

## Facilitating nursing and health education by incorporating ChatGPT into learning designs

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**ABSTRACT:** Traditional nursing and health education design courses usually only transfer knowledge via lectures, and lack interaction, drills and personalized feedback. However, the development and widespread adoption of generative artificial intelligence via the ChatGPT system presents an opportunity to address these issues. Some CIDI model-based ChatGPT systems have been developed, but how to effectively apply these technologies in nursing education design courses remains a challenging problem for researchers. In order to explore the application mode and effect of generative artificial intelligence via ChatGPT technology in nursing education, this study integrated generative artificial intelligence via the ChatGPT system into the teaching activities of nursing and health education design courses, and used computers as learning tools to guide learners to learn nursing and health knowledge. At the same time, two classes of nursing undergraduates were recruited to conduct a quasi-experiment. One of the classes was the experimental group, which used the generative artificial intelligence via the ChatGPT system for learning; the other class was the control group, which used traditional teaching methods for learning. By analyzing learners' learning efficiency and learning satisfaction, we obtained results about the application effect of generative artificial intelligence via ChatGPT technology in a nursing education design course. According to the experimental results, the generative artificial intelligence via ChatGPT system effectively improved learners' critical thinking ability, problem solving, and learning enjoyment. These results indicate that the generative artificial intelligence via ChatGPT system has great potential in nursing education design courses, and can improve the deficiencies of traditional teaching methods.

**Keywords:** ChatGPT, Generative artificial intelligence via ChatGPT system, Nursing Training, Computer-assisted learning, Generative artificial intelligence in education

### 1. Introduction

Nursing health education is the most commonly used communication method for promoting health, providing the general public with essential knowledge about relevant diseases and preventive care (Bezerra, 2020; Maneejak & Yasri, 2020). Therefore, enhancing nursing learners' professional knowledge and skills in health education is especially crucial. Nursing health education design courses aim to comprehensively and systematically introduce various health knowledge topics; for example, hypertension dietary education courses can teach individuals proper daily eating habits and blood pressure monitoring to prevent stroke occurrences (Shi et al., 2022); stroke education courses can enhance stroke patients' home care and reduce the risk of recurrent strokes (Hu et al., 2022); and antenatal health education courses can effectively prepare pregnant women for childbirth and boost their confidence (Donkor et al., 2023).

The objective of health promotion courses is to cultivate learners' understanding of nursing health education design from both macro and micro perspectives, emphasizing effective and systematic planning. This equips nursing learners with the ability to integrate professional knowledge in their workplace and deliver accurate health information (Bezerra, 2020). Consequently, they can provide patients with the correct knowledge, thereby promoting self-care abilities and maintaining a good quality of life (Leutualy et al., 2021). Scholars indicate that nursing health education is the process of imparting fundamental nursing knowledge and skills to patients and their families (Donkor et al., 2023; Hu et al., 2022). Through carefully designed nursing health education, nursing learners learn how to effectively convey medical knowledge, disease prevention, and health promotion information, thereby enhancing the quality of patient care (Sharifzadeh et al., 2020).

In the context of nursing and health education, critical thinking involves evaluating, analyzing, and synthesizing information for informed clinical decisions, while problem solving entails applying critical thinking skills to

address complex healthcare challenges (Rahman, 2019). Learner enjoyment is crucial as it motivates active participation, enhancing retention and skill development (Batita & Wedi, 2023). Enjoyment in learning, while seemingly distinct, is pivotal for cultivating critical thinking and problem solving, enhancing motivation and information retention. Research, like Norman and Schmidt's (1992) study, indicates that enjoyable experiences can deepen understanding and improve problem solving in healthcare education. Scholars have also pointed out that strategies to boost enjoyment include creating a supportive environment and tailoring teaching methods to student preferences. Critical thinking and problem solving are vital in healthcare education. Traditional methods have limitations, but research suggests various pedagogical approaches to improve these skills and learner enjoyment (Zhang et al., 2023). A comprehensive approach integrating theory, practice, and active learning can enhance overall educational outcomes in healthcare education. Nowadays, in the era of globalization and advancements in information technology, innovative teaching methods have presented challenges to educators (Hwang & Chu, 2023; Tang et al., 2021). To cope with the emergence of new diseases and medical knowledge, it is necessary to involve learners in real-world problem-solving environments related to nursing health education design (Randhawa & Jackson, 2020). Based on the principles of problem-solving theory and adopting an active, hands-on approach to education, learners engage in real-life problem situations, analyze issues, and collaborate to find solutions (Reed, 2019). Reed (2019) emphasized that learning should be an inquiry and discovery process, rather than passive information absorption, to improve learners' learning outcomes. Problem solving also fosters critical thinking, creativity, and practical skills essential for active participation in society (Akinsanya & Ojotule, 2022; Luo, 2023). One of the fundamental competencies in clinical care is providing nursing health education after assessment and intervention. Regardless of their future specialization, nursing learners need to learn how to write nursing health education plans and deliver accurate health education before entering the workplace. Meanwhile, in order to immerse learners in real-life scenarios, traditional training adopts a teaching approach, assisting learners in understanding the significance of nursing health education for national health.

Researchers have suggested that one promising solution is to incorporate generative artificial intelligence through ChatGPT technologies into nursing training programs, providing personalized learning guidance and knowledge construction (Gunawan, 2023). Empirical studies have demonstrated the importance of technology in guiding learners to think critically, analyze problems, explore solutions, and seek additional information in learning tasks (e.g., Alkhateeb & Al-Duwairi, 2019; Araiza-Alba et al., 2021; Sahin & Yilmaz, 2020). Although integrating such emerging technology into curricula has been considered effective, learners often still require guidance from teachers rather than encouragement to explore, discover problems, and make decisions in problem-solving processes. To address this, scholars have attempted to use artificial intelligence technology to promote learners' autonomous learning and improve their learning outcomes (Tang et al., 2021). For instance, Huang and Qiao (2022) applied artificial intelligence education in high school STEAM courses to enhance learners' computational thinking skills. Additionally, Fauzi et al. (2023) utilized ChatGPT and generative language models in medical education at higher education levels, enabling learners to explore and learn through ChatGPT environments, resulting in more helpful information and resources, improved language skills, enhanced collaboration, increased time efficiency and effectiveness, and greater support and motivation.

As indicated by the above studies, educational technology researchers have been exploring how generative artificial intelligence via ChatGPT technologies can enhance teaching and learning effectiveness (Hwang & Chen, 2023). Concurrently, learners can connect the knowledge they acquire with real-world problems through the application of generative artificial intelligence via ChatGPT technologies (Gunawan, 2023). For most learners, nursing health education is a complex clinical task that requires the collection of clinical medical examination data, medical treatments, and patient health needs to provide appropriate health education messages, making it an important and challenging routine task in nursing practice (Hu et al., 2022; Donkor et al., 2023). To perform nursing health education effectively, nursing learners must learn how to prepare and assess professional health education knowledge and deliver it accurately (Donkor et al., 2023). Moreover, studies have identified that critical thinking, problem-solving, and enjoyment are pivotal in the learning and research process. A researcher who is intrinsically motivated and finds joy in the process is more inclined to engage profoundly, overcome challenges, and yield innovative results (Ryan & Deci, 2000). While critical thinking, problem solving, and enjoyment have each been examined separately, exploring their interconnectedness can offer fresh insights. However, this has not been extensively explored in the context of nursing health education. To address these training challenges, this study aimed to integrate generative artificial intelligence via a ChatGPT system into nursing health education design training courses, departing from traditional didactic teaching methods, and enhancing learners' learning outcomes. In this context, generative artificial intelligence via ChatGPT technologies refers to learners utilizing stored professional knowledge in a knowledge base to prompt and generate content within the system. Previous studies have demonstrated the potential of using generative artificial intelligence via ChatGPT technologies, specifically the CIDI model-based ChatGPT learning method,

for providing learning support or decision guidance to enhance learners' critical thinking, problem solving, and enjoyment. To assess the efficacy of this approach, we posed the following research questions:

- Was the critical thinking tendency of the students using the CIDI model-based ChatGPT learning method for nursing and health education significantly higher than that of those who learned with the conventional instruction?
- Was the problem solving of the students using the CIDI model-based ChatGPT learning method for nursing and health education significantly higher than that of those who learned with the conventional instruction?
- Was the learning enjoyment of the students using the CIDI model-based ChatGPT learning method for nursing and health education significantly higher than that of those who learned with the conventional instruction?

