Innovation to Improve Critical Thinking Skills in the Generation Z using Peeragogy as a Learning Approach and Artificial Intelligence (AI) as a Tool

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Abstract: The current generation, known as generation Z (Gen Z), is a generation that lives and is familiar with information technology in everyday life, including but not limited to learning purposes. Gen Z is characterized by teamwork in cyberspace and solving problems. Gen Z can also adopt artificial intelligence (AI) technology as their learning tool. Meanwhile, Gen Z faces the challenge of acquiring 21st-century skills requiring higher-order thinking (HOTS). This paper will focus on learning skills, especially critical thinking (CT). For this reason, it is essential to improve the competency of CT skills in Gen Z by using a model that combines the 7E learning cycle with peeragogy learning approach and adopting the latest AI applications as a tool. This model will contribute to the theoretical and practical use of AI apps for education, particularly the role of correct utilization of AI. Additionally, it can be misused to improve learning skills, especially CT skills. The results carried out in class show AI's effectiveness in improving CT skills for Gen Z, especially the role of AI in the back-end learning process, namely to verify and validate understanding. This paper suggests that AI apps should be controlled if used in the front-end learning process, especially at the exploration stage, to improve CT skills. Without controlling the AI apps, they can reduce learners' ability to explore a topic according to their creativity and criticality.

Keywords: Innovation in learning, critical thinking, Generation Z, peeragogy, Artificial Intelligence.

Introduction

Technological innovation is part of a process that is in harmony with the progress of human civilization. Humans constantly innovate to be able to make their lives better. Therefore, technology plays a significant role in helping human activities, including but not limited to the teaching and learning process. The technological innovations created by humankind have developed in unprecedented forms. More technological innovations are based on information technology (IT) and digital technology. This development has influenced many aspects of society's life today, known as Society 5.0, namely a society that lives side by side with intelligent and sophisticated technology.

Currently, the use of IT, digital, and social media has made people's way of life different from before, including learning, because distance is no longer a barrier for people to learn. The current generation, generation Z, known as Gen Z, is a generation that lives side by side with this technology daily. Gen Z is very familiar with and seems dependent on this technology, so it is not surprising that it is called a digital native [1]. However, the digital familiarity of Gen Z does not indicate a high ability to learn skills, especially critical thinking skills (CT skills) [2]. Therefore, Gen Z needs to use their strength in digital familiarity to improve their learning skills and better face the challenges of the 21st century.

To face these challenges, Gen Z must have 21st-century skill competencies categorized into learning, literacy, and life skills. This paper will describe the 4C learning skills: critical thinking, creativity, collaboration, and communication [3]–[5]. Critical thinking (CT) skills will be the main focus of this paper because they are considered essential skills for Gen Z [3]–[5]. CT skills, among others, are a part of higher-order thinking skills (HOTS), which, are still ranked relatively low in the Program for International Student Assessment (PISA) [2].

Efforts related to improving CT skills have been carried out in several studies using various methods. However, improving CT skills specifically aimed at Gen Z with its unique characteristics is still necessary in the current conditions. Therefore, this paper aims to elaborate on a method to improve Gen Z competence in CT skills that are in tune with Gen Z's characteristics and utilize peeragogy approaches combined with artificial intelligence (AI). This paper not only discusses the use of AI in education, such as to improve CT skills but also provides awareness regarding the possible impacts of using AI unthinkingly, which can have ethical implications [6].

Methods

The methodology used in this paper is a literature study that is directly related to the topic. In addition, this paper also develops a method to achieve the objective. The method is to adopt 7E learning cycles and peeragogy as a learning approach combined with using artificial intelligence/AI as a tool (Figure 1). Another methodology used in this paper is action research, where this method is applied directly to the teaching and learning process in the classroom at a higher education institution.
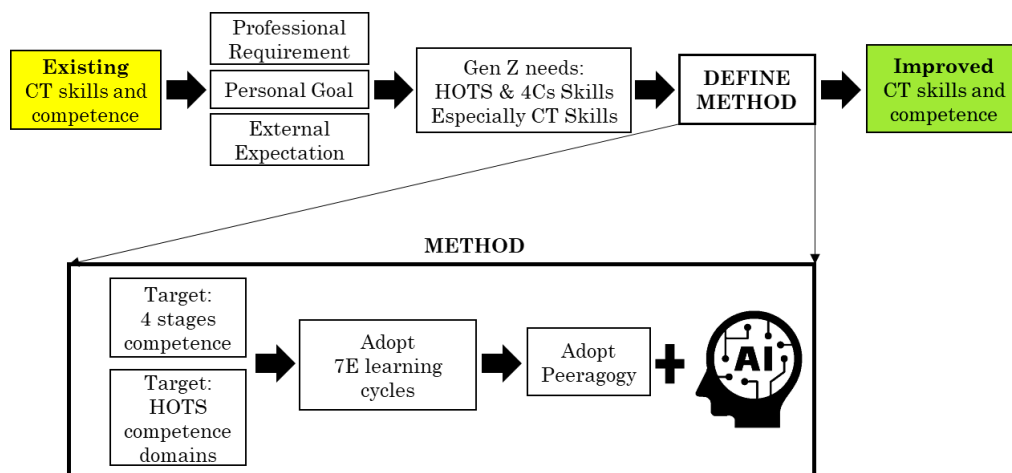

