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Transforming the Chemistry Education Curriculum: Students' Creativity Using AI in Lectures

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Abstract

This Research examines of The Usage of Artificial Intelligence (AI) such as ChatGPT and alike of that by Chemistry Education students in the learning process, and provides recommendations for the transformation of the chemistry education curriculum. The results of a survey of 76 students from universities in Palembang and Serang show that ChatGPT and similar AI have become important tools in supporting academic activities, especially in understanding chemistry concepts, compiling reports, and conducting research. However, students face several problems, including the cost of use, lack of knowledge about AI, limited access, and operational difficulties. Therefore, this study recommends the integration of AI into lecture materials, the provision of comprehensive training, increasing access and technical support, and periodic evaluation and adjustment of the curriculum.

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INTRODUCTION

Artificial intelligence (AI) has become an important part of technological development in the current circumstances. One of the most widely used AI technologies is natural language processing (NLP), which is applied in models such as ChatGPT and similar systems. This type of AI model can act as a virtual assistant or discussion partner for students. This is demonstrated by the AI's ability to respond to students' needs when looking for information related to college assignments. Moreover, students can currently get in-depth explanations of difficult concepts and practice questions with the assistance of this AI. This research shows that the use of AI, such as ChatGPT and others, in education can increase student engagement and understanding, as well as provide a more personalized and interactive learning experience (Akinwalere & Ivanov, 2022; Salido, 2023). Therefore, ChatGPT and similar technologies have greatly contributed to facilitating the learning process this current situation.

The existence of ChatGPT and similar systems brings challenges and opportunities for chemistry education. One of the main challenges is the necessary to adapt quickly the continuous development of technological advances. Students need to continuously update their knowledge and skills to utilize technology optimally in the learning process. For example, the application of ChatGPT in chemistry education can portrait challenges in terms of integrating technology into existing curricula, requiring adequate technological infrastructure and special training for students to ensure they do not violate academic rules (Ali et al., 2024; Johnson et

al., 2016). However, behind these challenges lies a great opportunity to improve the quality of chemistry education. AI technologies such as ChatGPT have the potential to enrich students' learning experiences through more personalized and adaptive interactions. ChatGPT can help students understand complex chemistry concepts by providing explanations tailored to their level of understanding. Additionally, this AI can provide direct and specific feedback, helping students identify errors and improve their understanding in real time (Holmes et al., 2015). Therefore, ChatGPT and similar technologies can be very effective tools in supporting more active and participatory learning.

The process of innovation in learning methods is essential to take advantage of the opportunities offered by digital technology. Traditional learning approaches, which tend to be passive, must be replaced with more interactive and collaborative methods. The use of ChatGPT and similar technologies can encourage students to be more active in the learning process through discussion and independent exploration. Additionally, AI can be used to develop more interesting and interactive teaching materials, such as chemical simulations and virtual experiments. These innovations not only increase students' interest and motivation to learn but also help them develop critical thinking and problem-solving skills, which are essential in chemistry (Luckin et al., 2016). In other words, AI technologies such as ChatGPT have great potential to improve the learning process and develop students' creative skills. This AI can facilitate students in exploring various scenarios and solutions through interactive discussions. The integration of AI, such as ChatGPT, into the curriculum not only enriches teaching methods but also prepares students to adapt to future technologies and foster innovation in chemistry (Holmes et al., 2019; Luckin et al., 2016). Thus, the chemistry education curriculum needs to be adapted including the use of AI technologies such as ChatGPT. To strengthen this hypothesis, it is important to conduct a survey on ChatGPT among chemistry education students.

This survey was conducted to understand how this technology can be effectively integrated into the chemistry education curriculum. Chemistry education students, as future educators and scientists, need skills that are relevant to the latest technological developments to teach and conduct research with more innovative methods. This survey will provide insight into the level of acceptance, understanding, and use of AI by students, as well as identify the benefits and challenges they face in using this technology in their learning. With the data obtained from this survey, educational institutions can design a curriculum that is more adaptive and responsive to student needs and encourage the use of AI technology to increase creativity and effectiveness in the chemistry teaching and learning process.