## **2. Relevant studies**

### **2.1. Artificial intelligence for educational purposes**

According to technology advances, Artificial Intelligence (AI) in education offers numerous benefits that can greatly enhance the learning experience for learners (Chen et al., 2020). Some of the key benefits of AI in education include personalized learning, adaptive learning, intelligent tutoring, enhanced assessment and feedback, efficient administrative tasks, virtual reality and simulations, and intelligent content creation (Chen et al., 2020). According to Chen et al. (2022), AI in education has the potential to revolutionize the learning process, making it more engaging, personalized, and effective. By leveraging AI technologies, educators can create a dynamic and adaptive learning environment that caters to the unique needs of each student, ultimately enhancing their educational outcomes.

### **2.2. ChatGPT**

ChatGPT is a computer application cooperating with users using natural language based on a generative language model launched by OpenAI (Eysenbach, 2023). There are several roles of ChatGPT in educational settings, such as information or knowledge providers (Eysenbach, 2023). It is an AI tool that assists in writing, learning, performing assessments, creative writing, language translating, personal assistant tutoring or providing educational resources, as well as being a content generator, problem solver and entertainment provider (Fauzi et al., 2023; Khan et al., 2023; Strzelecki, 2023). Scholars emphasize that when users interact with the ChatGPT platform by posing questions or introducing new topics, ChatGPT responds with generative language sentences based on a knowledge base (Hwang & Chen, 2023). Investigators have specifically noted that this interactive mode using generative language greatly enhances ChatGPT's acceptance among the general public (Kung et al., 2023). Moreover, Wardat et al. (2023) further identified that utilizing ChatGPT can effectively enhance learners' problem-solving and critical thinking skills.

Recently, investigators have applied ChatGPT to several areas including science education (Cooper, 2023), an L2 writing practicum (Yan, 2023), medical education (Friederichs et al., 2023), early childhood education (Luo et al., 2023), health and physical education (Killian et al., 2023), and revolutionizing patient care and education domains (Ahmed, 2023). For example, Ahmed (2023) indicated that the utilization of ChatGPT in nurse education courses can offer simulated scenarios for virtual training, and simulated patient communication to nursing learners. This virtual experience has the potential to enhance learners' practical abilities and self-confidence, while providing them with greater learning opportunities in terms of diagnosis, guidance, and assessment. As a result, the learners' learning efficacy is improved. Yan (2020) implemented ChatGPT in an L2 writing class and discovered its effectiveness in enhancing the learners' writing outcomes. It is foreseeable that the progress of computer networks, mobile, and AI technologies could continue to promote the adoption of ChatGPT in diverse fields, as suggested by Hwang and Chen (2023).

### **2.3. The current study**

Effective teaching and learning revolve around skillful questioning within the classroom. Student questioning is regarded as a crucial self-management strategy that yields multiple benefits in science education (Webb, 2005). These inquiries not only play a vital role in knowledge acquisition, discussions, self-evaluation, and fostering learning engagement, but also lead to tangible improvements in academic performance. For instance, the implementation of questioning strategies during the reading process was shown to significantly enhance reading

performance (Astrid et al., 2019). Xia (2020) pointed out that questioning strategies can also bolster second language learners' comprehension of text details and main ideas. Furthermore, Vacek and Liesveld (2020) implemented a Question strategy in nursing education. Throughout the teaching process, teachers guided learners to ask questions, aiming to foster their in-depth thinking and comprehension of concepts. The researchers observed that the application of this teaching method had a positive impact on nursing learners' learning and conceptual understanding. Moreover, it led to an improvement in their learning efficiency and satisfaction, while also enhancing their ability to apply acquired knowledge in actual nursing practice in the future.

Nevertheless, in a traditional classroom setting, student-initiated questions are relatively infrequent. Scholars have stated that teachers face the pressure of keeping up with the curriculum, which may restrict their ability to address every student's question within a single class session (Hsu et al., 2023; Kohnke, 2022). Consequently, this study delved into the utilization of ChatGPT, a generative language model, to optimize the communication pathway with learners, assisting them in formulating questions and accomplishing learning tasks. Through this approach, we aim to enhance the promotion of effective teaching and learning.

#### **2.4. Critical thinking, problem-solving learning, and enjoyment**

Problem-solving ability and critical thinking are essential core competencies that 21st-century learners need to possess (Baird & Parayitam, 2019; Song et al., 2022). Critical thinking involves learners objectively and systematically analyzing, evaluating, and synthesizing information, ideas, and arguments to make informed decisions and form sound judgments (Akbar, 2023). It encourages logical thinking, the evaluation of evidence, and drawing logical conclusions, enabling learners to solve problems and exercise good judgment in various situations. Developing critical thinking skills empowers individuals to face future challenges and complexities with intellectual rigor and insight.

Scholars propose that learners should possess "problem-solving ability," which entails acquiring knowledge, skills, and strategies to effectively identify, analyze, and resolve challenges and issues in diverse contexts (Gordon et al., 2021). This competency has significant value across different disciplines, and plays a crucial role in personal and professional development (Ábrahám et al., 2023). Thus, cultivating problem-solving skills is a vital task for today's educators.

Moreover, learning enjoyment refers to an emotional orientation that originates from the happiness and contentment learners experience during their educational endeavors (Jin & Zhang, 2021). By enhancing learners' learning enjoyment, they may develop a heightened interest in learning goals, leading to sustained learning and improved learning experiences (Hsu et al., 2023). This, in turn, enhances their critical thinking and problem-solving abilities.

It can be observed that education has become more student-centered and personalized, leading to enhanced learning outcomes for learners. Consequently, there is a growing necessity to consider individual differences during class activities and when integrating ChatGPT into educational practices (Hwang & Chen, 2023). ChatGPT has proven its effectiveness in assisting with complex pathology problems, such as explaining disease pathophysiology and providing diagnostic recommendations (Sinha et al., 2023). Educational researchers are not only involved in new pedagogical issues and methods, but have also embraced technology to facilitate efficient learning for learners in professional training, overcoming the limitations of location and time through cross-disciplinary cooperation (Aitchison et al., 2020). Vacek and Liesveld (2020) employed questioning strategies to support learners in comprehending nursing education concepts. In line with this, the present research applied ChatGPT's questioning strategies to enhance the learning efficacy of university learners enrolled in a health education design course. Learners interacted with ChatGPT through questioning strategies, with ChatGPT acting as the teacher to answer their queries, aiming to increase their learning enjoyment.

As a result, the adoption of ChatGPT technologies has gradually reshaped the role of teachers in educational environments. With the help of ChatGPT, instructors can focus more on guiding learners in thinking, practicing, and applying knowledge based on individual learners' needs, thereby improving the quality of teaching.

