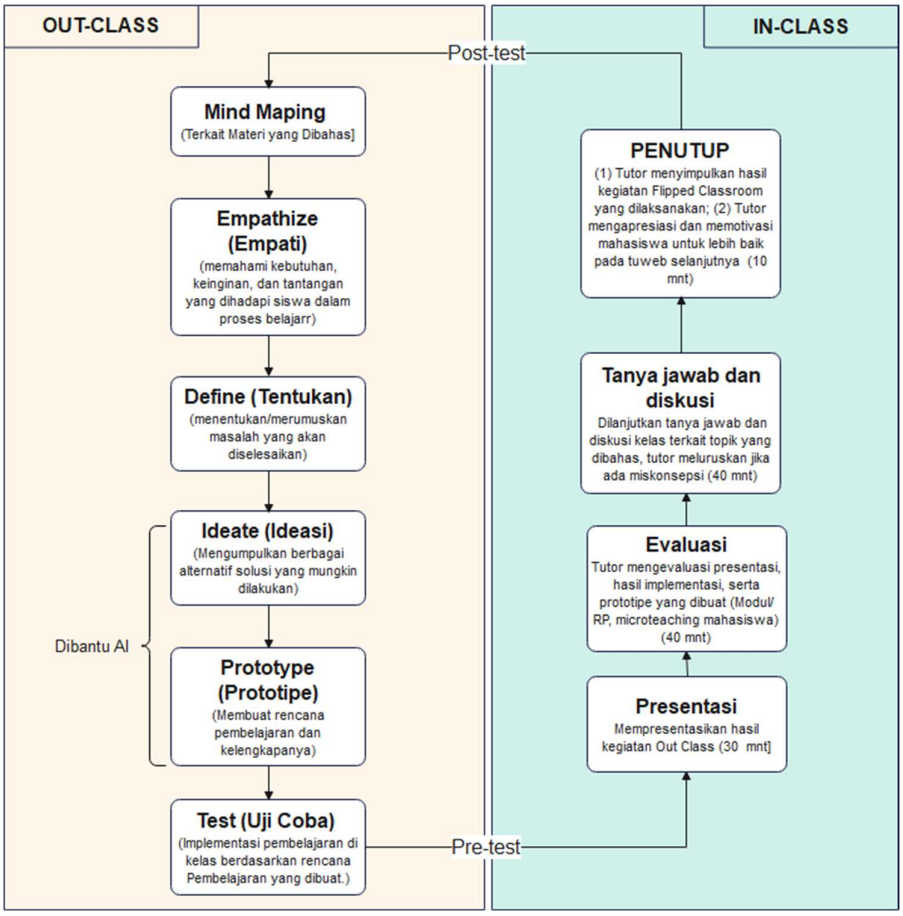

Figure 2. Syntax Scheme of the Flipped Classroom Design Thinking Model assisted by artificial intelligence (AI)

(a) Out-class

- Mind maping

Make mind mapping of important materials and concepts. This stage encourages prospective elementary tutors to understand the structure and relationships between concepts in the learning material. This improves their ability to think systematically and organize information, which is essential for designing effective learning.

- Empathy

Students identify the needs and problems of users (students). This stage encourages prospective elementary school tutors to understand the learning needs and challenges of elementary school students. This increases their empathy and ability to design learning solutions that are relevant and appropriate to the characteristics of elementary school students.

- Ideasi

Students collaborate to develop innovative learning solutions using generative AI-assisted brainstorming techniques. This stage encourages prospective elementary tutors to think creatively and generate innovative ideas for learning. The use of generative AI can help prospective elementary tutors find new ideas and explore various possible learning solutions that suit the needs of elementary school students.

- Prototype

Students make prototypes in the form of lesson plans (teaching modules) and student worksheets assisted by generative AI. This stage encourages prospective elementary tutors to apply their creative ideas into concrete forms. The use of generative AI can assist prospective elementary tutors in developing structured lesson plans and creating interactive and engaging student worksheets, which are in accordance with the characteristics of elementary school students.

- Test

Testing or Implementation of learning prototypes according to the plan prepared in the actual classroom. This stage is important to test the effectiveness of the learning solution that has been designed. Prospective elementary tutors can collect feedback from elementary school students and use that feedback to improve prototypes and improve the effectiveness of learning solutions.