The results of this study will make a significant contribution to chemistry education by highlighting how the use of AI, such as ChatGPT, can enhance the learning and research processes. By identifying the main benefits and challenges faced by students in using AI, this research provides insights for evaluating the Chemistry Education Curriculum and designing better strategies to ensure that AI can be used effectively by chemistry education students.

METHOD

This research was used descriptive survey method to collect the data on the use of ChatGPT and similar AI by chemistry education students in the learning process. This method was chosen because it provides the appropriate tools for collecting and analyzing the data needed to achieve the research objectives. It supports the comprehensive and representative collection of data, allows for an in-depth analysis of AI usage in education, and provides a solid foundation for relevant and practical recommendations. The subjects of the study consisted of 76 chemistry education students from universities in Palembang and Serang. The subjects were

selected by purposive sampling, based on their involvement in the use of AI such as ChatGPT in academic activities.

The main instrument used in this research was a structured questionnaire. The questionnaire consists of several parts that include:
1. Respondent Demographics (Gender, Semester)
2. Frequency of AI use in Learning Process
3. Types of AI used (ChatGPT, Codex OpenAI, Microsoft Bing Chat, and similar AI)
4. Benefits perceived from using AI
5. Difficulties faced in using AI
6. The need of Training program related to the use of AI

Data collection was carried out in the even semester of the 2023/2024 academic year. The questionnaire was distributed online through an online survey platform. Students were given clear instructions on how to complete the questionnaire, and they were asked to answer based on their real experiences in using AI in lectures. The collected data were analyzed descriptively using descriptive statistics (percentage, frequency) to identify patterns of use, benefits, and obstacles faced by students. Data analysis was carried out in stages: data processing, descriptive analysis, and data interpretation. In general, the stages of the research conducted can be seen in Figure 1 below.

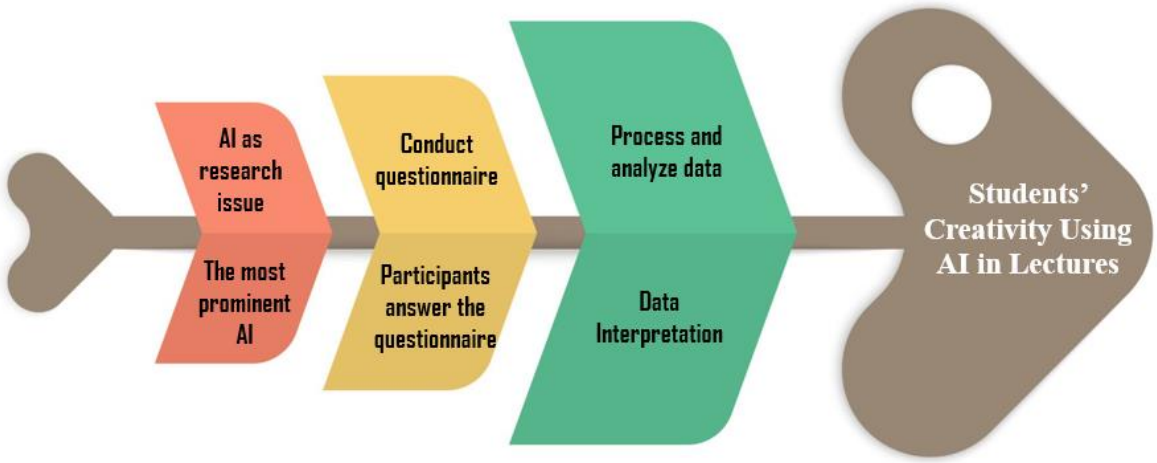

Figure 1. Fishbone Diagram of the Research Stages

This study adheres to the principles of research ethics. Respondents were given full information about the purpose of the study, their rights as participants, and the guarantee of confidentiality of the data they provided. Participation in the survey was voluntary and respondents could stop their participation at any time without consequences.