### 3. Method

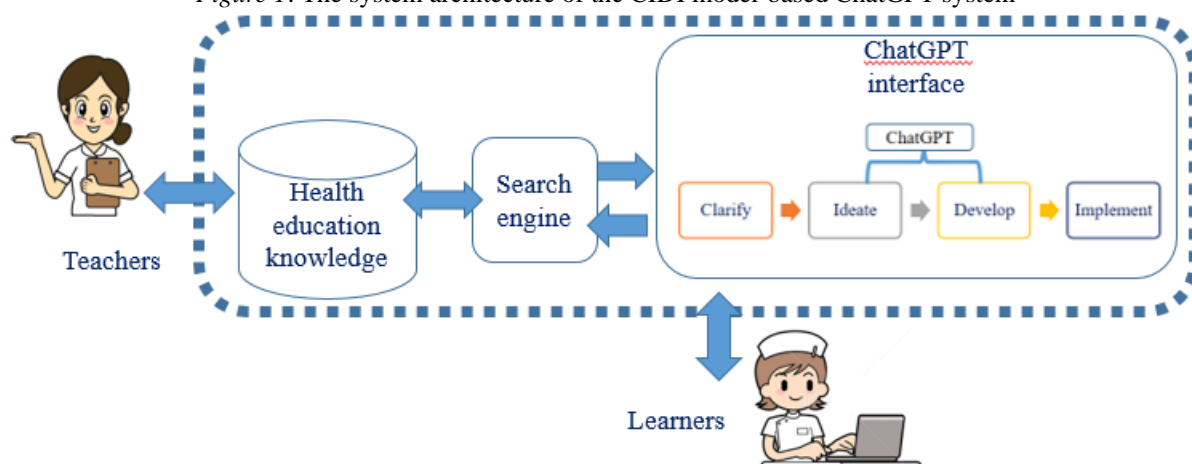
#### 3.1. Development of the CIDI model-based ChatGPT

The study utilized Alex Osborn's creative problem-solving model, known as CIDI (Clarify, Ideate, Develop, Implement), to guide the problem-solving process (Osborn, 1953; Zhanova, 2013). This CIDI method and process essentially involve four steps: (1) Clarify: In this step, learners need to identify and clarify the nature and scope of the problem. For example, learners must learn to define the learning task problem, determine learning objectives and goals, and understand the challenges and limitations in the problem-solving procedure. The purpose of this stage is to ensure that learners have a consistent understanding of the problem and lay the foundation for the subsequent ideation process. (2) Ideate: In the CIDI method, ideate is the most important and creative stage. Learners are encouraged to brainstorm and freely express ideas during this stage. Learners can provide more options for the subsequent selection of problem-solving methods, and propose diverse and rich solutions to the learning task. (3) Develop: Following the Ideate stage, learners will evaluate and conduct in-depth research on the various ideas or solutions generated. They can identify more promising ideas for solving the task and consider the feasibility and effectiveness of implementation, developing them into concrete and feasible solutions. (4) Implement: Learners can involve the actual implementation of the solutions developed through CIDI. It includes conducting experiments, testing, and making adjustments based on practical implementation.

The CIDI method and process is a systematic, practical problem-solving framework that helps learners be more organized and creative in problem solving. The approach has broad applications in business, innovation, education and other fields, helping people face challenges more effectively and find innovative solutions (Puccio et al., 2005).

The CIDI model-based ChatGPT system utilizes questioning strategies in knowledge inquiry to make decisions or provide assistance. The expertise of ChatGPT is derived from domain knowledge and non-domain-specific information, enabling it to respond to inquiries of varying depths. This research integrates ChatGPT's artificial intelligence capabilities as both an information and knowledge provider, allowing learners to interact with the system through questioning strategies. The generative language of ChatGPT serves as the knowledge repository, as depicted in Figure 1. During the interactive conversation between learners and the ChatGPT system, the requests and data from learners are interpreted by ChatGPT and related materials are retrieved from the repository. Subsequently, ChatGPT summarizes and formulates responses based on the retrieved information to provide answers to the learners.

Figure 1. The system architecture of the CIDI model-based ChatGPT system



In this instructional task example, learners are assigned to design a health education lesson plan in the form of a dietary education sheet for pregnant women within the first three months of pregnancy. This particular health education design is facilitated through the CIDI model-based ChatGPT system, offering interactive learning opportunities. Through the clarify phase, learners are required to ascertain and clarify the nature and scope of the dietary education task. This includes accurately defining the dietary issues associated with pregnancy, defining the determination and goals of the inquiry, and determining the tasks and constraints involved. The purpose of this clarify phase is to confirm that learners have a consistent understanding of the tasks, laying the groundwork for the subsequent process of creating the lesson plan. The instructional screen guides learners in how to utilize

the ChatGPT system effectively, as depicted in Figure 2. It delivers step-by-step instructions to support learners' understanding and mastery of the functionalities of the ChatGPT interface. Through interactive demonstrations, learners can learn how to input questions, analyze responses, and make use of the various available features. The activities also offer examples and practical exercises to enhance learners' proficiency in using ChatGPT as a powerful tool for knowledge inquiry and problem solving. By the end of the activities, learners will be equipped with the capability and confidence to leverage the ChatGPT system to its full potential.

Figure 2. Instructing learners on the ChatGPT system and method



Figure 3. Example of information retrieved and presented by ChatGPT

Please make a dietary education sheet for pregnant women within the first three months of pregnancy

please make a dietary education sheet for pregnant women within the first three months of pregnancy

Congratulations on your pregnancy! Here's a dietary education sheet for pregnant women within the first three months (first trimester) of pregnancy. It's important to focus on balanced and nutritious meals during this crucial time. Remember to consult with your healthcare provider for personalized advice and any specific dietary requirements.

**Dietary Education for Pregnant Women - First Trimester (Weeks 1-12)**

**1. Key Nutrients:**  
During the first trimester, your body needs essential nutrients to support the growth and development of your baby. Focus on the following nutrients:

- Folic Acid:** Crucial for the development of your baby's brain and spinal cord. Include folate-rich foods like leafy greens, fortified cereals, beans, and citrus fruits.
- Iron:** Important for the formation of red blood cells in both you and your baby. Consume iron-rich foods like lean meats, beans, fortified cereals, and spinach.
- Calcium:** Vital for your baby's bone development. Get calcium from dairy products (milk, yogurt), fortified plant-based milk, and leafy greens.
- Omega-3 Fatty Acids:** Support your baby's brain and eye development. Eat fatty fish (low in mercury) like salmon, chia seeds, flaxseeds, and walnuts.
- Protein:** Essential for cell growth and repair. Include lean meats, poultry, fish, eggs, legumes, and nuts.
- Vitamin D:** Aids in calcium absorption and supports bone health. Spend time outdoors in sunlight and consume vitamin D-fortified foods or supplements if advised by your doctor.

**2. Stay Hydrated:**  
Drink plenty of water throughout the day. Staying hydrated helps in maintaining amniotic fluid levels and supports the overall functions of your body.

**3. Meal Planning:**

- Aim for three balanced meals per day.
- Include a variety of fruits, vegetables, whole grains, lean proteins, and healthy fats in your diet.

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During the ideate phase of the instructional activity, teachers encourage learners to freely express their thoughts and opinions about their learning process. Learners can engage in interactive conversations with ChatGPT, exploring diverse solutions to clinical scenarios and collecting multiple options for making decisions in solving learning tasks. Through interactions with the ChatGPT system, learners have the opportunity to learn professional terminology and exercise critical judgment, fostering greater interactivity in the learning process. Moreover, they can practice repeatedly to become familiar with the questioning and response process facilitated by ChatGPT. Leveraging the knowledge-based ChatGPT system, learners are stimulated to complete learning tasks relevant to their chosen topics and address a series of questions. If learners make correct decisions or selections within the specified timeframe, their records are updated, as depicted in Figure 3.

