



Performance of ChatGPT on the pharmacist licensing examination in Taiwan

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Abstract

Background: ChatGPT is an artificial intelligence model trained for conversations. ChatGPT has been widely applied in general medical education and cardiology, but its application in pharmacy has been lacking. This study examined the accuracy of ChatGPT on the Taiwanese Pharmacist Licensing Examination and investigated its potential role in pharmacy education.

Methods: ChatGPT was used on the first Taiwanese Pharmacist Licensing Examination in 2023 in Mandarin and English. The questions were entered manually one by one. Graphical questions, chemical formulae, and tables were excluded. Textual questions were scored according to the number of correct answers. Chart question scores were determined by multiplying the number and the correct rate of text questions. This study was conducted from March 5 to March 10, 2023, by using ChatGPT 3.5.

Results: The correct rate of ChatGPT in Chinese and English questions was 54.4% and 56.9% in the first stage, and 53.8% and 67.6% in the second stage. On the Chinese test, only pharmacology and pharmacology sections received passing scores. The English test scores were higher than the Chinese test scores across all subjects and were significantly higher in dispensing pharmacy and clinical pharmacy as well as therapeutics.

Conclusion: ChatGPT 3.5 failed the Taiwanese Pharmacist Licensing Examination. Although it is not able to pass the examination, it can be improved quickly through deep learning. It reminds us that we should not only use multiple-choice questions to assess a pharmacist's ability, but also use more variety of evaluations in the future. Pharmacy education should be changed in line with the examination, and students must be able to use AI technology for self-learning. More importantly, we need to help students develop humanistic qualities and strengthen their ability to interact with patients, so that they can become warm-hearted healthcare professionals.

Keywords: Artificial intelligence; ChatGPT; Educational measurement; Pharmacists; Pharmacy licensure

1. INTRODUCTION

ChatGPT is an artificial intelligence model trained for conversations. The dialog format allows ChatGPT to chat, answer follow-up questions, admit mistakes, challenge incorrect assumptions, and reject inappropriate requests.¹ The program is trained using deep learning algorithms and large amounts of data to respond to users' questions similar to a human through repetitive feedback. The company behind ChatGPT, Open AI, is partnered with Microsoft, which in May 2020 launched powerful

supercomputers to train the GPT-3 model. In September 2020, Microsoft announced that GPT-3 was exclusively licensed to develop and deliver AI solutions.²

Since its release, ChatGPT has sparked discussion and research in medical education circles. Gilson demonstrated that the ChatGPT model can achieve passing scores equivalent to those of a third-year US medical student. Moreover, they emphasized the ability of ChatGPT to be logical and informative in most responses, demonstrating that ChatGPT can be used as an interactive medical education tool to support learning.³ Huh suggested that ChatGPT can answer questions and provide explanations to help students understand complex topics. ChatGPT also provides tutorials and homework help, but knowledge and explanations during parasitology examinations were still inferior to those of Korean medical students. Such problems must be improved through deep learning. Moreover, ChatGPT can be applied to medical education programs.⁴ Fijačko et al used ChatGPT to test its accuracy in answering American Heart Association's Basic Life Support and Advanced Cardiovascular Life Support exam questions and demonstrated that ChatGPT could pass neither examination.⁵ These results were similar to those of Gilson, who used ChatGPT on the United Medical Licensing Examination. Another study revealed that ChatGPT achieved 55.8% accuracy on the multiple-choice Ophthalmic Knowledge Assessment Program exam and 42.7% on two 260-question

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mock examinations. In this experiment, the best performance was recorded in general medicine, and the worst performance levels were on neuro-ophthalmology, ocular pathology, and intraocular tumors.⁶ Sabry et al noted the excellent performance of ChatGPT in answering questions on clinical toxicology, which can provide physicians with assistance in rare cases.⁷ Nisar et al used ChatGPT to test pharmacology textbook questions on pharmacokinetics, mechanisms of action, clinical use, adverse effects, contraindications, and interactions. The results indicated that the accuracy and relevance of ChatGPT answers were sufficient for students to use for self-study, but complex questions required improvement.⁸ As previously mentioned, ChatGPT has been applied in general medical education, cardiology, and ophthalmology, but research on ChatGPT's knowledge of pharmacy topics is lacking. This study tested the accuracy of ChatGPT on the Taiwanese Pharmacist Licensing Examination to evaluate ChatGPT's professional pharmaceutical knowledge. Eventually, an AI model can be developed for pharmaceutical education.