RESULTS AND DISCUSSION

Respondent Demographics

There were 76 Chemistry Education students who responded to the distributed questionnaire. The number of respondents who participated was representative enough to portray a general picture of the use of ChatGPT and similar AI among Chemistry Education students. These students came from universities in Palembang and Serang. As many as 96.1% of the respondents were female students, with the rest being male students. They provided answers based on their experiences in using AI such as ChatGPT and similar tools. The dominance of

female respondents may be due to several factors, including a higher interest in education and technology among women at the universities surveyed.

The results of this survey are in line with previous studies showing that AI technologies such as ChatGPT are often preferred by female students in certain educational fields (Ofosu-Ampong, 2023; Teo, 2010). Female students are more likely to use educational technology in their learning activities compared to male students. Female students are more active in seeking digital learning aids to improve their understanding and academic performance (Teo, 2010). They showed a greater interest in technologies that can provide additional support in learning, such as AI and chatbots. This is due to their perception that these technologies can offer more personalized and responsive assistance compared to conventional methods (Ofosu-Ampong, 2023).

The results of this survey indicate that the use of ChatGPT and similar AI varies by student education level. Students in the early and late semesters tend to use AI more, likely due to their need for early adaptation and later support in writing and research. This variation also reflects the important role of AI technology in supporting various aspects of learning in higher education. This survey was conducted in the even semester, with the distribution of respondents as follows

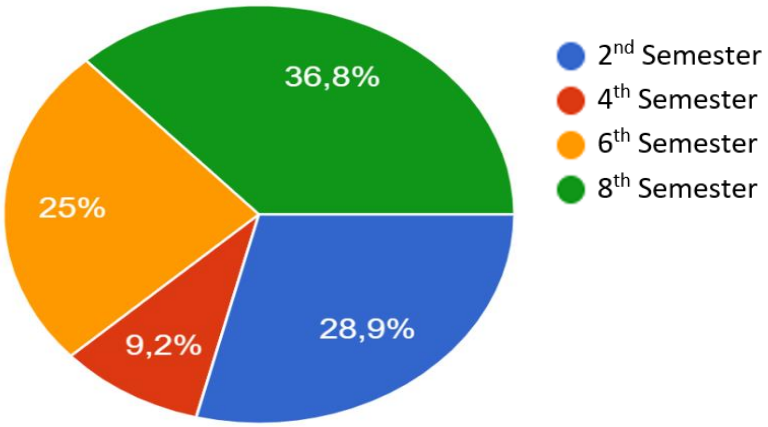

Figure 2. Number of Respondents at Each Semester Level

Students in the second semester showed significant use of ChatGPT and similar AI. At this stage, they began to engage more deeply with the more complex curriculum and may seek additional support to understand the course material. Students at the beginning of their study program tend to seek learning aids to navigate the transition from secondary school to higher education (Huang et al., 2020). Meanwhile, the use of ChatGPT and similar AI by students in the fourth semester was relatively lower. At this stage, it is possible that students are more familiar with existing learning methods and teaching materials, reducing their reliance on AI tools. However, this lower number could also reflect a high academic load or a focus on practical activities that require a different learning approach.

In the sixth semester, the use of ChatGPT and similar AI also increased. Students at this stage are faced with more specific and complex material and they prepare for their final assignments. ChatGPT and similar AI can assist them in academic research and writing. The highest use of ChatGPT and similar AI was recorded in the eighth semester. Students at this stage are at the end of their study program, often completing their thesis or final project. ChatGPT and similar AI can provide support in writing, data analysis, and literature research. Students who are in the final phase of their studies are more likely to utilize ChatGPT and similar AI technologies to improve the efficiency and quality of their academic work (Atchley et al., 2024; Kaledio et al., 2024).