Figure 4 depicts the learning scenario of the knowledge-based ChatGPT system undergoing training within a computer environment. One of the tasks involves determining the type of diet to respond to the instructional prompts. Learners can interact with ChatGPT to seek evidence supporting their instructional design tasks. During this stage of development, learners will evaluate and delve deeper into various ideas generated from the previous phase of ideation. They can explore ideas that best address the instructional task, and consider the feasibility and effectiveness of implementation based on the instructional objectives. Moreover, learners can use questioning strategies iteratively to familiarize themselves with knowledge related to pregnancy diets and transform it into a concrete and feasible instructional plan. Additionally, learners can further inquire and request, “Make a dietary education sheet for pregnant women with diabetes within the first three months of pregnancy,” to obtain different information, as illustrated in Figure 4.

Figure 4. Learners interact with ChatGPT during the learning process

Please make a dietary education sheet for pregnant women via diabetes within the first three months of pregnancy

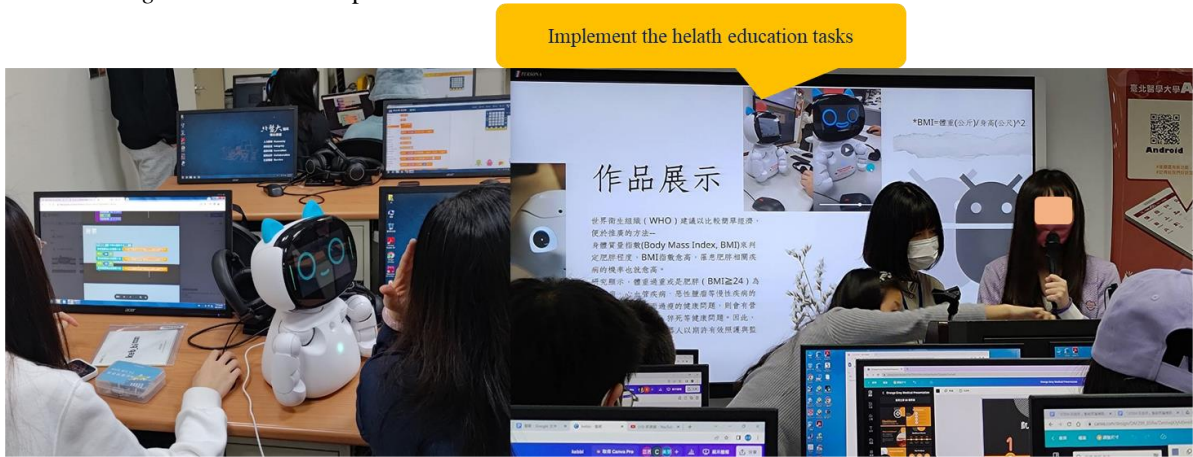
**Dietary Education for Pregnant Women with Diabetes - First Trimester (Weeks 1-12)**

- 1. Balanced Meals:**
  - \* Aim for three balanced meals and two to three small, healthy snacks each day.
  - \* Include a variety of nutrient-dense foods, such as fruits, vegetables, whole grains, lean proteins, and healthy fats.
- 2. Carbohydrate Management:**
  - \* Monitor your carbohydrate intake and spread it throughout the day to help control blood sugar levels.
  - \* Choose complex carbohydrates like whole grains, legumes, and non-starchy vegetables over refined carbohydrates and sugary foods.
- 3. Glycemic Control:**
  - \* Focus on maintaining stable blood sugar levels.
  - \* Avoid large spikes in blood sugar by avoiding high glycemic index foods and sugary snacks.
- 4. Portion Sizes:**
  - \* Be mindful of portion sizes to prevent overeating and to better manage blood sugar levels.
- 5. Fiber-Rich Foods:**
  - \* Choose foods high in fiber, such as whole grains, fruits, and vegetables, to help regulate blood sugar levels.

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In the final implementation phase, the developed dietary education sheet solution is put into practice. It is released to the robot for conducting health education testing, adjustments, and ultimately, presenting and sharing the instructional plan, as illustrated in Figure 5.

Figure 5. Learners implement and share the tasks in the activities via an educational robot



## 3.2. Experimental design

### 3.2.1. Participants

The purpose of this study was to engage learners in a nursing health education design course and to train them in the effectiveness of generating health education content using the CIDI model-based ChatGPT system. Nursing health education is a mandatory course in nursing schools and clinical internships, and it constitutes an essential part of nursing professional development. To evaluate the effectiveness of the proposed method, this research comprised a quasi-experiment. Fifty nursing learners, with an average age of 21, participated in the experiment. Among them, 25 learners in the experimental group learned with the generative AI system, while the remaining 25 learners in the control group were taught using the traditional lecture-based approach. To compare the critical thinking, problem solving, and enjoyment levels of the two groups, pre- and posttest questionnaires were administered.

### 3.2.2. Measuring instruments

This study's critical thinking scale was adapted from Lin et al.'s (2019) modification of the critical thinking disposition questionnaire developed by Chai et al. (2015). The scale assesses learners' awareness of their learning processes, such as decision making, task analysis, and evaluation. It consists of six items, one of which is: "During the learning process, I reflect on the correctness of what I have learned." The Cronbach's  $\alpha$  value for this scale is .83.

The problem-solving scale used in this research originated from Hwang and Chen (2017). It comprises five items, including statements like "I often pause to check my level of understanding" and "I ask myself how well I have achieved the objectives after completing a task." Employing a 5-point Likert scale, the Cronbach's  $\alpha$  value for this scale was .78.

The enjoyment scale utilized in this study was developed by Dixon et al. (2015). It consists of 19 items, such as "I seek ways to make this course enjoyable for myself" and "I genuinely want to learn the materials." This measure also employs a 5-point Likert scale, with a Cronbach's  $\alpha$  value of .86.

All of the above scales utilize a 5-point Likert-style scale with response options ranging from *Strongly Agree* (5 points), *Agree* (4 points), *Neutral* (3 points), *Disagree* (2 points), to *Strongly Disagree* (1 point). Higher scores indicate better abilities, while lower scores reflect lower abilities.

### 3.2.3. Experimental process

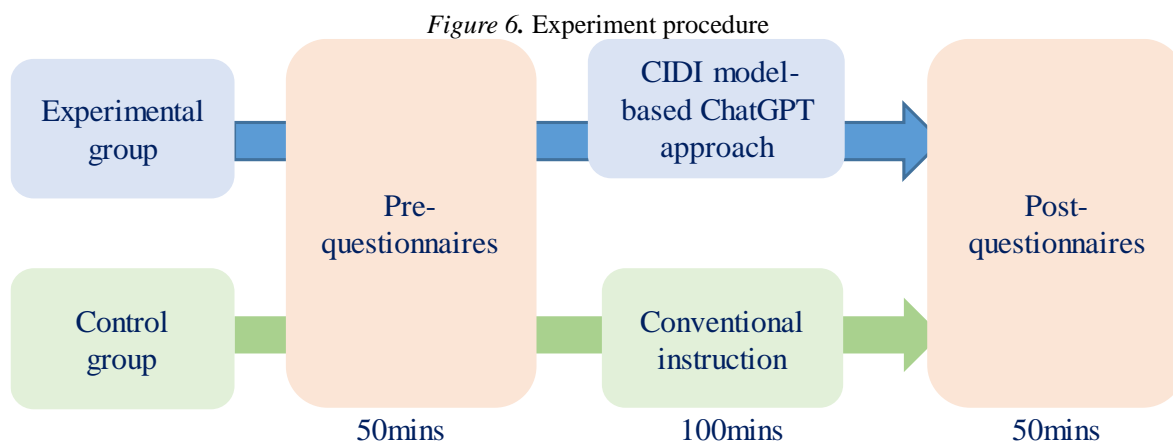
The experimental procedure is illustrated in Figure 6. Before engaging in the learning activities based on the CIDI model-based ChatGPT, the learners took a pretest to assess their foundational knowledge in nursing health education. They also filled out questionnaires related to critical thinking, problem solving, and enjoyment. During the learning activities, each group participated for a total of 4 hours.