(b) In-Class

- Presentation

Students present all activities carried out in the out class carried out by one of the predetermined groups. This stage encourages prospective elementary tutors to present the results of their work and explain their thought process. This improves the communication and presentation skills of prospective elementary school tutors, which is important to convey learning materials to elementary school students effectively.

- Evaluation

Tutors evaluate lesson plans, student worksheets, and classroom learning implementation. The tutor is also obliged to explain again if there is a theory that is not clear or a misconception. This stage is important to ensure that the learning solutions designed are in accordance with the learning objectives and effective in improving the understanding of elementary school students. Tutors can provide input and suggestions to prospective elementary tutors to improve student lesson plans and worksheets.

- Q&A and class discussion

Students conducted questions and answers and class discussions related to presentations of out-of-class activities and evaluations. This stage encourages prospective elementary tutors to think critically and discuss the ideas that have been put forward. This improves their critical thinking skills and ability to collaborate with other prospective elementary tutors, which is essential for developing effective learning in the classroom.

- Cover

Tutors make learning conclusions, appreciation, and information related to further learning. This stage is important to summarize the learning that has been done and provide information about the next learning. This helps prospective elementary tutors to understand the learning flow and prepare themselves for the next lesson.

The design thinking syntax integrated in the flipped classroom model is expected to help prospective elementary school tutor students develop digital literacy, creative thinking skills, and self-efficacy. Stages such as mind mapping, empathy, ideation, prototyping, testing, presentation, evaluation, and discussion encourage prospective elementary tutors to think critically, collaborate, and use AI technology to improve their learning. This is important to prepare prospective elementary tutors to become effective and innovative educators in the digital era.

3.2 Theoretical and Empirical Foundations for the Development of Flippped Classroom Design Thinking Models Assisted by Artificial Intelligence (AI)

a. Theoretical Foundations for the Development of *the Flippped Classroom Design Thinking Model Assisted by Artificial Intelligence (AI)*

- **Constructivism Theory**

Constructivism is a learning theory that emphasizes the active role of learners in constructing their own knowledge based on their experiences. This theory challenges the traditional view that knowledge can be transferred directly from tutor to student. Rooted in cognitive and social constructivism, constructivism in education highlights the importance of considering the knowledge already possessed by students in the learning process. This theory states that students build their understanding of the world through observation and scientific study. (Splan et al., 2011) (Bodner, 1986) (Kaufman, 2004) (Jing, 2017)

Overall, the model supports constructivism by: (1) Encouraging active and participatory learning; (2) Facilitating the formation of knowledge through experience and reflection; (3) Emphasizing collaboration and social interaction in the learning process; and (4) Paying attention to individual needs and perspectives. The role of generative AI in this model can be seen as a tool that supports the process of constructivism by: (1) Assisting students in accessing and processing information; (2) Facilitating brainstorming and development of creative ideas; and (3) Provide personalized feedback.

- **Theory Cognitism**

The theory of cognitivism in learning emphasizes mental processes such as thinking, remembering, solving problems, and making meaning. This theory focuses on the internal cognitive processes of learners, including insight, perception, and metacognition Unlike behaviorism, which concentrates on observable behaviors, cognitivism studies how the mind works to understand how individuals process information and learn. This theory gives meaning to events by involving knowledge and generating meaning through mental processes . Cognitivism is rooted in Gestalt theory and is associated with concepts such as memory, insight, and metacognition. This theory is considered the second most important learning theory at all levels of education . (Allen et al., 2022; Alqurashi, 2018; Spiro et al., 2013) (Altuna & Lareki, 2015) (Alqurashi, 2018; Muzam et al., 2023) (Allen et al., 2022) (Hashem Neghad, 2014)

Overall, this model supports cognitivism by: (1) Facilitating mental processes such as organizing, processing, and storing information; (2) Encouraging the application of knowledge in real situations; (3) Providing opportunities for reflection and improvement of the thinking process; and (4) Facilitating social interactions that support learning. The role of AI in this model can be seen as a tool that supports cognitivism by: (1) Assisting prospective elementary school tutors in accessing and processing relevant information; (2) Provide personalized feedback to help correct errors in understanding; and (3) Facilitate simulations and interactive learning environments.