Figure 1. Method to achieve competence of critical thinking

Generation

Generations represent a distinct and separate group of people with a standard set of beliefs, experiences, and values about how the world works. Generations are individuals who live in the same period and have the same age, year of birth, and similar events in the lives of these individual groups [7]. In the characterization of generations based on the year of birth, according to Tracy Francis and Fernanda Hoefel [8], at least we already know some of them: Baby boomers (1940-1959), Gen X (1960-1979), Gen Y/Millennial (1980-1994), Gen Z (1995-2010). There are several characteristics of each of these generations, the most prominent being mastery of IT, internet, use of gadgets, and active use of social media such as SMS, email, BBM, WhatsApp, Line, Facebook, Instagram, online applications, etc. [9]–[14].

Generation Z (Gen Z)

In this paper, we will specifically discuss Gen Z, born between 1995 and 2010 and currently aged between 13 and 28. This generation was born when IT and digital technology innovation and development experienced much progress. Not surprisingly, they were born and developed in a social environment heavily influenced by IT technology's use in everyday life. Due to the influence of environmental developments, including but not limited to technology, this generation has specific characteristics, strengths, and weaknesses compared to other generations. Generation Z is also known in many references with other terms such as iGeneration, net generation or internet generation, post-millennials, Facebook generation, digital natives, switchers, dotcom children, C-connection–generation, D-digital–generation, and R-responsibility–generation.

Characteristics of Generation Z

Some of the distinctive characteristics of Gen Z, as conveyed by Singh and Dangmei [9] among others, are tend to be impatient, have an instant way of thinking, lack ambition, have symptoms of ADHD (Attention Deficit Hyperactivity Disorder), especially attention deficit with high dependence on technology, individualistic, self-

directed, too demanding, tend to be greedy, materialistic. Max Mihelich [10] provides an overview of the characteristics of Gen Z, including being very concerned about environmental issues and aware of water shortages. In other words, they are very aware and susceptible to natural resources. According to Amanda Slavin in Singh and Dangmei [9], Gen Z expects their voice to be heard. They are tech-savvy but need to gain skills in solving problems. In making decisions, they tend to see the contextual situation poorly and participate less in social activities than the previous generation.

Work and Study Preferences of Generation Z

Gen Z's work and study preferences are highly dependent on the weaknesses and strengths of Gen Z. Gen Z's work preferences, according to Bascha [11], including that they prefer transparency, independence, flexibility, and personal freedom, which are essential for them. Meanwhile, according to Teresa Bridge [12], Gen Z prefers a work environment that assists and provides learning and opportunities for professional self-development because they know that their education does not provide sufficient skills to cope with real problems in life. They like workplaces that challenge their business-like skills and have flexible work schedules. They prefer workplaces with good technology support because they are used to living side by side with technology. They also prefer a place to work with leaders who have good practices in terms of honesty and integrity [9]. In addition, they also prefer a workplace with a deep concern for social and environmental responsibility and a close relationship with the community [9].

Gen Z's learning preferences highly depend on the education level pursued. In general, the learning preferences of Gen Z can be grouped into 1. Method, 2. Facilitator, 3. Technology. The Gen Z learning approach prefers learning by doing, which has clear learning objectives and topics and hopes to get feedback quickly [15]. In addition, they have a way of communicating using online media. Gen Z's way of learning also likes the way of learning together (co-learning), which can be done in a blended way (offline and online). Gen Z likes learning facilitators who can position themselves as friends. Gen Z likes learning technology that can be done anywhere, anytime, using gadgets and other digital media (U-learning) [15]. They are also used to multitasking and learning using technology.