2. METHODS

2.1. Background

Graduates of pharmacy schools in Taiwan must pass the Senior Professional and Technical Examinations for Pharmacists (staged examination) held by the Ministry of Examination and obtain a pharmacist certificate before they can practice. The examination consists of two stages. The first stage comprises three subjects: pharmacology and pharmaceutical chemistry, pharmaceutical analysis and pharmacognosy (including Chinese medicine), and pharmaceutics and biopharmaceutics. Pharmacy students who

have passed those courses can take the first stage of the examination by providing a school certificate. The second stage of the examination comprises three advanced subjects: dispensing pharmacy and clinical pharmacy, therapeutics, and pharmacy administration and pharmacy law. Those who do not pass the first stage of the examination are not allowed to continue to the second stage. After passing the second stage of the examination, students receive a pharmacist certificate from the Ministry of Health and Welfare.

2.2. Data Source

This study used the Taiwanese Senior Professional and Technical Examinations for Pharmacists (staged examination) as the test database. The test questions of the first examination of 2023, which was held on February 11, 2023, were downloaded from the Ministry of Examination website, along with standard answers. The questions were all in Chinese, but drug names, chemical names, and specific nouns were occasionally written in English. A translator translated the Chinese examination questions into English. The English questions were then reviewed by a physician and two pharmacists.

2.3. Study Design

Step 1: The Chinese questions for pharmacology and pharmaceutical chemistry, pharmaceutical analysis and pharmacognosy, and pharmaceutics and biopharmaceutics were manually entered into ChatGPT during the first stage, and those for dispensing pharmacy and clinical pharmacy, therapeutics, and pharmacy administration and pharmacy law were entered during the second stage. Step 2: The English questions of the first and second stages were entered sequentially into ChatGPT (Fig. 1). Each answer was recorded once for each question. Step 3: The

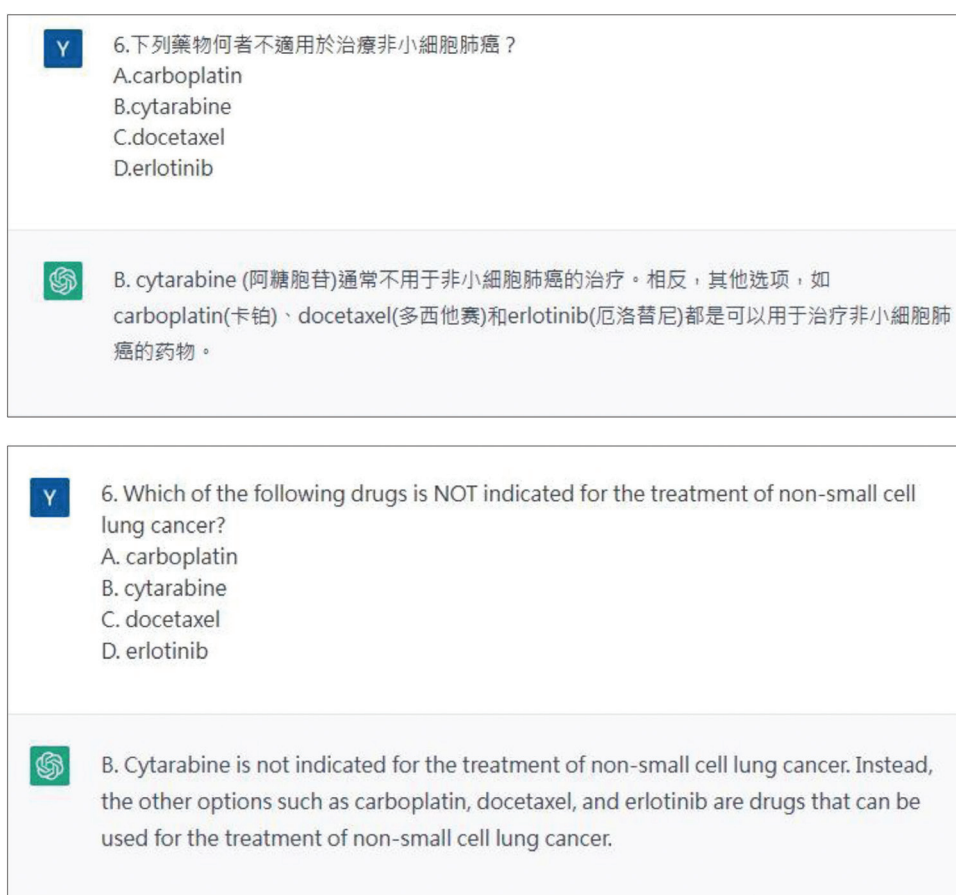


Fig. 1 Template of a question posed in Chinese and in English.