The learners in the experimental group were guided to log into ChatGPT to practice and complete the tasks provided by the teacher. Each student interacted with ChatGPT individually to complete the self-study tasks in four time periods. There was a 10-minute break between each 50-min time period. Learners were allowed to engage in text-based interactions and conversations with ChatGPT. On the contrary, those in the control group received conventional teaching, wherein the teachers used relevant PowerPoint materials, images, and videos to illustrate the teaching content of the health education lesson plan.

It is worth noting that both groups were assigned to design a health education lesson plan in the form of a dietary education sheet for pregnant women within the first three months of pregnancy, focusing on identical learning content. The only difference between the two groups was the use of the CIDI model-based ChatGPT in the experimental group and the conventional internet search method in the control group. Both groups performed their tasks at different times. After the learning activities, the learners in both groups were assisted in completing posttests and post-questionnaires related to critical thinking, problem solving, and enjoyment.

During the practice and discussion stage, learners had the opportunity to inquire about health education project design and engage in discussions with their teachers or fellow classmates. They were guided to apply the knowledge they had acquired to address health education project cases presented by the teacher. Moreover, they were encouraged to exchange ideas and deliberate on their case decisions and dietary education recommendations, with a special focus on the initial three months of pregnancy, with their peers.



## 4. Experimental results

The IBM Statistical Toolset and Service Offerings, edition 22 (SPSS v.22), was employed to evaluate the outcomes of the experiment and to examine the validity and reliability of the study's instrument. To assess critical thinking and decision-making, along with the learning enjoyment of learners' learning through varying methods (for instance, the CIDI paradigm-driven ChatGPT versus traditional teaching methods), we utilized ANCOVA (Analysis of Covariance). The outcomes from the Shapiro-Wilk examination for distinct measures range from 0.88 to 0.90 ( $p > .05$ ). This suggests that the datasets for each measurement align with a normal distribution.

### 4.1. Critical thinking

In this study, the critical thinking pretest served as the covariate, and the critical thinking posttest was the dependent variable. The homogeneity assumption was validated through Levene's test, showing  $F(1, 48) = 1.05$  ( $p > .05$ ). Moreover, the assumption of regression homogeneity was not violated, as evidenced by  $F(1, 46) = 10.19$  ( $p > .05$ ). ANCOVA was utilized for post-hoc analysis to compare the two groups. The ANCOVA results in Table 1 revealed that learners using the CIDI model-based ChatGPT learning method (Mean = 4.73;  $SD = 0.44$ ) had significantly higher critical thinking than those using the conventional learning method (Mean = 3.88;  $SD = 0.51$ ),  $F(1, 47) = 33.22$  ( $p < .001$ ).

The adjusted values for the experimental group and control group were 4.71 and 3.89, respectively, indicating that the CIDI model-based ChatGPT learning approach significantly improved learners' critical thinking compared to the conventional learning method. Moreover, the correlation coefficient ( $\eta^2 = 0.414$ ) exceeded

0.138, suggesting that the CIDI model-based ChatGPT learning method had a substantial positive influence on learners' critical thinking. In other words, the CIDI model-based ChatGPT learning method effectively improved learners' critical thinking. The experimental results of this study confirmed that the CIDI model-based ChatGPT learning method could effectively enhance learners' critical thinking.

Table 1. Results of ANCOVA on learners' critical thinking

Group	<i>N</i>	Mean	<i>SD</i>	Adjusted Mean	Std. error	<i>F</i>	$\eta^2$
Experimental group	25	4.73	0.44	4.71	0.09	33.22***	.414
Control group	25	3.88	0.51	3.89	0.09		

Note. \*\*\*  $p < .001$ .

#### 4.2. Problem solving

This study used the problem-solving pretest as the covariate and the problem-solving posttest as the dependent variable. .05). Moreover, the assumption of regression homogeneity was not violated, as evidenced by  $F(1, 48) = 0.01$  ( $p > .05$ ). For post-hoc analysis between the two groups, ANCOVA was utilized. The ANCOVA results in Table 2 revealed that learners using the CIDI model-based ChatGPT learning method (Mean = 4.53;  $SD = 0.71$ ) had significantly better problem solving compared to those using the conventional learning method (Mean = 3.75;  $SD = 0.58$ ),  $F(1, 47) = 24.53$  ( $p < .001$ ). The adjusted means for the experimental and control groups were 4.63 and 3.65, specifying that the CIDI model-based ChatGPT learning method better enhanced learners' problem solving when compared to the conventional learning method. Moreover, the correlation coefficient ( $\eta^2 = 0.343$ ) exceeded 0.138, suggesting that the CIDI model-based ChatGPT learning method had a substantial positive influence on learners' problem solving. In other words, the CIDI model-based ChatGPT learning method effectively improved learners' problem-solving ability. The experimental results of this study confirmed that the CIDI model-based ChatGPT learning method could effectively enhance learners' problem-solving ability.

Table 2. ANCOVA of problem solving comparing the experimental and control groups

Group	<i>N</i>	Mean	<i>SD</i>	Adjusted Mean	Std. error	<i>F</i>	$\eta^2$
Experimental group	25	4.53	0.71	4.63	0.13	24.53***	.343
Control group	25	3.75	0.58	3.65	0.13		

Note. \*\*\*  $p < .001$ .

#### 4.3. Learning enjoyment

The learning enjoyment pretest was employed as the covariate, and the learning enjoyment posttest was the dependent variable. The homogeneity assumption was proved using Levene's test,  $F(1, 48) = 1.00$  ( $p > .05$ ). Additionally, the assumption of regression homogeneity was not violated, with  $F(1, 46) = 10.89$  ( $p > .05$ ). Accordingly, ANCOVA was employed. Table 3 revealed that learners using the CIDI model-based ChatGPT learning method (Mean = 4.69;  $SD = 0.46$ ) had significantly higher learning enjoyment compared to those using the conventional learning method (Mean = 3.61;  $SD = 0.68$ ),  $F(1, 47) = 15.46$  ( $p < .001$ ). The adjusted means for the experimental and control groups were 4.49 and 3.81, showing the effectiveness of using the CIDI model-based ChatGPT learning method for enhancing learners' learning enjoyment. Moreover, the correlation coefficient ( $\eta^2 = 0.248$ ) exceeded 0.138, suggesting that the CIDI model-based ChatGPT learning method had a substantial positive influence on learners' learning enjoyment. In other words, the CIDI model-based ChatGPT learning method effectively improved learners' learning enjoyment. The experimental results of this study confirmed that the CIDI model-based ChatGPT learning method could effectively enhance learners' learning enjoyment.

Table 3. Results of ANCOVA on learners' learning enjoyment

Group	<i>N</i>	Mean	<i>SD</i>	Adjusted Mean	Std. error	<i>F</i>	$\eta^2$
Experimental group	25	4.69	0.46	4.49	0.11	15.46***	.248
Control group	25	3.61	0.68	3.81	0.11		

Note. \*\*\*  $p < .001$ .