Learning

What is learning, and how to do effective learning? These are fundamental questions that must be understood to carry out effective learning. It is important to understand learning behavior to achieve effective learning [16]. *Learning* is simply a process of acquiring knowledge, skills, or both. According to Ambrose *et al.* [17] and LM Gauthier [18], learning is /a process that leads to change, occurs due to experience, and increases the potential for performance improvement and learning in the future. The learning process is acquiring knowledge due to the learner's interaction with the facilitator, lecturer, or teacher and the environment. According to the constructivism model, knowledge is built by the learner because of the active interaction, known as active learning, with the environment and not merely transmitted from teacher to learner. Constructivism is a dynamic and interactive model of human learning [19]. The principle of constructivism emphasizes the investigation, explanation, experimental design, evidence-based conclusion, etc. In this learning process, the learner may experience cognitive conflict if the initial conception or perception he/she has is different from the new phenomenon he/she is learning, so cognitive structure modification is needed. The application of this constructivist learning model is known as the learning cycle [20].

The Learning Cycles

The learning cycles model as indicated in Marfilinda *et al.* [20] such as 3E model (exploration, invention, discovery) [20], 4E model (explore, explain, expand, evaluate) (Carin 1993), 5E model (engage, explore, explain, elaborate, evaluate) [21], and 7E model (elicit, engage, explore, explain, elaborate, evaluate, extend) [22]. This learning cycle can be simplified into front-end and back-end learning processes. The front end focuses, among others, on idea generation knowledge exploration, while the back end focuses, among others, on evaluation, verification, validation, and expansion. The application of the learning cycle must be considered according to the content and context to increase learning effectiveness. In addition, supporting methods, tools and technologies can also be adopted.

The 7E learning model, according to Rahman and Chavhan [23] , has several advantages, namely 1. Help to understand deeply, 2. Makes efficient learning, 3. Transfer of learning, 4. Motivation to learn, 5. Develop thinking skills, 6. Develop communication and social skills, and seven as a basis for developing instruction materials. Therefore, the 7E learning model is an active learning suitable for improving critical thinking skills.

Higher Order Thinking Skills (HOTS) and Critical Thinking Skills

Higher Order Thinking Skills (HOTS) is a critical thinking skill for the 21st Century. World Economic Forum (WEF) identified the top 10 work skills of 2025, which is 1. analytical thinking and innovation, 2. active learning and learning strategies, 3. complex problem-solving, 4. critical thinking and analysis, 5. creativity, originality, and analysis; 6. leadership and social influence; 7. technology use, monitoring, and control; 8. technology design and programming; 9. resilience stress tolerance; and 10. flexibility, reasoning, problem-solving, and ideation. Skills no. 1, 3, 4, 5, and 10 are categorized as HOTS [24]. Shanti *et al.* [24] argued that HOTS ability is problematic for many countries. *Thinking skills* are the process that emphasizes how to analyze and evaluate information gained from experiences or observations. This process involves cognitive and affective domains [3], [25]. Revised Bloom's taxonomy by Anderson and Kratwohl [26] defined the cognitive domains as C1 (remember), C2 (understand), C3 (apply), C4 (analyze), C5 (evaluate), C6 (create). Anderson and Kratwohl [25] defined (C1-C3) as Low Order Thinking Skills (LOTS), namely the ability to remember, memorize, or imitate. (C4-C6) High Order Thinking Skills/HOTS are the ability to think analytically, critically, and creatively. To achieve the cognitive domain of HOTS, it is required to improve, among others, critical thinking skills. Critical Thinking (CT) skills are, in fact, one of the essential learning and innovation skills for the 21st Century [4]. CT skills are defined differently depends on the author [27]–[35]. This paper defines CT skills as a (logical) thinking process that comprehends a topic freely based on correct arguments and judgments. Several other definitions of CT are shown in Table 1.