ChatGPT answers were compared with the standard answers, and the scores were calculated. The textual score was calculated by dividing the total number of questions in each section by the score (out of 100 points) and multiplying the answer by the number of correct answers. The chart score was calculated by multiplying the number of correct answers by the total number of chart-type questions in each subject. The average score for each stage was higher than 60 points; a score of 60 points or higher is a passing score for both stages. The model test was conducted from March 5 to 10, 2023, by using ChatGPT 3.5.

2.4. Study Analysis

The relevant data for this study were collected and analyzed as percentages by using Microsoft Excel (Microsoft, Redmond, WA, USA).

3. RESULTS

The first stage of the Senior Professional and Technical Examinations for Pharmacists (staged examination) consisted of three subjects with 80 questions each for a total of 240 questions. The second stage consisted of three subjects with 50 questions on pharmacy administration and pharmacy law and 80 questions on each of the other two subjects for a total of 210 questions. Each question was multiple-choice, that is, one of four possible answers (i.e., A, B, C, or D) was selected.

The results of the module test conducted using ChatGPT are shown in Table 1. The correct rates for the Chinese and English exams were 54.4% and 56.9% in the first stage, and 53.8% and 67.6% in the second stage, respectively. In the first stage of both exams, 12 (15.0%) questions in pharmacology and pharmaceutical chemistry, 9 (11.3%) in pharmaceutical analysis and pharmacognosy, and 16 (20.0%) questions in pharmaceutics and biopharmaceutics were chart questions. The second stage of the examination consisted of 210 questions, all of which were text-based.

Of all the test sections in the first stage of the Chinese examination, ChatGPT only received a passing score (71 points) in pharmacology and pharmaceutical chemistry. ChatGPT scored below 60 points in pharmaceutics and biopharmaceutics and had an average score of 55 points. In the second stage, ChatGPT scored below 60 in three subjects (average score: 54). In the English exam, ChatGPT scored higher in all sections than in the Chinese examination. In the first stage, ChatGPT scored one to three points more than in the equivalent Chinese sections and had an average score increase of two points. In the second stage, ChatGPT's score significantly increased by 17 and 20 points in

dispensing pharmacy and clinical pharmacy and therapeutics, respectively, and increased by four points in pharmacy administration and pharmacy law. In this section, ChatGPT had an average increase of 14 points.

The English test scores for pharmacology and pharmaceutical chemistry were 1.4% higher than the Chinese test scores. Moreover, the English test scores for pharmaceutical analysis and pharmacognosy increased by 5.8%, and 7.3% in pharmaceutics and biopharmaceutics, compared with the Chinese test scores. The English scores were higher than the Chinese test scores for dispensing pharmacy and clinical pharmacy (29.3%), therapeutics (37.0%), and pharmacy administration and pharmacy law (8.0%). Fig. 2 presents the performance of ChatGPT on Chinese and English examinations for each subject. The percentage of answers that are correct both in Chinese and English was highest in pharmacology and pharmacochemistry (58.8%), followed by dispensing pharmacy and clinical pharmacy (55%), therapeutics (50%), pharmaceutical analysis and pharmacognosy (39.4%), pharmacy administration and pharmacy law (38%), and pharmaceutics and biopharmaceutics (29.7%). The percentage of answers that are correct neither in Chinese and English was as followed in pharmaceutics and biopharmaceutics (45.3%), pharmacy administration and pharmacy law (34%), pharmaceutical analysis and pharmacognosy (32.4%), dispensing pharmacy and clinical pharmacy (22.5%), therapeutics (22.5%), and pharmacology and pharmacochemistry (16.2%). The percentage of correct answer only either in Chinese or English was different from 22.5% to 28.2% in six subjects.