- **Social Cognitive Theory**

Social cognitive theories, as proposed by , emphasize the role of observational learning, imitation, and modeling in human behavior. This theory distinguishes between three types of agencies: private agencies, proxy agencies, and collective agencies. Bandura's work highlights the importance of individuals learning through observation of others and imitating behavior in different environments . Social cognitive theory in the context of career and academic interests, choices, and performance integrates social cognitive theory into an understanding of an individual's career and academic decisions and outcomes. (Bandura, 2001) (Bandura, 2001) (Lent et al., 1994)

Overall, this model supports social cognition by: (1) Emphasizing the importance of social interaction and collaboration in learning; (2) Pay attention to social and emotional factors that affect learning; (3) Encouraging observation and reflection on group dynamics and social interaction; and (3) Facilitate the development of social and communication skills.

- **Vigotsky's Sociocultural Theory**

Vygotsky's Sociocultural Theory, developed by Lev Vygotsky, emphasizes the importance of social interaction and cultural context in the learning process and cognitive development. This theory states that individuals learn and develop in the context of social interaction, where *more knowledgeable others* (MKO) play an important role in guiding learners to achieve tasks within their *zone of proximal development (ZPD*). Vygotsky's work highlights the importance of the sociocultural environment in shaping an individual's understanding of the world and cognitive abilities. (Gauvain, 2020) (Cong-Lem, 2023)

Overall, this model supports Vygotsky's sociocultural theory by: (1) Emphasizing the importance of social interaction and collaboration in learning; (2) Provide opportunities for prospective tutors to work in their ZPD with the help of tutors and peers; (3) Using scaffolding to support the learning and development of prospective tutors; and (4) Pay attention to the social and cultural context of learning. The role of AI in this model can be seen as a tool that supports Vygotsky's sociocultural theory by: (1) Providing resources and tools that can be used for scaffolding; and (2) Analyze learning data to identify areas where prospective tutors need additional support.

- **Transformative Learning Theory**

Transformative Learning Theory is a concept that involves individuals critically examining and challenging their assumptions and beliefs, leading to the development of new perspectives and behaviors. Mezirow, a leading figure in the field, defines transformative learning theory as a process that includes qualitative elements such as "meaning perspectives," "frames of reference," and "habits of thinking." This theory emphasizes holistic changes in how individuals experience emotionally and mentally frame their understanding of the world during learning experiences that are personally developmental, socially controversial, or involve healing. (Rahman & Hoque, 2017) (Faslı, 2019) (Yorks & Kasl, 2006)

Overall, the model supports transformative learning by: (1) Encouraging self-reflection and critical evaluation of assumptions and beliefs; (2) Facilitating dialogue and discussion that challenges old perspectives; (3) Encouraging creativity and innovation in the development of learning solutions; and (4) Creating a learning environment that supports personal change and growth.

- **Theory of Connectivity**

Connectivity theory is a modern learning theory that highlights the importance of networks and connections in the learning process. This theory states that learning involves not only the acquisition of knowledge, but also the establishment of relationships between various information and resources. In connectivityism, learners are seen as active participants who play an important role in constructing their knowledge by interacting with various sources of information within their personal learning network. This theory distinguishes itself from traditional learning theories such as behaviorism, cognitivism, and constructivism by

emphasizing the dynamic nature of the creation and exchange of knowledge through networks. (Goldie, 2016) (Dziubaniuk et al., 2023) (Dennis, 2020)

Role of the Platform: (1) Silayar virtual class as the main platform to access materials, upload assignments, and interact with discussion forums; (2) Microsoft Teams, as a platform for virtual face-to-face, presentation, discussion, and collaboration in real-time; and (3) WhatsApp Groups, as an informal communication and coordination platform between prospective tutors and tutors. Advantages of Technology Integration: (1) Flexibility, prospective tutor students can learn and collaborate anywhere and anytime; (2) Accessibility, learning materials and resources can be accessed easily; (3) Collaboration, technology facilitates collaboration and interaction between prospective tutors; (4) Creativity, digital tools support the creative process and idea development; and (5) Efficiency, technology can automate some tasks and improve learning efficiency.

b. Empirical Foundations for the Development *of Flippped Classroom Desing* Differentiated Thinking Models Assisted *by Artificial Intelligence (AI)*

Table 6 describes the empirical basis of each Model development syntax *Flippped Classroom* Assisted Differentiated *artificial intelligence (AI)* by adapting the syntax *Design thinking.*

Table 6 Syntax Design Process of *the Flippped Classroom Desaign Thinking Model Assisted by Artificial Intelligence (AI)*