Table 1. Definition of critical thinking

Source	Definition
Chance [27]	The ability to analyze facts, generate and organize ideas, defend opinions, make comparisons, draw inferences, evaluate arguments and solve problems.
Tama [28]	A way of reasoning that demands adequate support for one's beliefs and an unwillingness to be persuaded unless support is forthcoming.
Mertes [29]	Conscious and deliberate process used to interpret or evaluate information and experiences with a set of reflective attitudes and abilities that guide thoughtful beliefs and actions.
Scriven and Paul [31]	The intellectually disciplined process of conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action in actively and skillfully [36].
Lipman [32]	Skillful, responsible thinking that facilitates good judgment because it (1) relies upon criteria, (2) is self-correcting, and (3) is sensitive to context
Chaffee [33]	Making sense of the world by carefully examining the thinking process, as well as to clarify and improve our understanding.
Trilling and Fadel [34]	The ability to analyze, interpret, evaluate, summarize, and synthesize information
Santrock [35]	Critical thinking skills include productive, reflective, and evaluation thinking about and event

Ways to Achieve Competence of Critical Thinking

When asking Gen Z students to elaborate on a topic in the class, not surprisingly, they will explain the topic differently. The best one may explain in a structured, clear, and confident way like explaining by intuition and right. On the other hand, the worst one may be explained by intuition but wrong and even confusing. The best or most competent one may have prior knowledge, attention, and use to interact with the topic. In contrast, the worst one may have no interest, no attention, or low ability on the topic and need more ability to perform well. In other words, the incompetent individual lacks metacognitive, meta-memory, meta-comprehension, or self-monitoring skills [37]. This statement is related to the competence level that Gen Z may have.

Competence level consists of four stages: 1. Unconscious incompetence, 2. Conscious incompetence, 3. Conscious competence, and 4. Unconscious competence [38], [39]. Unconscious incompetence is the early stage of learning as a beginner who does not know what he/she does not know. The conscious incompetence is the intermediate level of learning, the one who recognizes that he/she does not know. Conscious competence is the competent level of learning. The one who makes good progress in learning still makes mistakes and needs more intuitive judgment. Unconscious competence is mastery in the level of learning. The one who develops a high level of competence still makes few mistakes and has an intuitive correct judgment.

This paper aims to develop a method for Gen Z to achieve the competence of CT skills in the level of conscious incompetence (stage 2, intermediate) and or conscious competence (stage 3, competent) by adopting the 7E learning cycles, Peeragogy learning approach, and utilizing the AI (Figure 1).

Innovation in Learning Pedagogy

Pedagogy is the approach, method, way, or strategy for learning in education. However, other approaches have been recognized, such as andragogy, heutagogy and peeragogy or paragogy, namely the latest education that is more in line with the current state of society (Figure 2). *Pedagogy* is an approach, method, or traditional learning approach in which the learner depends on the teacher. Pedagogy is also a teaching method using various approaches to achieve learning objectives. The types of Pedagogy approaches are 1. constructivist, 2. collaborative, 3. integrative, 4. reflective, and 4. inquiry based.
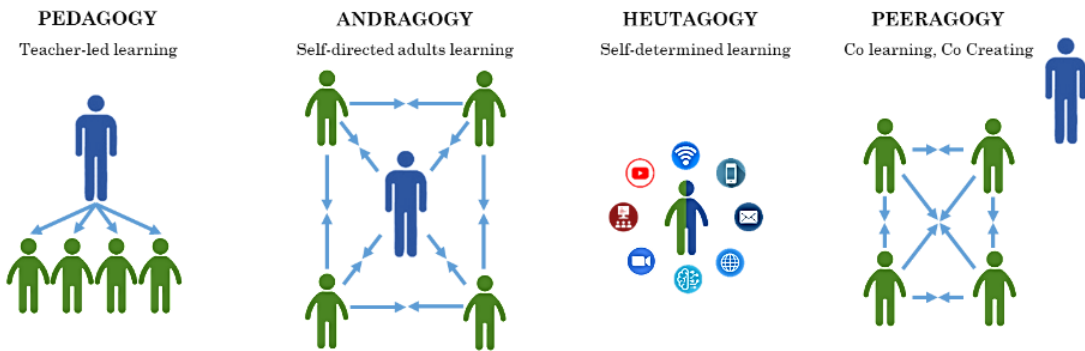

Figure 2. Types of learning approach

Meanwhile, andragogy, or adult learning, is a self-directed learning approach, heutagogy is a self-determined learning approach, and pedagogy, or , pedagogy is another learning approach with the basic word "Peer," which means partner (Figure 2). Peeragogy is simply an integrative approach or way of learning with friends or collaboratively, namely being able to integrate the classroom with the outside world. This learning approach is naturally carried out by humans, namely learning with other colleagues so that knowledge is produced and used together. This is a form of active learning approach (active learning) in which the learning process occurs due to interactions with fellow students. Peeragogy is a self-determined learning approach that is peer-to-peer and not centered on educators (decentered). Furthermore, Alexander *et al.* [40] explained that peeragogy is peer learning together and helping each other in learning. This pedagogy learning approach encourages everyone to actively and freely contribute to the group. According to Corneli and Danoff [41] peeragogy is a set of techniques and patterns that can be imitated for effective peer learning and problem-solving. Corneli and Danoff [41] further explained that participants in the peeragogy approach collaborated to build emergent structures responsive to changes in their context. Therefore, this learning approach is suitable for the characteristics of Gen Z, which tend to be oriented, even dependent on IT, digital technology, social media, and online learning in their daily lives. According to Corneli and Danoff [41], the pedagogy learning approach that uses various types of online learning emphasizes autonomous and interactive learning systems where knowledge can be generated through peer-to-peer learning cooperation and from many sources.