4. DISCUSSION

This study involved ChatGPT taking the Senior Professional and Technical Examinations for Pharmacists (staged exam) in 2023. First, we input the original Chinese questions into ChatGPT and recorded the answers. The average score of the three subjects in Stage 1 of the Chinese exam was 55 and the average score of the three subjects in Stage 2 was 54, both of which were close to the passing score but did not pass the examination. Thereafter, we input the English questions and recorded the answers given. The average score of the three subjects in Stage 1 of the English examination was 57, which was not a passing score, but was 4.3% higher than the average score in the Chinese test. The average score of the three subjects in Stage two of the English examination was 68, which was a passing score but 25.3% higher than the average Chinese test score. Therefore, ChatGPT came close to a passing score in the English exam but ultimately failed. For the Chinese test, ChatGPT did not pass Stage 1 or Stage 2. For the English test, ChatGPT did not pass Stage 1 but passed Stage 2. However, according to the examination rules, the second stage of the examination cannot be taken without passing the first stage; thus, ChatGPT did not pass the Taiwanese Pharmacy License Examination.

The study found that the correct answer rates in Chinese and English in the first stage of the test were 54.4% and 56.9%, and 53.8% and 67.6% in the second stage, respectively. The first stage proved more difficult than the second stage, but the first stage must be passed before progression to the second stage. Our results are consistent with those of the first Senior Professional and Technical Examinations for Pharmacists (staged examination) in 2023, in which the passing rate was only 21.3% for the first stage but 80.7% for the second stage.⁹ The correct rates of both stages were similar to those of the US Medical Licensing Examination, which were 45.4%, 54.1%, and 68.0% for steps 1 to 3, respectively.¹⁰ One reason for the different outcomes in stages is that the questions in the first stage are more rudimentary than those in the second stage, and ChatGPT received less training in pharmaceutical analysis and pharmacognosy,

Table 1
Overview of ChatGPT's performance in stage 1 and stage 2 of the pharmacist licensing examination

Subject	Chinese			English	
	No. text questions	No. correct items	%	No. correct items	%
Stage 1					
1-1 Pharmacology & Pharmaceutical Chemistry	68	48	70.6	49	72.1
1-2 Pharmaceutical Analysis & Pharmacognosy	71	37	52.1	39	54.9
1-3 Pharmaceutics & Biopharmaceutics	64	26	40.6	28	43.8
Stage 2					
2-1 Dispensing Pharmacy & Clinical Pharmacy	80	46	57.5	60	75.0
2-2 Therapeutics	80	43	53.8	59	73.8
2-3 Pharmacy Administration & Pharmacy Law	50	25	50.0	27	54.0

