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# THE PROFILE OF STUDENTS' SELF-EFFICACY IN CHEMISTRY LEARNING DURING THE TRANSFORMATION OF GENERATIVE AI USAGE

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**Abstract**

The integration of Generative Artificial Intelligence (GAI) in chemistry education offers an innovative shift in teaching abstract concepts and high cognitive demands. This study aims to investigate the self-efficacy profile of students related to the application of GAI in chemistry learning. Using a descriptive quantitative approach with a survey design, this study involved 44 students of the Chemistry Education Study Program at the Islamic University of Indonesia, Yogyakarta, who completed a validated self-efficacy questionnaire. This instrument measures three dimensions of self-efficacy, namely level, generality, and strengthData analysis shows that most respondents (38.64%) have self-efficacy in the medium category with an average score of 67.68, while 29.55% are in the low category (63.94). As many as 20.45% of respondents have high self-efficacy with an average score of 72.76. The dimension of optimism towards AI-assisted task completion showed the highest score (70.55), reflecting students' positive perception towards AI as a learning partner. However, the predominance of moderate and low self-efficacy levels indicates challenges related to digital literacy, technology anxiety, and suboptimal pedagogical integration of GAI. These findings indicate that the effectiveness of GAI in enhancing academic confidence and self-directed learning is contingent upon adequate instructional support, effective faculty facilitation, and institutional preparedness. Thus, GAI implementation in education must prioritize the development of a pedagogical framework that considers students' psychological readiness and digital competencies.

**Keywords:** Generative Artificial Intelligence; Self-Efficacy; Chemistry Learning.

## INTRODUCTION

The industrial revolution 4.0 has driven major changes in the world of education, especially through the adoption of Artificial Intelligence (AI)-based technology. AI is no longer seen as a future concept, but has been implemented in the learning process at various levels of education. AI is defined as artificial intelligence designed to mimic human thought processes, such as learning, analyzing, correcting errors, and making decisions independently (Harkut & Kasat, 2019). Zhu, (2017) emphasized that AI is the result of the integration of various disciplines including linguistics, cognitive psychology, and information theory which makes it a dynamic learning tool that is able to adapt to the needs of the learner.

In learning practices, AI has reinforced the shift from traditional approaches towards a more personalized and interactive model. The technology enables live analysis of learner performance, instant feedback, and customization of learning materials based on individual needs (Holmes et al., 2018). Salas-Pilco et al., (2022) mentioned that AI not only improves efficiency and productivity, but also encourages creativity and motivation to learn. Teachers and students have also started recommending the use of AI as part of active learning strategies (Mambu et al., 2023; Sangapu, 2018), indicating a wider acceptance of this technology in educational settings.

One of the determinants of learning success is self-efficacy, which is an individual's belief in their ability to complete academic tasks. Bandura, (1997) states that self-efficacy affects the way of thinking, motivation level, and resilience in the face of learning obstacles. In learning chemistry, which is known to have a high level of difficulty and abstract concepts, self-efficacy plays an important role in achieving learning outcomes. Students with low self-efficacy tend to experience academic anxiety, avoid challenges, and show low learning achievement (Zarkasyi & Partana, 2020).

Previous research shows that the use of learning technologies, such as Computer-Aided Instruction (CAI) and blended learning, can increase students' self-efficacy in learning chemistry. Julius et al., (2018) found that CAI has a positive effect on female students' self-efficacy. Fitriyana et al., (2020) proved that the combination of android-based games and blended learning can significantly improve self-efficacy and learning achievement. Furthermore, Dai, (2023) showed that the integration of AI in learning can strengthen students' self-efficacy in completing machine learning-based tasks. The findings of Yang et al., (2024) also showed that the application of AI-based classification models in chemistry learning helped students form concepts and increase positive perceptions of their academic abilities.

However, studies that specifically evaluate the impact of AI on self-efficacy in chemistry learning are still very limited. Therefore, this study focused on empirically identifying the effect of using AI on students' self-efficacy in chemistry learning.

## METHOD

This study uses a descriptive quantitative approach with a survey design, which aims to describe the level of self-efficacy of students in learning chemistry involving Artificial Intelligence (AI) technology. This approach was chosen because it allows researchers to systematically collect and analyze numerical data to describe the tendency of respondents' responses to the topic under study (Creswell, 2012).

The subjects of this study were undergraduate Chemistry Education Study Program (S1) students at Universitas Islam Indonesia (UII) who already had a basic understanding of AI, either through lectures or self-learning experiences. The sample was selected using purposive sampling technique, with the main criteria being students who have used AI technology in the learning process.