Utilization of AI in Lectures

All chemistry education students reported having used AI tools like ChatGPT and similar AI during their coursework. The survey results indicate that ChatGPT and similar AI tools have become essential for chemistry education students in seeking information and supporting their academic activities. A total of 90.8% of students favor ChatGPT as their preferred AI tool for information retrieval. Additionally, 18.4% of students choose Codex OpenAI and 17.1% select Microsoft Bing Chat, with a smaller portion opting for other types of AI. Thus, several chemistry education students utilize these three AI tools for information gathering.

The dominance of ChatGPT highlights that students appreciate the ease and accuracy of information provided by this AI. ChatGPT excels in understanding and responding to questions with relevant context, making it a highly useful tool in academic settings (Brown et al., 2020). Meanwhile, the use of Codex OpenAI and Microsoft Bing Chat indicates a diversification of tools used by students according to their specific needs. Codex OpenAI, known for its capabilities in programming and code writing, is also used by some students. Although the primary focus of this survey is on chemistry education students, the use of Codex suggests that students are also interested in technical and programming aspects that may relate to research projects or specific assignments. Research by (Chen et al., 2021) indicates that Codex is highly beneficial for students in understanding programming concepts and completing tasks requiring code writing. Microsoft Bing Chat, though not as popular as ChatGPT, remains a choice for some students. Bing Chat offers integration with the Bing search engine, enabling users to access more diverse and up-to-date information (Malik et al., 2023).

Several students use more than one AI tool, indicating a multifaceted approach to information seeking. The use of various AI tools also reflects students' adaptation to technology to maximize their academic outcomes. The combination of multiple AI tools allows students to leverage the strengths of each platform, such as using ChatGPT for concept understanding and Codex for programming assistance. In other words, utilizing various AI tools can enhance the effectiveness of students' learning and research (Ofosu-Ampong, 2023).

The survey results reveal that ChatGPT and similar AI tools have become primary resources for chemistry education students when seeking references or solutions. This is evidenced by the high frequency of students' interactions with these AI tools. The following section presents the frequency of students' use of ChatGPT and similar AI tools in their daily activities.

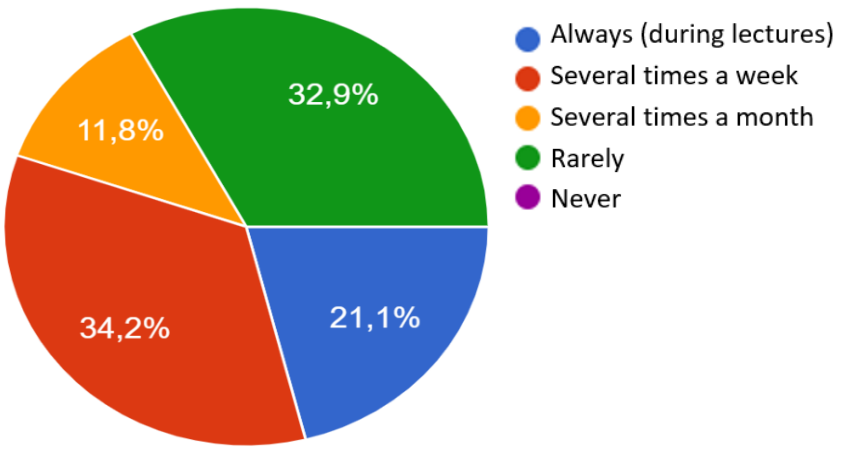

Figure 3. Frequency of ChatGPT and Similar AI Usage

ChatGPT and similar AI tools have become integral to the teaching and learning process. Routine use of AI technology can enhance better concept comprehension and assist students in overcoming difficulties in course materials (Huang et al., 2020). However, moderate AI usage

can help students manage their study time and improve their academic productivity (Kaledio et al., 2024).

Survey results have revealed that chemistry education students creatively utilize ChatGPT and similar AI tools in various aspects of their academic activities. These utilizations include seeking explanations of chemistry concepts (80.3%), preparing reports/papers/theses (43.4%), assisting with data analysis (19.7%), and a smaller portion using AI for solving problems and finding references.