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		Activities outside the classroom (*Out Class)*	
Mind mapping (Product Differentiation)	1. Reading the modules then makes mind mapping the material and important concepts.	• Students can choose a mind map format that suits their learning style, such as diagrams, flowcharts, or images. • The level of complexity of the mind map	• Mind maps help in organizing the mind, facilitating the development of ideas, and improving memory. (Fadillah, 2019) • Mind maps have been shown to

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		can be adjusted, from simple to very detailed, according to the abilities of each student. • This activity directly supports creative thinking and digital literacy. Students are asked to create a mind map of the modules studied, allowing them to choose a digital format that suits their learning style, such as diagrams or flowcharts. Through this process, students not only practice their digital skills in using digital tools or platforms for mind mapping but also hone their creative thinking skills in organizing and visualizing complex concepts. The use of digital tools in mind mapping helps	increase motivation, creativity, confidence, and problem-solving abilities among college students. (Hamka et al., 2021) • Mind maps also play an important role in enhancing critical thinking, integrating information across disciplines, and understanding complex relationships in subjects such as medical education. (Fauziah et al., 2022; Ravindranath et al., 2016) • Mind mapping helps students in expressing and understanding learning materials creatively, making the learning process more systematic and fun.

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		them become more familiar with technology, while increasing their confidence in expressing and compiling their ideas independently.	(Fauziah et al., 2022) • Mind maps help improve students' understanding of concepts, aid in knowledge retention, and stimulate creativity. (Fauziah et al., 2022)
Empathy (Process Differentiation)	2. Prospective tutor students identify student needs and problems through observation.	• Students can use a variety of methods to identify student needs and problems, such as observations, interviews, or surveys. • Students can choose the focus of their observations, whether on academic, social, or emotional aspects of students.	• The learning process with observation is very important to improve educational experiences and outcomes. Observational learning has been shown to be effective in a variety of contexts, such as motor skills learning, social learning in children, as well as cognitive and social development. (Harris et al., 2018; Shneidman & Woodward, 2016) (Shneidman & Woodward, 2016) (Rodriguez

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
			Buritica et al., 2016) • Research has shown that the mechanism of observational learning is essential for cognitive development, by studying causal relationships through observation. (Meltzoff et al., 2012) • Peers in facilitating behavior change through observation. (Schunk, 1983) • Observational learning has been associated with an increase in predictive estimation without further learning, which suggests its role in improving generalization mechanisms. (Struyf et al., 2014)
Ideation (Process and Product Differentiation)	3. Students collaborate to develop innovative learning	• College students can use generative AI to generate ideas, but they	• Brainstorming improves students' critical thinking skills, increases

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
	solutions using generative AI-assisted brainstorming techniques	can also use traditional brainstorming methods or other creative thinking techniques. • Students can choose a format to present their ideas, such as oral presentations, visual presentations, or written reports. • At this stage, students collaborate using generative AI-assisted brainstorming techniques, which play an important role in improving digital literacy and creative thinking. The use of AI to generate ideas helps students integrate technology in the creative thinking process, so they learn how to utilize digital tools to enrich ideas and	creativity and learning knowledge, increases motivation and learning performance, and positively impacts student learning outcomes. (Widiastuti et al., 2022) (Masoumifard, 2021) (Yellow, 2017) (Obro et al., 2021) • Brainstorming has been shown to be effective in promoting the development of creative ideas. (Ulger, 2018) • Brainstorming improves teamwork skills, improves analysis, and problem-solving abilities among college students. (Alenezi & Brinthaupt, 2022) • Brainstorming is effective for encouraging critical thinking along with other

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		concepts. This activity also fosters self-efficacy because students have control over the idea creation process and can choose a brainstorming method that suits their preferences, either with the help of AI or traditional techniques. This experience strengthens their confidence in solving problems independently and innovating in the digital environment.	methods such as problem-based learning and case studies. (Eze et al., 2022) • Brainstorming encourages innovation and problem-solving among students. (Sharif, 2019) • These AI tools can help generate original and varied ideas, ultimately improving the quality and quantity of ideas generated during brainstorming sessions. (Rampa & Agogué, 2021) • AI can play a crucial role in project-based learning by facilitating brainstorming sessions, creativity creation, role assignment, and iterative design processes. (Wan & Hu, 2022)