Artificial Intelligence (AI)

Currently, we are surprised by the emergence of various applications of Artificial Intelligence (AI) in various aspects of our lives. Many things in our lives today have intersected with the results of AI work, such as online shopping systems, online advertising, etc. In the future, it is estimated that AI will significantly influence human life; even AI is said to be "the coming of electricity". It is predicted that the emergence and development of AI today is like the emergence and development of mobile phones 20 years ago, which could only make calls and SMS. It is unimaginable that the development of AI in the next 20 years will be like the development of cell phones, which have turned into smartphones (smartphones). According to Wikipedia, artificial intelligence (abbreviated as AI) is intelligence that is added to a system that can be managed in a scientific context. Meanwhile, according to Kaplan and Haenlein [42] AI is a system's ability to interpret external data correctly, to learn from that data, and to use that learning to achieve specific goals and tasks through flexible adaptation. According to McCarthy *et al.* [43] in Miao *et al.* [6], AI is the science and engineering of making intelligent machines, brilliant computer programs.

Various Pros and Cons opinions regarding AI have emerged in the public. Some see AI as a threat in various aspects of life, such as fears of losing jobs because they cannot compete with AI, fears of fading or expiration of education, no need for educators anymore because they are replaced by AI, as well as views that the competence of AI will exceed the competence of the human itself and the concern about the use of AI in the field of weapons

and warfare. However, few see AI as an excellent opportunity for humans to improve their quality of life and dignity in education, medicine, environment, industry, etc. AI can help us implement a new, better teaching and learning system in education.

The Use of AI in the Teaching and Learning Process

In education, we may ask what AI can do now, which is aligned with the capabilities (advantages and disadvantages) of current AI technology/applications, and what might happen and be able to do in the future. In the context of education, the use of AI can be applied to the entire educational process. This paper will only discuss the use of AI, which is focused on efforts to increase effectiveness in the cognitive domain of peeragogy learning systems.

Many recent AI applications can be used to support independent learning by exploring, explaining, elaborating, assessing, verifying, and validating what we learn and understand (see Table 2 7E learning cycles). For example, learners can use chatbots such as ChatGPT or other generative AI to help improve their learning, but they still have their own opinions and cannot rely entirely on AI. ChatGPT is a generative AI application capable of processing natural language (NLP) and can respond to questions and provide answers in text form. However, the use of ChatGPT in education raises many pros and cons, especially regarding plagiarism. Therefore, in this paper, AI applications in the learning process should be used as a learning aid, especially to explore, explain, elaborate, assess, verify, and validate learning. Because this application can immediately respond to any questions, the effectiveness of the learning process using ChatGPT is very dependent on the ability to formulate questions. AI applications such as ChatGPT should not be used in creating scientific work as if it were personal work because this could be an indication of a violation of ethics and law.

Results and Discussions

This paper has outlined a method for improving critical thinking skills, especially in Gen Z with the 7E learning cycle, peeragogy learning approach, and artificial intelligence/AI. Utilization of the 7E learning process helps to improve CT skills structurally. Peeragogy, with all its advantages and disadvantages, is an appropriate learning approach for Gen Z. AI can be used to increase the effectiveness of the cognitive domain in the Peeragogy learning system, both HOTS and LOTS. Even though students can use AI for any purpose, in education, AI can be used as a learning aid in class, especially in exploring, verifying, and validating learning topics. Normally, students already have previous knowledge and memory when they learn a new topic. When students explore the topic, they either confirm their previous knowledge and enrich it during the learning process of the new topic, or they become unsure about their previous knowledge with the new one as they need help finding an indication of correctness. They may ask for confirmation or validation if they are unsure and even feel a contradiction between previous knowledge and the new topic. In the old learning approach, confirmation or validation can be sourced from books, references, or the lecturer or facilitator. With AI's use, verification, confirmation, and validation can also be done with AI's help. This is the role of AI in the back-end process of learning. AI can help students further in the front-end process of learning, such as exploring, explaining, and elaborating on the topic.