## 5. Discussion and conclusions

The study incorporated a CIDI model-based ChatGPT system into a health education design class, utilizing computers to facilitate learners' practice of nutrition knowledge for pregnant women during the learning activities. The study results specified that the CIDI model-based ChatGPT system effectively boosted learners' critical thinking, problem solving and learning enjoyment compared to conventional teaching. According to learning theories, to enhance our study, we planned to delve deeper into the interactions between learners and the ChatGPT system. We aimed to employ the Constructivist Theory, Cognitive Load Theory, and Flow Theory to better comprehend the observed improvements in a holistic manner. Previous studies have indicated that the constructivist learning theory correlates with enhanced critical thinking and problem-solving skills, suggesting that learners actively shape their knowledge. In designing future iterations of the ChatGPT system, which is based on the CIDI model, we aspired to create an environment where learners were actively engaged, posing questions, and reflecting on their insights. Such dynamic interactions underpin a profound understanding and knowledge application, thereby fostering critical thinking.

As for critical thinking, the experimental data revealed that the integration of the CIDI model-based ChatGPT system positively influenced learners' critical thinking. This outcome is consistent with previous studies that have investigated the use of chatbots in educational contexts. For instance, Chang et al. (2022) employed a chatbot in a nursing course, and found that the chatbot was able to guide learners to make judgments in physical examination, thereby strengthening their critical thinking skills. As a result, the learners achieved better learning performance compared to those who underwent conventional teaching methods. Past research has also indicated that using an interactive learning mode, which provides situational contexts and guidance, would facilitate learners' critical thinking (Adur, 2022; Kohnke, 2023).

Regarding learners' problem solving, it was found that the learners who utilized the CIDI model-based ChatGPT system demonstrated its advantages in the health education design course. The CIDI model-based ChatGPT system offered an interactive learning mode, enabling learners to acquire relevant knowledge based on their learning progress, thus providing personalized learning opportunities. This aligns with the findings of Setyosari et al. (2023), who emphasized that enhancing problem-solving skills depends on the learning design's ability to cater to individual student needs, leading to improved learning efficacy.

As for learners' learning enjoyment, the research showcased that participants favored using the CIDI model-based ChatGPT system during the learning process. The conventional teaching mode focuses more on delivering lectures with multimedia content; there are often limited opportunities for interaction between teachers and learners, as well as a lack of immediate feedback to the learners. One significant advantage of the CIDI model-based ChatGPT system is likely its capability to offer instant feedback, facilitating engagement and enabling learners to study efficiently according to their needs (Acquah & Katz, 2020). Hsu et al. (2023) also supported the idea of using computer systems to facilitate interactions to enhance learners' enjoyment.

The CIDI model-based ChatGPT system offers valuable assistance to users in making appropriate choices and conducting systematic studies focused on specific learning content. Simultaneously, the system provides practice materials suitable for different learning levels, tailoring them to learners' individual learning progress and helping them identify and address any misconceptions during the practice. As a result, the CIDI model-based ChatGPT system offers personalized practice and guidance, leading to improved learning efficiency and effectiveness. In this learning process, learners take an active role in knowledge construction while the CIDI model-based ChatGPT system serves as an assistant and learning facilitator.

The findings of this study further support Hwang and Chen's (2023) suggestion that ChatGPT systems can fulfill various roles for educational purposes. While several ChatGPT in education studies have focused on analyzing and predicting learners' perceptions of using ChatGPT, the present study demonstrates that ChatGPT systems can benefit learners by acting as a tutor. Consequently, teachers could have more time to address the challenges learners have encountered; moreover, personalized learning supports can be provided based on individual learners' requirements. If learners download the CIDI model-based ChatGPT system onto their tablets or smartphones, it transforms into a Smart Learning Partner. Consequently, learners can adapt their learning approach, accessing teaching materials that suit their preferences and repeatedly reviewing unfamiliar content. This sense of having a learning partner with shared learning goals enhances their cognitive development and creates a more enriching learning experience.

Despite obtaining the expected results, this study has limitations attributed to its research design and the instructional context. For instance, the research focus was solely on nursing learners, and it is suggested that

future studies encompass learners from various disciplinary backgrounds. Furthermore, the inability to track learners' learning process using the CIDI model-based ChatGPT system limited the understanding of their learning experiences and challenges. Additionally, the relatively small sample size poses a limitation to this study. Based on the limitations and findings of this research, the following recommendations are proposed for future studies on the application of ChatGPT in education:

- Investigate the relationship between learning methods based on ChatGPT systems and individual characteristics, that is, learning achievement, cognitive load, metacognition, or self-efficacy, and their learning performance and perception. Different learners with diverse individual traits and learning statuses may be impacted differently by the integration of ChatGPT technology.
- Apart from nursing learners, school teachers, patients, patients' families, caregivers, and healthcare professionals also require continuous learning and updates on health-related knowledge. Therefore, studying the benefits of the CIDI model-based ChatGPT system for these learners is equally essential.
- In traditional teaching environments, teachers often face challenges in understanding learners' learning situations and difficulties that may require additional guidance. In the future, using ChatGPT applications to analyze the learning process of struggling learners could allow teachers to gain insights into their learning status and provide personalized support. Moreover, teachers can use this information to improve learning content or design ChatGPT-based instructional activities. Integrating classroom management into educational applications based on the CIDI model-based ChatGPT system should also be considered.
- While recent research has primarily focused on language education applications based on ChatGPT, it is suggested to undertake interdisciplinary research to delve deeper into the educational applications of the CIDI model-based ChatGPT system. Additionally, future studies could explore the incorporation of various learning strategies, that is, game-based learning, peer assessment, and self-directed learning, in the design of CIDI model-based ChatGPT-based learning.
- Exploring the long-term impact of the approach on learners' attitude, learning behavior, and learning performance is crucial. Understanding the benefits of using the CIDI model-based ChatGPT system, which relates to active and self-directed learning, can provide personalized learning opportunities. Given the potential limitations of ChatGPT, it is vital for readers and future researchers who intend to use ChatGPT in medical education to ensure that users discern accurate medical knowledge.

The main contribution of this study lies in proposing a learning approach based on the CIDI model-based ChatGPT system and demonstrating its effectiveness across multiple dimensions. The research findings can serve as a reference for researchers preparing to implement ChatGPT in education and school teachers planning to enhance learners' learning outcomes through the utilization of ChatGPT technology.

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## References

- Ábrahám, Z., Szógyényi, D., Eckert, B., & Németh, S. (2023). Mapping problem-solving competencies and talent management strategies for universities. *Higher Education, Skills and Work-Based Learning*. <https://doi.org/10.1108/HESWBL-03-2022-0063>
- Acquah, E. O., & Katz, H. T. (2020). Digital game-based L2 learning outcomes for primary through high-school learners: A systematic literature review. *Computers & Education*, 143, 103667. <https://doi.org/10.1016/j.compedu.2019.103667>
- Adur, K. (2022). Knowing critical thinking in two stray learning modle. *SocioEdu: Sociological Education*, 3(1), 18-24. <https://doi.org/10.59098/socioedu.v3i1.642>
- Ahmed, S. K. (2023). The impact of ChatGPT on the nursing profession: Revolutionizing patient care and education. *Annals of Biomedical Engineering*. <https://doi.org/10.1007/s10439-023-03262-6>
- Aitchison, C., Harper, R., Mirriahi, N., & Guerin, C. (2020). Tensions for educational developers in the digital university: Developing the person, developing the product. *Higher Education Research & Development*, 39(2), 171-184. <https://doi.org/10.1080/07294360.2019.1663155>