Most students use ChatGPT to understand chemistry concepts. This indicates that this AI is highly effective in providing easily understood and detailed explanations. According to research by (Brown et al., 2020), AI technology like ChatGPT can enhance concept comprehension through explanations tailored to the user's needs. This utilization also shows that students tend to seek interactive and responsive learning sources. Meanwhile, the use of AI in academic writing can save time and improve the quality of writing by providing suggestions and automatic corrections (Atchley et al., 2024).

The Impact of the Use of AI

Most chemistry education students feel supported in understanding chemistry through ChatGPT and similar AI (61.8%), while the rest feel slightly helped. The results of this survey indicate that ChatGPT and similar AI play an important role in helping Chemistry Education students understand learning materials. The majority of students feel significantly helped by this AI, which is reflected in their ability to provide clear, relevant, and accessible explanations. This aligns with research showing that AI technology can improve students' understanding and engagement in the learning process (Huang et al., 2020).

However, some students feel only slightly helped. This may be due to various factors, such as limitations in the use of AI, different learning preferences, or the need for more in-depth explanations that AI may not always be able to provide. According to (Kaledio et al., 2024), it is important for educational institutions to provide guidance and training in using AI technology effectively, so that all students can maximize its benefits.

The majority of chemistry education students agree that ChatGPT and similar AI provide great efficiency when studying. This shows that technology has a significant impact on increasing learning productivity. This AI not only helps in understanding concepts but also speeds up the process of completing academic assignments and analyzing data, contributing to time and effort efficiency. This efficiency allows students to allocate more time to aspects of learning that are more complex or require deeper attention. Saving time in searching for information, simplifying concepts, and completing academic assignments allows students to learn more effectively and in an organized manner. The integration of AI in education can provide significant benefits in terms of learning efficiency and quality (Akinwalere & Ivanov, 2022; Butson & Spronken-Smith, 2024; Li et al., 2024; VanLEHN, 2011).

A total of 86.8% of chemistry education students agree that ChatGPT and similar AI are very helpful when conducting chemical research or experiments. The majority of Chemistry Education students who feel great benefits from using ChatGPT and similar AI in chemical research and experiments indicate that this technology has great potential in supporting the scientific process. AI not only makes it easier to access information but also provides significant assistance in various stages of research, from experimental design to data analysis and report preparation.

The efficiency and accuracy offered by AI allow students to focus on the creative and critical aspects of their research, reducing time spent on routine tasks and improving the quality of research output. This is in line with research findings showing that the integration of AI in the

research process can improve the productivity and quality of scientific output (Jiang et al., 2017; Khalifa & Albadawy, 2024; Luxton, 2014).

Challenges and Necessities

Some of the constraints faced by students in using ChatGPT and similar AI include the cost of using AI, lack of knowledge about AI, limited access to the application, and difficulty in operating the AI. The constraints faced by students in using ChatGPT and similar AI show that although this technology offers significant benefits, several challenges need to be overcome to maximize its use.

The high cost of use can be addressed by providing more affordable access or subsidies from educational institutions. Education and training programs on AI can help overcome the lack of knowledge and facilitate the effective use of this technology. For access issues, improving technological infrastructure and policies that support access to AI tools can help overcome this obstacle. Operational difficulties can be reduced by providing better technical support and guidance on use. Addressing these obstacles is important to ensure that all students can make the most of AI's potential. Further research can help identify effective solutions and develop strategies to increase the adoption and use of AI in academic settings (Crompton & Burke, 2023; Nurtayeva et al., 2024; Qin & Wang, 2022).

The survey results showed that almost all respondents agreed that training related to the use of AI in the learning process is needed, through seminars, discussions, practical workshops, and simple tutorials. These results reflect the importance of improving students' skills and knowledge in utilizing AI technology to support the teaching and learning process. By providing comprehensive training, educational institutions can help students overcome the obstacles they face, improve their technical skills, and maximize the potential of using AI in lectures. A diverse training approach can ensure that students gain not only theoretical knowledge but also the practical skills needed to use AI effectively in their academic contexts (Neumeyer et al., 2021; Pham Tra & Dau Thi Kim, 2024; Sen & Leong, 2020).