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
			• AI technology can provide personalized feedback and suggestions to students during brainstorming activities, encouraging creativity and critical thinking. (Grech et al., 2023)
Prototype (Product Differentiation)	4. Students create prototypes in the form of lesson plans (teaching modules) and student worksheets assisted by generative AI.	• Students can create different types of lesson plan prototypes, such as teaching modules, student worksheets, or interactive learning media. • Students can choose the level of detail of their prototypes, from simple to highly detailed. • Prototyping activities in the form of lesson plans and student worksheets with the help of AI contribute to the development of	• The ability to design and update lesson plans is essential for aspiring tutors to ensure professionalism and keep pace with educational progress. (Erlina et al., 2022) • Learning to prototype trains learners to come up with creative solutions to real-life problems. (Soomro et al., 2021) • Prototyping stimulates students' critical thinking and

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		digital literacy, creative thinking, and self-efficacy. Through prototyping, students learn to design learning content using AI technology, which improves their understanding of how technology works and its application in education. This process encourages creativity in designing innovative and need-based learning solutions. In addition, the experience of making and testing this prototype gives students confidence in compiling learning materials and adapting them according to real situations, strengthening their self-efficacy as prospective	encourages the search for innovation. (Martins, 2014) • Prototypes play an important role not only in evaluating design solutions, but also in fostering creativity, critical thinking, and innovation skills among learners. (Chunpungsuk et al., 2021; Petrakis et al., 2021; Surender & Patil, 2019) • Prototypes unlock cognitive association mechanisms related to visualization, previous experiences, and interpersonal communication, which support iterative learning among peers in the product development community (Berglund & Leifer, 2013)

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		educators who are able to adapt to technology.	
Test (Differentiation of Learning Environment)	5. Testing or Implementation of learning prototypes according to the plan prepared in the actual classroom.	• Students can test their prototypes in a variety of learning environments, such as in the classroom, in the lab, or outdoors. • Students can choose different groups of students to test their prototypes, such as students with different skill levels or students with different learning styles. • In this phase, students can test the learning plans they have developed, whether in the classroom, in the laboratory, or in a digital environment, which expands their ability to use technology tools and digital platforms. This activity also	• Prototype implementation is proven to increase student creativity and resources, as well as help better concept evaluation. (Petrakis et al., 2021) • The implementation of prototype results in design thinking learning plays an important role in fostering creativity, critical thinking, and innovation skills among learners. (Chunpungsuk et al., 2021; Petrakis et al., 2021; Surender & Patil, 2019)

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		encourages them to adapt to diverse situations and think creatively in adjusting the right learning methods. This testing process allows students to identify the strengths and weaknesses of their plans, thereby increasing their self-evaluation skills and confidence in developing effective learning solutions. This hands-on experience helps them hone their technological skills, think innovatively, and increase confidence in their ability to manage the learning process independently.	
		Activities in the classroom (*In Class)*	
Presentation (Process and Product Differentiation)	1) Students present all activities carried out in the out class carried out by one of the	• Students can choose a presentation format that suits their	• The role of presentations for student learning in higher tutoring

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
	predetermined groups.	learning style, such as oral presentations, visual presentations, or demonstrations. • Students can tailor the level of detail of their presentations to their audience. • The Presentation Phase (Process and Product Differentiation) plays a role in improving students' digital literacy, creative thinking, and self-efficacy by giving them the opportunity to use various digital tools in preparing and conveying ideas creatively. Through this activity, students can choose an appropriate presentation format, such as data visualization, multimedia presentation, or	has many aspects and is very important to increase student engagement and understanding. Active learning methods have been proven to significantly improve student performance in science, engineering, and mathematics courses (Freeman et al., 2014). • Different modes of presentation, such as role-playing, simulation, and multimedia, have been shown to motivate learners, spark their interest, and enhance their learning compared to traditional lecture formats (Kelsch & Werremeyer, 2010; Puspita, 2021; Wibowo & Masruro, 2022).

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		interactive video, that hone their technology skills. The process of conveying ideas in front of the class also encourages students to think critically and creatively in formulating and conveying information in an interesting and clear way. In addition, success in presentations and positive feedback from peers and tutors can strengthen students' confidence in their ability to master the material and communicate effectively.	• By representing and constructing personally meaningful artifacts, the use of portfolio processes and project-based learning has been shown to improve student understanding and learning outcomes (Murphy et al., 2011; Giawa, 2022). • The role of presentation in learning is very important to encourage active learning, increase student engagement, and improve learning outcomes (Freeman et al., 2014; Wibowo & Masruro, 2022; Giawa, 2022).
Evaluation (Process Differentiation)	2) Tutors evaluate lesson plans, student worksheets, and classroom learning implementations	• Tutors can use a variety of evaluation methods, such as formative assessment, summative	• This evaluation process is essential to provide feedback to tutors and students, helping in improving