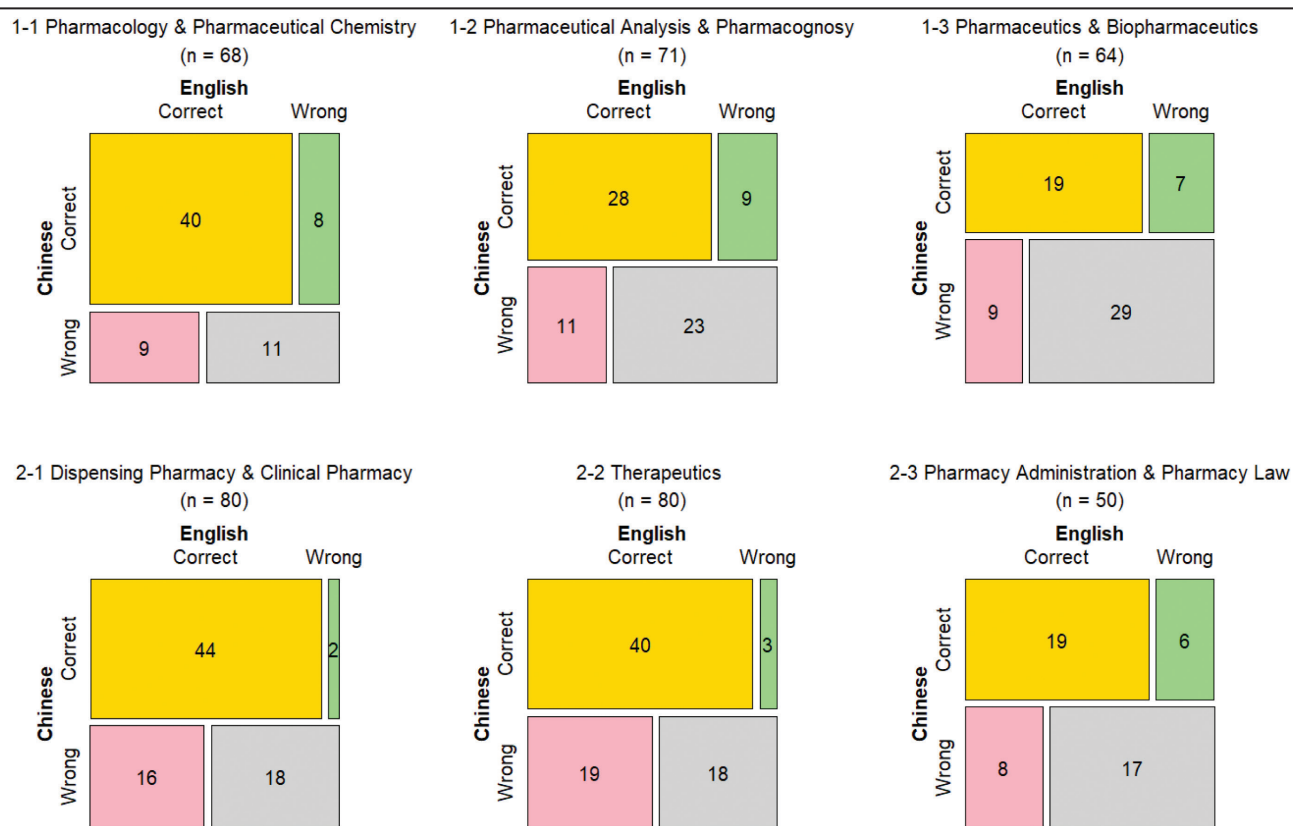


Fig. 2 Performance of ChatGPT on six subjects in both Chinese and English. The yellow part in the upper left corner indicates that both the Chinese and English answers are correct. The gray part in the lower right corner indicates that both the Chinese and English answers are incorrect. The pink area in the bottom left corner indicates that the Chinese answer is incorrect and the English answer is correct. The green section in the upper right corner indicates that the Chinese answer is correct and the English answer is incorrect.

pharmaceutics, and biopharmaceutics than all the other subjects. Subjects in the second stage, namely dispensing pharmacy and clinical pharmacy and therapeutics, are similar to those in doctor examinations and those used in clinical applications. Thus, ChatGPT should undergo more training in such subjects and for higher accuracy.

The first stage of the examination contains some diagram questions that cannot be input into ChatGPT 3.5. Therefore, this study calculated the scores of diagram questions by using the correct rate of text questions for each subject. Of the 80 questions in pharmacology and pharmaceutical chemistry, 12 questions contained chemical structure formulae; we predicted eight correct answers based on a 70.6% correct answer rate for the textual Chinese questions and a 72.1% correct answer rate for the textual English questions. Pharmaceutical analysis and pharmacognosy contained seven questions on chemical structure formulae and two questions on mass spectrometer graphs, and the predicted number of correct answers in Chinese and English was five. Pharmaceutics and biopharmaceutics contained 10 formula symbols and six diagrams, and the correct number of answers predicted in Chinese and English was seven. Because the scores for chart questions were estimated, they varied based on the number of chart questions. Once ChatGPT 4 is publicly available, we can perform the test again to determine the correct answer rate for the chart questions.


The study results revealed that the correct rate of ChatGPT on the English examination was higher than that of the Chinese exam across all subjects, but the difference varied depending on the subject. The English language has less impact on the first

stage of the examination. But it has a significant impact on the subjects in the second stage. In particular, in dispensing pharmacy, clinical pharmacy, and therapeutics, the English language scores were 29.3% and 37.0% higher than the Chinese language scores, respectively. Because those subjects contain a lot of text and descriptions of conditions, the ability to translate and understand the text becomes an important factor that affects whether the answer is correct.


The performance of ChatGPT for each subject was different (Fig. 2). The percentage of answers that are correct both in Chinese and English was higher than incorrect both in Chinese and English in pharmacology and pharmacology (58.8% vs 16.2%), dispensing pharmacy and clinical pharmacy (55.0% vs 22.5%), and therapeutics (50.0% vs 22.5%). These three subjects use the same textbooks in Taiwan and the United States and possess highly relevant clinical information that is available online. In pharmaceutical analysis and pharmacognosy, the questions have some traditional Chinese medicine, which ChatGPT may lack training on. The questions in pharmacy administration and pharmacy law include a large number of Taiwanese laws, which cannot be answered correctly either in Chinese or English. For pharmaceutics and biopharmaceutics, the questions were almost from the *Chinese Pharmacopoeia* and biopharmaceutical formulae. Although ChatGPT provides logical reasoning and calculating for its answers, the final answers were still incorrect.