The model in Figure 3 has been tried in the classroom by applying the modified peeragogy learning approach where students are divided into study groups, each consisting of 5 people. The case study is a course with two credits taught in class for one semester. In model 1, each learner in the group can use any IT tool to help them understand the topic and freely discuss it with their peers, but ChatGPT is not allowed during the discussion or other front-end processes. The lecturer's role is to facilitate the discussion and provide feedback and a summary. ChatGPT is limited only to the back-end process to verify and validate the summary related to the topic and evaluate the learning process (see Table 2 7E learning cycles). In model 2, each learner explores and understands the topic in a group discussion. The group can utilize IT Tools and ChatGPT to help them explore, explain, and elaborate on the topic (see Table 2 7E learning cycles).

Similarly, the lecturer's role is only to facilitate the discussion and provide feedback and a summary. The ChatGPT is also used to verify and validate the summary related to the topic and evaluate the learning process (see Table 2 7E learning cycles). On the other hand, AI in model 2 is used in both front-end and back-end processes.
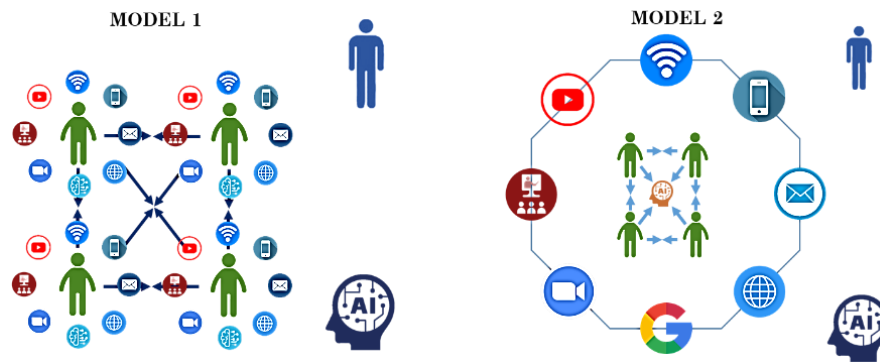
Figure 3. Modified peeragogy learning approach

Table 2. 7E learning cycles

Phases	Description	Method & Tools
Elicit	Using existing or prior knowledge and experience to construct the new knowledge	Questionings, concept sheets, activity sheets
Engage	Motivate the learner to engage in the learning activity	Video, diagram, story-telling, activity
Explore	Using prior knowledge to explore the new understanding and knowledge	Learning together in collaboration, cooperation
Explain	Learner explain and discuss understanding	Group discussion
Elaborate	Challenge with more complex questions to reflect the gained knowledge	Focus group exercise
Evaluate	Assessment to measure achieved learning objective	Self/peer-assessment, assignment, evaluation
Extend	Retention and or transfer of learning and apply to the real situations.	Project assignment

From the classroom observation, it can be seen that class activities are very dynamic. Students are enthusiastic, collaborative, confident, able to determine their own way of learning, independent learning process, and creative and integrative, especially in connecting topics in class with real-world experience. These results show the positive impact of AI on increasing learning effectiveness.

Conclusion

From the theoretical description and discussion, the method of increasing CT skills competency for Gen Z has shown promising improvements compared to traditional approaches. The method used in the learning process is peeragogy combined with the use of AI in both front-end and back-end learning processes. This is called a modified peeragogy approach. The modified peeragogy approach (Figure 3) supports Gen Z's preferred way of learning.

The effectiveness of learning can be increased with the help of AI, both in front-end and back-end learning processes, significantly improving the HOTS cognitive domain. AI Apps such as ChatGPT, on the one hand, can help students increase learning effectiveness, especially in the back-end learning process, to verify and validate their understanding of the topic. However, if AI is not controlled properly, it can cause students to choose learning shortcuts that are considered unethical. Although AI can also be used in front-end learning processes, it is advised to control it because it can reduce learners' creativity and criticality.

The current form of AI apps, such as ChatGPT, which is based on text, will undoubtedly continue to develop and can reach levels that were never imagined. AI, like technology in general, is neutral. Therefore, the user of AI technology will ultimately determine whether AI technology is positive or negative. Unthinkingly utilizing AI applications in education will have ethical implications. Thinking positively, current AI technology such as ChatGPT and other applications significantly increase learning effectiveness

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