Curriculum Transformation

Based on the survey results on the use of ChatGPT and similar AI by Chemistry Education students, several important recommendations can be proposed to improve and enhance the chemistry education curriculum. The survey findings show that students find AI very helpful in understanding chemistry concepts, conducting research, and compiling reports. However, they also face obstacles such as the cost of use, lack of knowledge, limited access, and technical difficulties. To address these issues and maximize the benefits of AI in education, several strategic steps need to be taken. First, the integration of AI into learning materials is an important step. AI can be used to provide more in-depth explanations of chemistry concepts and assist students in compiling reports or papers. AI-based simulations can be integrated into labs to provide a more interactive and immersive experimental experience. By utilizing AI as a reference tool and for conceptual explanations, students can more easily understand complex chemistry topics (Pham Tra & Dau Thi Kim, 2024).

Second, training on the use of AI should be an integral part of the curriculum. This training should include seminars, practical workshops, and simple tutorials to help students understand how to use AI effectively. Effective training can address the lack of knowledge and technical difficulties, and improve students' skills in using these technologies. Research shows that training that combines theory and practice can accelerate the learning process and increase the effectiveness of using new technologies (Sen & Leong, 2020).

Third, issues related to access and the cost of using AI must be addressed to ensure that all students can benefit from this technology. Educational institutions need to provide adequate

access to AI applications and consider subsidies or free licenses for students. Adequate technical support is also important to help students overcome any technical issues they may encounter. Issues of accessibility and cost can affect students' ability to make optimal use of AI technologies (Crompton & Burke, 2023). Fourth, regular evaluation and adjustment of the curriculum are needed to ensure that the curriculum remains relevant to developments in AI technology and the needs of students. Collaboration with the technology industry can help ensure that the curriculum is up to date and meets the needs of students. Regular evaluation can provide useful feedback for curriculum adjustments and better integration of AI in chemistry education (Nurtayeva et al., 2024). By implementing these recommendations, it is hoped that the chemistry education curriculum can be more effective in utilizing AI, helping students overcome obstacles, and improving the overall quality of education. The right integration of AI can bring many benefits, including a better understanding of chemical concepts, efficiency in research, and better technical support for students.

CONCLUSION

Chemistry Education students extensively use AI, such as ChatGPT, for various academic purposes like understanding chemistry concepts, compiling reports, and conducting research, making AI a crucial tool in their learning process. However, they face several barriers, including the cost of use, lack of knowledge about AI, limited access to applications, and operational difficulties, which hinder the optimal utilization of AI in education. Nearly all students recognize the need for effective training on AI usage, which should include seminars, practical workshops, and simple tutorials to help them understand and maximize the benefits of AI. To fully leverage AI in chemistry education, the curriculum should integrate AI into learning materials, provide comprehensive training, ensure adequate access and technical support, and conduct periodic evaluations and adjustments. Additionally, there are differences in perceptions based on gender and student grade levels in the use of ChatGPT, which should be considered in the learning process.

RECOMMENDATIONS

Based on the research results obtained, the following important recommendations should be considered as follows: (1) Integrate AI into learning materials to improve students' understanding and analytical skills; (2) Provide Comprehensive training on the use of AI, including seminars, workshops, and tutorials; (3) Ensure adequate access to AI applications by providing free or subsidized licenses and technical support; (4) Conduct periodic evaluations and adjustments of the curriculum to ensure relevance to the latest technological developments. An example of an evaluation method that can be used is curriculum review by a team of experts. This method involves regular reviews, comparison with current standards, and implementation of changes to ensure the curriculum remains relevant to the latest technological developments; (6) Develop digital literacy as an integral part of the chemistry education curriculum; (7) In the depth research or future research related the gender perceptions and also grade of the students in the usage of Chat GPT in the Chemistry Education learning process.

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