- Akbar, R. A. (2023). Critical thinking as a twenty first century skill. *Journal of Educational Research and Social Sciences Review*, 3(1), 8-15.
- Akinsanya, P. O., & Ojotule, A. O. (2022). Freire's critical pedagogy and professional teaching in the twenty-first century. *UNIZIK Journal of Educational Research and Policy Studies*, 14(3), 145-160.
- Alkhateeb, M. A., & Al-Duwairi, A. M. (2019). The Effect of Using Mobile Applications (GeoGebra and Sketchpad) on the Learners' Achievement. *International Electronic Journal of Mathematics Education*, 14(3), 523-533. <https://doi.org/10.29333/iejme/5754>
- Araiza-Alba, P., Keane, T., Chen, W. S., & Kaufman, J. (2021). Immersive virtual reality as a tool to learn problem-solving skills. *Computers & Education*, 164, 104121. <https://doi.org/10.1016/j.compedu.2020.104121>
- Astrid, A., Amrina, R. D., Desvitasari, D., Fitriani, U., & Shahab, A. (2019). The power of questioning: Teacher's questioning strategies in the EFL classrooms. *Indonesian Research Journal in Education*, 3(1), 91-106. <https://doi.org/10.22437/irje.v3i1.6601>
- Baird, A. M., & Parayitam, S. (2019). Employers' ratings of importance of skills and competencies college graduates need to get hired: Evidence from the new England region of USA. *Education and Training*, 61(5), 622-634. <https://doi.org/10.1108/ET-12-2018-0250>
- Batita, M. S. R., & Wedi, A. (2023). Fully online in-demand skill training: Understanding participant' reason and reaction. *Journal of Technical Education and Training*, 15(2), 106-118. <https://doi.org/10.30880/jtet.2023.15.02.009>
- Bezerra, I. M. P. (2020). State of the art of nursing education and the challenges to use remote technologies in the time of corona virus pandemic. *Journal of Human Growth and Development*, 30(1), 141-147. <http://dx.doi.org/10.7322/jhgd.v30.10087>
- Chang, C. Y., Kuo, S. Y., & Hwang, G. H. (2022). Chatbot-Facilitated Nursing Education: Incorporating a Knowledge-Based Chatbot System into a Nursing Training Program. *Educational Technology & Society*, 25(1), 15-27.
- Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, 8, 75264-75278. <https://doi.org/10.1109/ACCESS.2020.2988510>
- Chen, X., Xie, H., Zou, D., & Hwang, G. J. (2020). Application and theory gaps during the rise of artificial intelligence in education. *Computers and Education: Artificial Intelligence*, 1, 100002. <https://doi.org/10.1016/j.caeai.2020.100002>
- Chen, X., Zou, D., Xie, H., Cheng, G., & Liu, C. (2022). Two decades of artificial intelligence in education. *Educational Technology & Society*, 25(1), 28-47. <https://www.jstor.org/stable/48647028>
- Clark, T. M. (2023). Investigating the use of an artificial intelligence Chatbot with general chemistry exam questions. *Journal of Chemical Education*, 100(5), 1905-1916. <https://doi.org/10.1021/acs.jchemed.3c00027>
- Cooper, G. (2023). Examining science education in ChatGPT: An exploratory study of generative artificial intelligence. *Journal of Science Education and Technology*, 32(3), 444-452. <https://doi.org/10.1007/s10956-023-10039-y>
- Dixson, M. D. (2015). Measuring student engagement in the online course: The online student engagement scale (OSE). *Online Learning*, 19(4), n4. <https://doi.org/10.24059/olj.v19i4.561>
- Donkor, D. R., Ziblim, S. D., Dzantor, E. K., Asumah, M. N., & Abdul-Mumin, A. (2023). Neonatal jaundice management: Knowledge, attitude, and practice among nurses and midwives in the Northern Region, Ghana. *SAGE Open Nursing*, 9, 23779608231187236. <https://doi.org/10.1177/23779608231187236>
- Eysenbach, G. (2023). The role of ChatGPT, generative language models, and artificial intelligence in medical education: A conversation with ChatGPT and a call for papers. *JMIR Medical Education*, 9(1), e46885. <https://doi.org/10.2196/46885>
- Fauzi, F., Tuhuteru, L., Sampe, F., Ausat, A. M. A., & Hatta, H. R. (2023). Analysing the role of ChatGPT in improving student productivity in higher education. *Journal on Education*, 5(4), 14886-14891. <https://doi.org/10.31004/joe.v5i4.2563>
- Friederichs, H., Friederichs, W. J., & März, M. (2023). ChatGPT in medical school: How successful is AI in progress testing? *Medical Education Online*, 28(1), 2220920. <https://doi.org/10.1080/10872981.2023.2220920>

- Gordon, S., Gardner, D., Weston, J., Bolwell, C., Benschop, J., & Parkinson, T. (2021). Fostering the development of professionalism in veterinary learners: Challenges and implications for veterinary professionalism curricula. *Education Sciences, 11*(11), 720. <https://doi.org/10.3390/educsci11110720>
- Gunawan, J. (2023). Exploring the future of nursing: Insights from the ChatGPT model. *Belitung Nursing Journal, 9*(1), 1-5. <https://doi.org/10.33546/bnj.2551>
- Hsu, T. C., Huang, H. L., Hwang, G. J., & Chen, M. S. (2023). Effects of incorporating an expert decision-making mechanism into chatbots on learners' achievement, enjoyment, and anxiety. *Educational Technology & Society, 26*(1), 218-231. <https://www.jstor.org/stable/48707978>
- Hu, W., Li, T., Cao, S., Gu, Y., & Chen, L. (2022). Influence of nurse-led health education on self-management ability, satisfaction, and compliance of elderly patients with chronic obstructive pulmonary disease based on knowledge, belief, and practice model. *Computational and Mathematical Methods in Medicine, 2022*. <https://doi.org/10.1155/2022/1782955>
- Huang, X., & Qiao, C. (2022). Enhancing computational thinking skills through artificial intelligence education at a STEAM high school. *Science & Education*. <https://doi.org/10.1007/s11191-022-00392-6>
- Hwang, G. J., & Chen, C. H. (2017). Influences of an inquiry-based ubiquitous gaming design on learners' learning achievements, motivation, behavioral patterns, and tendency towards critical thinking and problem solving. *British Journal of Educational Technology, 48*(4), 950-971. <https://doi.org/10.1111/bjet.12464>
- Hwang, G. J., & Chen, N. S. (2023). Editorial position paper: Exploring the potential of generative artificial intelligence in education: Applications, challenges, and future research directions. *Educational Technology & Society, 26*(2). [https://doi.org/10.30191/ETS.202304\\_26\(2\).0014](https://doi.org/10.30191/ETS.202304_26(2).0014)
- Hwang, G. J., & Chu, S. T. (2023). Roles and research issues of robots in education: A review of the 2011-2021 publications. *International Journal of Mobile Learning and Organisation, 17*(3), 426-442. <https://doi.org/10.1504/IJMLO.2023.131879>
- Jin, Y., & Zhang, L. J. (2021). The dimensions of foreign language classroom enjoyment and their effect on foreign language achievement. *International Journal of Bilingual Education and Bilingualism, 24*(7), 948-962. <https://doi.org/10.1080/13670050.2018.1526253>
- Khan, R. A., Jawaid, M., Khan, A. R., & Sajjad, M. (2023). ChatGPT-Reshaping medical education and clinical management. *Pakistan Journal of Medical Sciences, 39*(2), 605-607. <https://doi.org/10.12669/pjms.39.2.7653>
- Killian, C. M., Marttinen, R., Howley, D., Sargent, J., & Jones, E. M. (2023). "Knock, knock... who's there?" ChatGPT and artificial intelligence-powered large language models: reflections on potential impacts within health and physical education teacher education. *Journal of Teaching in Physical Education*. <https://doi.org/10.1123/jtpe.2023-0058>
- Kohnke, L. (2023). L2 learners' perceptions of a chatbot as a potential independent language learning tool. *International Journal of Mobile Learning and Organisation, 17*(1-2), 214-226. <https://doi.org/10.1504/IJMLO.2023.128339>
- Kohnke, L. (2022). A qualitative exploration of student perspectives of chatbot use during emergency remote teaching. *International Journal of Mobile Learning and Organisation, 16*(4), 475-488. <https://doi.org/10.1504/IJMLO.2022.125966>
- Kung, T. H., Cheatham, M., Medenilla, A., Sillos, C., De Leon, L., Elepaño, C., Madriaga, M., Aggabao, R., Diaz-Candido, G., Maningo, J., & Tseng, V. (2023). Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models. *PLoS Digital Health, 2*(2), e0000198. <https://doi.org/10.1371/journal.pdig.0000198>
- Leutualy, V., Trisyany, Y., & Nurlaeci, N. (2021). Effectivity of health education with telenursing on the self-care ability of coronary artery disease patients: A systematic review. *Open Access Macedonian Journal of Medical Sciences, 9*(F), 690-698. <https://doi.org/10.3889/oamjms.2021.7619>
- Lin, H. C., Hwang, G. J., & Hsu, Y. D. (2019). Effects of ASQ-based flipped learning on nurse practitioner learners' nursing skills, learning achievement and learning perceptions. *Computers & Education, 139*, 207-221. <https://doi.org/10.1016/j.compedu.2019.05.014>
- Luo, S. (2023). Fostering nursing students' critical thinking and problem solving skills in online discussion forums. *Journal of Nursing Education, 62*(6), 376-376. <https://doi.org/10.3928/01484834-20230208-10>