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
	carried out by students.	assessment, or peer feedback. • Tutors can provide different feedback to students based on their needs and learning styles. • The Evaluation Phase (Process Differentiation) supports the improvement of students' digital literacy, creative thinking, and self-efficacy through the use of digital-based evaluation tools that develop their technological skills, as well as feedback from tutors that encourage creative reflection and improvement of ideas. This process allows students to explore and implement new strategies, while strengthening their confidence in	teaching methods and student performance. (Ngai et al., 2012) • Tutor evaluations serve as a means to provide feedback to tutors from students on the quality of their facilitation. (Papinczak, 2010) • Evaluation by tutors helps in guiding students through the learning process, ensuring a deeper understanding, active participation, and their motivation. (Ilhami et al., 2020) • Tutor evaluation helps improve student learning outcomes by providing valuable feedback. (Ngai et al.,

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		overcoming learning challenges. Through interactive and adaptive evaluation, students become more proficient in using technology, think creatively in solving problems, and be confident in their ability to achieve better results.	2012; Papinczak, 2010)
Q&A and class discussion (Differentiation of Learning Processes and Environment)	3) Students conducted questions and answers and class discussions related to presentations of out-of-class activities and evaluations. Tutors facilitate and straighten out misconceptions.	• Students can ask questions and discuss in various formats, such as small group discussions, large class discussions, or online forums tailored to the conditions and situation of the class. • Tutors can create an inclusive and supportive learning environment, where all students feel	• Through questions and answers, students can ask questions related to the material presented, thus allowing them to gain a deeper understanding (. (Goedhart et al., 2019) • Classroom-based learning also provides individualized attention to students and frees up tutors to act as classroom facilitators. This is

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		comfortable participating. • Discussion and question-and-answer activities facilitated by tutors play a role in improving digital literacy, especially when carried out through digital platforms or online forums. This provides an opportunity for students to ask questions and discuss actively, using a variety of digital communication tools that support collaborative learning. This discussion also stimulates creative thinking, because students are encouraged to think critically and convey their ideas in a clear and structured manner. In addition, support from	important because it allows students to engage in in-depth dialogue and discussion with tutors or classmates, which in turn can improve their understanding of the material being studied. (Ogan et al., 2012) (Ogan et al., 2012)

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
		tutors during discussions can help strengthen students' self-efficacy by providing positive feedback and creating an environment that encourages the courage to actively participate in the learning process.	
Cover	4) Tutors make learning conclusions, appreciation, and information related to further learning.	-	• The role of tutors in an educational environment is multifaceted and very important. Tutors stimulate active learning by encouraging students to summarize what they have learned and make connections between concepts. (Enwereji et al., 2024; Van Berkel and Dolmans, 2006) • Tutors help students with module-specific problems, discuss difficult

Phase	Learning Description	Learning Differentiation and dependent variables developed	Theoretical and Empirical Foundations
			topics, and make course content interesting (Enwereji, 2024). • Tutors combine imaginative assessment with dynamic experience to lay the groundwork in producing flexible, reflective and creative graduates. (Wharton et al., 2014)

3.3 Product Development Draft

The initial stage of product development in the form of a product development framework in the form of a Learning Model Book and digital literacy data collection instruments, creative thinking skills, and self-efficacy are shown in Table 7.

Table 7 Product Development Draft

Product Type	Shape	Skeleton
Prototype of the Differentiated Flipped Classroom Learning Model Design thinking assisted by artificial intelligence (AI)	Learning Model Book	The main part of the learning model book consists of 4 parts with the following framework. **PART 1** **Development of Artificial Intelligence (AI)-Assisted Flippped Classroom Design Thinking Model** A. Rationale for the Development of a Differentiated Flippped Classroom Model