The research instrument used was a self-efficacy questionnaire consisting of 20 statements using a 4-point Likert scale. The preparation of this instrument is based on the theory of self-efficacy proposed Bandura, (1997), and reinforced by the views of Nicholas et al., (2015) and Santrock, (2011), Self-efficacy is defined as an individual's belief in his or her ability to organize and carry out the actions necessary to achieve a particular goal. The instrument is designed to measure three main dimensions of self-efficacy, namely level, generality, and strength. Before being distributed, the questionnaire went through a validation process by experts and was distributed online through google form.

The collected data were analyzed using descriptive statistical techniques with the help of statistical software to obtain a clear picture of the students' self-efficacy level. The measurement results were then categorized based on ideal assessment criteria on a five-point Likert scale, as shown in Table 1 (Azwar, 2022). The results of the analysis were interpreted and connected with findings from previous research to strengthen understanding of the role of AI technology in supporting student self-efficacy in learning chemistry (Fraenkel et al., 2012; Sugiyono, 2017).

Table 1. Ideal Assessment Criteria on a Scale of 5

| Score Range | Category |
|---|---|
| **□ > M□ + 1,5 SD** | Very high |
| **M + 0,5 SD < □ ≤ M + 1,5 SD** | High |
| **M – 0,5 SD < □ ≤ M + 0,5 SD** | moderate |
| **M – 1,5 SD < □ ≤ M – 0,5 SD** | low |
| **x ≤ M – 1,5 SD** | very low |

## FINDINGS AND DISCUSSION

The development of artificial intelligence technology, especially Generative AI, has brought significant changes in the world of education, including in chemistry learning which requires understanding abstract concepts and complex problem solving skills. Students' self-efficacy is an important factor that influences their success in adopting technology as a learning tool (Pramudya et al., 2024). This study aims to map the self-efficacy profile of students in learning chemistry during the transformation period of using Generative AI, by analyzing the distribution of self-efficacy scores grouped into five categories. The main objective is to illustrate the extent to which students feel capable, confident, and motivated in participating in learning that is now increasingly moving towards AI-based digital. The findings regarding the distribution of these scores are presented in Table 1.

Table 1. Distribution of Student Self-Efficacy Score in Chemistry Learning

| frequency | % | average score | criteria |
|---|---|---|---|
| 1 | 2.27 | 59.03 | very low |
| 13 | 29.55 | 63.94 | low |
| 17 | 38.64 | 67.68 | moderate |

| | | | |
|---|---|---|---|
| 9 | 20.45 | 72.76 | High |
| 4 | 9.09 | 75.87 | Very high |

The results of data analysis show that the majority of students have self-efficacy in the moderate category (38.64%) with an average score of 67.68, followed by the low (29.55%) and high (20.45%) categories. Only a small proportion of students had very high (9.09%) or very low (2.27%) self-efficacy. This finding indicates that most students feel quite confident in their ability to understand and complete chemistry learning tasks, although they have not yet reached the optimal level of confidence. In a learning transformation influenced by the use of Generative AI (GAI) technology, this distribution indicates the potential for increased self-efficacy, but also reflects challenges that must be overcome.

Generative AI provides new opportunities in chemistry learning through its ability to simplify complex concepts, provide contextual explanations, and support problem-solving-based learning. AI such as ChatGPT or adaptive learning systems allow students to obtain instant feedback and learn independently, which can strengthen their perception of control and competence - two key factors in self-efficacy according to Bandura's theory, (1997) theory. Some studies suggest that the appropriate use of AI technology can increase students' self-efficacy by providing a more responsive and personalized learning environment (Holmes et al., 2019; Zawacki-Richter et al., 2019). This is in line with the proportion of students in the high and very high self-efficacy categories which, although not yet dominant, suggests that AI has a potential role in building learning confidence.

However, the dominance of the medium and low categories also suggests that there are obstacles in the process of transforming AI-based learning. Factors such as low digital literacy, technology anxiety, and lack of pedagogical integration of AI in the curriculum may be responsible for the limited increase in self-efficacy (Jaggars & Xu, 2016; Panadero, 2017). In an environment that is still adapting to new technologies, the role of the teacher is vital as a facilitator who bridges students' interactions with technology through scaffolding and metacognitive strategies. Without adequate assistance, AI's potential as a self-efficacy booster may be overshadowed by students' confusion or resistance to new technology.

Therefore, the implementation strategy of AI in chemistry learning must consider the psychological aspects of students, teacher training, and educational infrastructure readiness (Vorsah & Oppong, 2024). This

approach is expected to not only improve students' self-efficacy, but also encourage the creation of a generation of learners who are adaptive and confident in facing academic and technological challenges simultaneously.