- Luo, W., He, H., Liu, J., Berson, I. R., Berson, M. J., Zhou, Y., & Li, H. (2023). Aladdin's genie or Pandora's box for early childhood education? Experts chat on the roles, challenges, and developments of ChatGPT. *Early Education and Development*. <https://doi.org/10.1080/10409289.2023.2214181>
- Maneejak, N., & Yasri, P. (2020). The uSAP model: A ubiquitous observation protocol for improving teamwork skills, time management and accuracy in high fidelity simulation among nursing students. *International Journal of Mobile Learning and Organisation*, *14*(4), 478-491. <https://doi.org/10.1504/IJMLO.2020.110784>
- Norman, G. R., & Schmidt, H. G. (1992). The psychological basis of problem-based learning: A review of the evidence. *Academic Medicine*, *67*(9), 557-565.
- Osborn, A. E. (1953). *Applied imagination*, Scribner's. Charles Scribner.
- Puccio, G. J., Murdock, M. C., & Mance, M. (2005). Current developments in creative problem solving for organizations: A focus on thinking skills and styles. *Korean Journal of Thinking and Problem Solving*, *15*(2), 43-76.
- Rahman, M. M. (2019). 21st century skill "problem solving": Defining the concept. *Asian Journal of Interdisciplinary Research*, *2*(1), 64-74. <https://doi.org/10.34256/ajir1917>
- Randhawa, G. K., & Jackson, M. (2020). The role of artificial intelligence in learning and professional development for healthcare professionals. In *Healthcare Management Forum*, *33*(1), 19-24. <https://doi.org/10.1177/0840470419869032>
- Reed, W. M. (2019). Intensity of treatment and its relationship to programming problem solving. In *Educational Computing and Problem Solving*, 119-128. [https://doi.org/10.1300/J025v04n03\\_13](https://doi.org/10.1300/J025v04n03_13)
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivations: Classic definitions and new directions. *Contemporary Educational Psychology*, *25*(1), 54-67. <https://doi.org/10.1006/ceps.1999.1020>
- Sahin, D., & Yilmaz, R. M. (2020). The effect of augmented reality technology on middle school learners' achievements and attitudes towards science education. *Computers & Education*, *144*, 103710. <https://doi.org/10.1016/j.compedu.2019.103710>
- Setyosari, P., Kuswandi, D., & Ulfa, S. (2023). Creative problem solving process instructional design in the context of blended learning in higher education. *Electronic Journal of E-Learning*, *21*(2), 80-97. <https://doi.org/10.34190/ejel.21.2.2653>
- Sharifzadeh, N., Kharrazi, H., Nazari, E., Tabesh, H., Edalati Khodabandeh, M., Heidari, S., & Tara, M. (2020). Health education serious games targeting health care providers, patients, and public health users: Scoping review. *JMIR Serious Games*, *8*(1), e13459. <https://doi.org/10.2196/13459>
- Shi, Z., Zhao, Y., Jin, L., Chen, X., & Huang, J. (2022). Application of hospital-community-family health education to family caregivers of nasal fed patients under the background of a regional medical association. *American Journal of Translational Research*, *14*(12), 8751-8760.
- Sinha, R. K., Roy, A. D., Kumar, N., Mondal, H., & Sinha, R. (2023). Applicability of ChatGPT in assisting to solve higher order problems in pathology. *Cureus*, *15*(2), e35237. <https://doi.org/10.7759/cureus.35237>
- Song, Y., Lee, Y., & Lee, J. (2022). Mediating effects of self-directed learning on the relationship between critical thinking and problem-solving in student nurses attending online classes: A cross-sectional descriptive study. *Nurse Education Today*, *109*, 105227. <https://doi.org/10.1016/j.nedt.2021.105227>
- Strzelecki, A. (2023). To use or not to use ChatGPT in higher education? A study of learners' acceptance and use of technology. *Interactive Learning Environments*. <https://doi.org/10.1080/10494820.2023.2209881>
- Tang, K. Y., Chang, C. Y., & Hwang, G. J. (2021). Trends in artificial intelligence-supported e-learning: A systematic review and co-citation network analysis (1998–2019). *Interactive Learning Environments*, *31*(4), 2134-2152. <https://doi.org/10.1080/10494820.2021.1875001>
- Vacek, J., & Liesveld, J. (2020). Teaching concepts to nursing learners using model case studies, the Venn diagram, and questioning strategies. *Nursing Education Perspectives*, *41*(6), 373-375. <https://doi.org/10.1097/01.NEP.0000000000000514>
- Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, *19*(7), em2286. <https://doi.org/10.29333/ejmste/13272>

- Webb, M. E. (2005). Affordances of ICT in science learning: Implications for an integrated pedagogy. *International Journal of Science Education*, 27(6), 705-735. <https://doi.org/10.1080/09500690500038520>
- Xia, S. (2020). Developing awareness of questioning strategies for second language learner teachers. *Journal of Language Teaching and Research*, 11(6), 853-862. <http://dx.doi.org/10.17507/jltr.1106.01>
- Yan, D. (2023). Impact of ChatGPT on learners in a L2 writing practicum: An exploratory investigation. *Education and Information Technologies*, 28, 13943–13967. <https://doi.org/10.1007/s10639-023-11742-4>
- Zhang, R., Zou, D., & Cheng, G. (2023). A review of chatbot-assisted learning: Pedagogical approaches, implementations, factors leading to effectiveness, theories, and future directions. *Interactive Learning Environments*, 1-29. <https://doi.org/10.1080/10494820.2023.2202704>
- Zhbanova, K. S. (2013). *Comparing sixth grade learners' creativity in word play to spatial construction with integrated academic content eliciting a distal or proximal perspective*. <https://scholarworks.uni.edu/etd/489>