For dispensing pharmacy and clinical pharmacy, 20% questions were incorrect in Chinese but correct in English. For therapeutics, 23.8% questions were incorrect in Chinese but correct in English. Therefore, ChatGPT's understanding of English


Y 73. 王小姐31歲，剛生完小孩；近日常頭暈虛弱，其Hgb 7.6 g/dL、Hct 25%、MCV 75 μm^3 、MCH 20 pg、serum iron 40 $\mu\text{g}/\text{dL}$ 、serum ferritin 9 $\mu\text{g}/\text{mL}$ ，依序回答下列三題。
王小姐她可能有下列何種類型貧血？
A. macrocytic and hypochromic anemia
B. microcytic and hyperchromic anemia
C. microcytic and hypochromic anemia
D. macrocytic and hyperchromic anemia

 根據題目描述，王小姐的 Hgb 和 Hct 均低於正常值，MCV 和 MCH 均低於正常值，而血清鐵和血清 ferritin 均偏低，因此她可能有下列何種類型貧血？
C. microcytic and hypochromic anemia

Y 73. Ms. Wang is 31 years old, just had a baby; recently, she has daily dizziness and weakness, her Hgb 7.6 g/dL, Hct 25%, MCV 75 μm^3 , MCH 20 pg, serum iron 40 $\mu\text{g}/\text{dL}$ 、serum ferritin 9 $\mu\text{g}/\text{mL}$. Answer the following three questions in order.
Ms. Wang may have which of the following types of anemia?
A. macrocytic and hypochromic anemia
B. microcytic and hyperchromic anemia
C. microcytic and hypochromic anemia.
D. macrocytic and hyperchromic anemia

 C. microcytic and hypochromic anemia.

Y 74. 若醫師決定處方鐵劑，下列何者最適宜？
A. ferrous sulfate
B. ferric sulfate
C. carbonyl iron
D. iron dextran

 A. ferrous sulfate

Y 74. If a physician decides to prescribe iron, which of the following is most appropriate?
A. ferrous sulfate
B. ferric sulfate
C. carbonyl iron
D. iron dextran


 A. ferrous sulfate is the most appropriate iron supplement as it is readily absorbed by the body and has a high bioavailability. Ferric sulfate is less absorbed and is more likely to cause gastrointestinal side effects. Carbonyl iron is a pure form of iron and is well tolerated but is less commonly used due to its high cost. Iron dextran is usually reserved for patients who cannot tolerate oral iron supplements or those with severe iron deficiency anemia.

Fig. 3 Template of a question posed in Chinese and in English.

questions was superior to that of Chinese questions. Further analysis of the questions that were incorrect in Chinese but correct in English revealed that these were questions with a mix of Chinese and English words, and most of the questions were answered correctly after translation into English.

ChatGPT 3.5 has performed well on multiple-choice questions (Fig. 1) and has logical judgment on series situation case questions with adequate explanations for options (Fig. 3). Therefore, ChatGPT has been used to take various exams, including the MBA examination,¹¹ law school examination,¹² and the United

States Medical Licensing Examination (USMLE),^{3,10} with each examination's scores have exceeded the passing line. Now that the GPT can correctly answer memorized questions and has the ability to integrate and make judgments, it can be used in pharmacy education as well as medical education. This includes explaining complex topics, using it as an interactive teaching tool, and helping to practice patients' drug counseling skills.¹³

This study has some limitations. First, we assumed that we were applying ChatGPT to the Taiwanese Pharmacist Licensing Examination for the first time, but this cannot be verified. Second, the English questions were translated into Chinese by using translation software and then reviewed by a doctor and pharmacists before the test; therefore, translation errors may have persisted. Finally, the Pharmacist Licensing Examination contains questions with pictures, such as chemical structure which ChatGPT cannot identify.¹⁴ Consequently, we only predicted the correct rate for the graphical questions by using the correct rate of the textual questions rather than the actual answers.

In this study, ChatGPT 3.5 was tested on Chinese and English versions of the Taiwanese Pharmacist Licensing Examination. The results revealed that ChatGPT 3.5 could not pass the pharmacist exam. Although ChatGPT 3.5 is not yet able to pass the pharmacist examination, it can be improved quickly through deep learning. While GPT can pass the exam perfectly, it reminds us that in the future, we should not only use multiple-choice questions to assess a pharmacist's ability but also use more variety of evaluations. Pharmacy education must also change along with the examination, and students must be able to use AI technology to self-learning. More importantly, we have to help the students to develop humanistic qualities and strengthen the ability to interact and communicate with patients, so that they can become warm-hearted healthcare professionals.¹⁵

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