Then, to see the distribution of students' self-efficacy based on the dimensions that have been identified, this study analyzed the average scores on the three main dimensions of self-efficacy, namely level, generality, and strength. Each dimension includes indicators related to students' interest, enthusiasm, learning confidence, and optimism in facing chemistry learning with the help of AI technology. The results of this analysis will illustrate students' perceptions of their ability to adapt AI technology in the chemistry learning process. The findings of the score distribution can be seen in Table 1.

Table 2. Average Score of Student Self-Efficacy Based on Indicators

| Dimensions | Indicator | Average Score | Category |
|---|---|---|---|
| **Level** | Interest in learning chemistry concepts with the help of AI | 67.05 | moderate |
| | Enthusiasm to complete chemistry tasks despite obstacles | 66.86 | moderate |
| **Generality** | Confidence in learning chemistry in AI-based situations | 68.66 | moderate |
| | Confidence in facing a variety of challenges in chemistry tasks | 66.95 | moderate |
| **Strength** | Confidence in potential to understand chemistry material with AI | 69.98 | moderate |
| | Optimism in completing tasks with AI assistance | 70.55 | High |

Based on the analysis of the six indicators of self-efficacy categorized into the three main dimensions of level, generality, and strength, it can be concluded that most indicators are in the medium category, and one indicator is in the high category. This illustrates that students have formed a sense of confidence in AI-based chemistry learning, although not all of them have reached the optimal level of confidence.

In the level dimension, the indicators of interest in learning chemistry concepts with the help of AI (67.05) and enthusiasm for completing chemistry tasks despite obstacles (66.86) show that students' initial motivation in AI-assisted learning is at a moderate level. This is in line with the findings of Lukman & Ulfa, (2020) who revealed that student motivation in learning chemistry increases with the help of digital media, but depends on previous experience in using technology. Although Generative AI provides quick information, the ease of access does not automatically guarantee an increase in enthusiasm for learning if it is not balanced with appropriate teacher guidance.

Furthermore, in the generality dimension, two indicators, namely confidence in learning chemistry in AI-based situations (68.66) and confidence in facing a variety of chemistry task challenges (66.95) are also in the medium category. This shows that students feel quite capable of learning in digital, but not yet fully flexible in facing complex learning challenges. Sun & Zhou, (2024) in their study stated that the successful implementation of AI in learning depends on the readiness of students' adaptation to fast-changing learning.

In the strength dimension, there is one indicator in the high category, namely optimism in completing tasks with AI assistance (70.55), and another in the medium category, namely confidence in their potential to understand chemical materials with AI (69.98). These results provide a positive signal that students begin to trust their ability to complete tasks with AI as a learning partner. Fathoni et al., (2023) in a digital platform-based chemistry learning study concluded that students showed increased self-efficacy when they obtained instant feedback and independent exploration through technological media.

Although AI shows positive potential, the predominance of the medium category indicates the need for pedagogical and technological improvement strategies. Teachers should act as facilitators and assistants who are able to link AI with problem-based learning strategies. Kusnanto et al., (2024) emphasized the importance of teacher training in understanding the role of AI and adapting it to students' learning styles to avoid passive dependency.

International studies support the importance of contextual approaches. Chen et al.,( 2024) showed that students' confidence increased if they had positive experiences with AI, while Yilmaz & Yilmaz, (2023) found that the use of AI in learning programming was able to significantly increase self-efficacy. Jia & Tu, (2024) also emphasized that critical AI literacy needs to

be instilled so that students are not only users, but are able to direct the use of AI effectively.

These findings suggest that generative AI has great potential in improving students' self-efficacy in learning chemistry, particularly in the self-efficacy dimension. However, interventions in the form of increasing digital literacy, active learning strategies, and integration of technology-based pedagogy remain a major need to ensure this transformation has a comprehensive impact.

## CONCLUSION

The transformation of the utilization of Generative Artificial Intelligence (GAI) in chemistry learning is proven to have a real impact on improving students' self-efficacy profile. The findings show that most students are at a moderate level of self-efficacy, with a positive trend in the indicator of optimism in completing tasks using AI. This suggests that GAI does not only act as a technological aid, but also as a trigger for confidence in individual academic capabilities, especially in facing complex cognitive challenges in chemistry.

However, the presence of students in the low and medium self-efficacy categories indicates that there are still barriers that need to be overcome, such as limited digital literacy, resistance to technology, and lack of systematic integration of AI in learning. Therefore, empowering pedagogical interventions are urgently needed. The role of the educator as a guide and companion in the technology adaptation process is a determining factor so that GAI can really be utilized productively to strengthen learning character and increase student confidence in a sustainable manner.

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