		Design thinking assisted by artificial intelligence (AI) B. Purpose **PART 2** **Integration and Theoretical and Empirical Foundations of the Flippped Classroom Design Thinking Model Assisted by Artificial Intelligence (AI)** A. Integration of the Flipped Classroom Model with Artificial Intelligence (AI)-assisted Design Thinking Learning B. Theoretical and Empirical Foundations for the Development of a Differentiated Flippped Classroom Model Design thinking assisted by artificial intelligence (AI) **SECTION 3** **Komponen Model Flippped Classroom Design Thinking Berbantuan Artificial Intelligence (AI)** A. Syntax of the Flippped Classroom Model Differentiated Design thinking assisted by artificial intelligence (AI) B. Flippped Classroom Social System Differentiated Design thinking assisted by artificial intelligence (AI) C. Principle of Differentiated Flippped Classroom Reaction Design thinking assisted by artificial intelligence (AI) D. Support System **SECTION 4** **Flippped Classroom Design Thinking Model Assisted by Artificial Intelligence (AI)** A. Planning B. Implementation C. Valuation REFERRAL LIST ATTACHMENT - SAT RAT Design Example
Digital literacy instruments	Questionnaire	The questionnaire uses a Likert scale with a scale of 1-5 each indicator is represented by at least 2 statements
Creative thinking skills instruments	Test	Test essay with a scoring rubric of 0-4 each indicator is represented by at least 2 questions

Self-efficacy instruments	Questionnaire	The questionnaire uses a Likert scale with a scale of 1-5 each indicator is represented by at least 2 statements

The initial product standard of the learning model is in the form of a model book which includes: (1) the rationale for the development of the learning model, (2) the theoretical basis for the development of the learning model; (3) the design *of the AI-assisted differentiated Flipped Classroom* learning model refers to the five basic elements of the learning model, namely syntax, social system, reaction principle, support system, and instructional impact and accompanying impact. The prototype of the model book follows the framework in Table 3.3, with a maximum size of A4 paper (21 x 29.7 cm) with a UNESCO standard book size. (Joyce & Because , 2003)

The digital literacy questionnaire data collection instrument is based on 6 indicators, namely Information Literacy, Computer Literacy, Media Literacy, Communication Literacy, Visual Literacy, and Technology Literacy. From the six indicators, it was developed into 27 items consisting of 14 positive statements and 13 negative statements with a likert scale of 1-5.

The creative thinking test instrument is in the form of essay questions made based on 6 indicators, namely Curiosity, Fluency, Originality, Imagination, and Flexibility. From the six indicators, it was developed into 12 questions with a likert scale assessment rubric of 0-4.

The self-efficacy questionnaire data collection instrument is based on three dimensions, namely the Magnitude Dimension, Strength Dimension, and Generality Dimension. From these three dimensions, it was developed into 34 items consisting of 17 positive statements and 17 negative statements with a likert scale of 1-5.

4 CONCLUSION

This preliminary research identifies an urgent need to improve the digital literacy, creative thinking skills, and self-efficacy of Open University students, which are hampered by limited access to technology, a learning culture that lacks support for creativity, and an inadequate mindset. Innovative and adaptive learning models that can accommodate different learning styles and enhance the role of tutors in providing personal support are urgently needed. In addition, despite the interest in the application of AI, challenges in understanding and implementing it remain, so improving AI literacy and infrastructure is crucial. Feedback from

the flipped classroom experience shows that students value flexibility and interaction, but also want improvements in internet connection and variety of learning activities.

The development of the AI-assisted flipped classroom model is based on key learning theories, such as constructivism, cognitivism, social cognition, sociocultural, transformative learning, and connectivityism. These theories support an active, interactive, and collaborative approach to learning, which is essential for building an understanding of knowledge through experience and reflection. AI integration plays an important role in providing tools that facilitate the learning process, improve accessibility and collaboration, and provide personalized feedback. By leveraging technology platforms such as virtual classrooms and Microsoft Teams, this model offers flexibility, efficiency, and creativity in the learning process, which is expected to effectively develop students' skills and knowledge in the digital age.

The development of a prototype of the differentiated flipped classroom learning model assisted by artificial intelligence (AI) includes the preparation of a learning model book consisting of four main parts, namely the rationale and purpose of model development, the integration of theoretical and empirical foundations, model components, and learning design which includes planning, implementation, and assessment. The book refers to the five basic elements of the learning model, including syntax, social systems, reaction principles, support systems, and instructional and accompanying impacts. In addition, the data collection instruments used to evaluate digital literacy, creative thinking skills, and self-efficacy have been designed with the appropriate Likert scale and assessment rubric, ensuring that each indicator is well represented. With a systematic structure and measurable instruments, this model is expected to increase the effectiveness of learning and support the development of student skills in the digital era.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support provided by LPPM UT for this research and the subsequent publication of this article.

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