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Research Article

PROMOTING TEACHERS' USE OF CHATGPT: A CASE STUDY ON GENERATING REAL-WORLD PROBLEMS IN 10TH GRADE ALGEBRA INSTRUCTION

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ABSTRACT

The application of AI, particularly ChatGPT, is being extensively studied in education to generate new content, support personalized learning, and facilitate self-directed study. This study aimed to promote teachers' use of ChatGPT to generate real-world mathematical problems by engaging them in a guided process of training the chatbot using structured prompts and examples drawn from a 10th-grade algebra textbook. Participating teachers explored ChatGPT's capabilities across different algebra topics and discussed its effectiveness in generating authentic problem contexts. Over a five-week intervention with 33 mathematics teachers, results indicated statistically significant improvements in key factors of technology acceptance and ChatGPT adoption, based on the Technology Acceptance Model (TAM). Despite limitations related to sample size and context, teachers generally found ChatGPT-generated problems acceptable, demonstrated initial proficiency in training the tool for educational use, and expressed intentions to integrate ChatGPT into future teaching practices.

Keywords: 10th-grade algebra; ChatGPT; real-world math problems; teacher training

1. Introduction

1.1. ChatGPT and Teachers

Since OpenAI launched ChatGPT in November 2022, the research and application of generative AI have rapidly expanded, setting new trends in education. Generative AI predicts and generates data sequences based on inputs, performing various tasks related to language and creative content (Walczak & Cellary, 2023). ChatGPT has quickly become a revolutionary education tool, enabling personalized learning experiences and supporting teachers in daily tasks (Javaid et al., 2023). It assists in creating assessments, evaluating

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student performance, and providing personalized feedback, saving time and allowing teachers to focus on specialized teaching activities (Chaudhry & Kazim, 2021). Beyond answering questions, ChatGPT may also help teachers design math lesson plans aligned with competency-based education as outlined in the 2018 Education Program (Tang et al., 2024).

Despite its potential, AI (particularly ChatGPT) also presents several challenges and concerns in education. One primary concern is the potential for over-reliance on AI, which could compromise academic integrity. Students might depend too heavily on AI tools to complete assignments, leading to reduced analytical thinking and creativity (Chaudhry et al., 2023). Moreover, AI's ability to generate inaccurate information raises concerns about the reliability of the content accessed by students (Lo, 2023).

1.2. Real-World Problems

A key feature of the 2018 Mathematics Curriculum is its emphasis on students' ability to apply knowledge to real-world scenarios or interdisciplinary subjects (Ministry of Education and Training – MOET, 2018). Various terms, such as real-world problems, authentic tasks, applied problems, and contextualized scenarios, have been used to describe problems that integrate real-life elements (MOET, 2018; Ta, 2020). However, no standardized criteria exist for classifying a problem as a real-world problem.

Ta (2020) employs both the terms authentic tasks and real-world problems to refer to problems that require solutions through mathematical modeling. Authentic tasks are defined as tasks that occur in real life, have the potential to occur, or simulate real-world situations. According to Vu and Do (2021), real-world problems involve content related to real-life contexts, encompassing phenomena that exist and occur in nature and society, as well as those connected to human life. Instructional materials classify problems into three categories based on increasing levels of real-world relevance: word problems, standard applications, and modelling problems (Blum et al., 2007). Among these, word problems are understood as mathematical problems that incorporate real-life elements.

In this study, a real-world problem is defined as a word problem that describes an actual or possible real-life situation or a simulated scenario in daily life, science, economics, or finance (MOET, 2018). Teaching real-world problems under the 2018 Curriculum poses challenges due to limited reference materials and the interdisciplinary knowledge required to create relevant examples (Vu & Nguyen, 2023). Researchers suggest using technology to support teaching real-world problems. ChatGPT has been found to understand and solve various mathematical problems, including real-world problems, albeit with occasional errors (Dao & Le, 2023; Nguyen et al., 2024). ChatGPT can generate real-world problems in linear systems (Zong & Krishnamachari, 2023) and simplify problem statements for better readability (Patel et al., 2023).

1.3. Teachers' Perceptions

Teachers' perceptions play a crucial role in determining the effectiveness of AI integration in education. Akgun and Greenhow (2021) note that many teachers lack

sufficient AI integration skills, leading to ineffective implementation. This skill gap may widen the digital divide between teachers and students, negatively impacting technology adoption in education (Kohnke et al., 2023). To address this, teachers must be equipped with digital literacy skills for effective AI integration.

Teachers' perceptions within the framework of the Technology Acceptance Model (TAM) (Davis et al., 1992; Venkatesh & Bala, 2008) include Perceived Enjoyment (PE), Perceived Usefulness (PU), Perceived Ease of Use (PEU), and Behavioral Intention (BI). PE measures the extent to which the use of technology is enjoyable in and of itself, regardless of performance outcomes; PU assesses an individual's belief that using a system will enhance job performance; PEU evaluates the extent to which a person believes that using technology requires minimal effort; and BI represents an individual's willingness to use technology when given the option. Previous studies have examined the influence of PE, PU, and PEU on BI. However, this study does not investigate these causal relationships, but instead employs these factors as measurement scales to evaluate the effectiveness of teacher training in using ChatGPT for generating real-world math problems.

1.4. Research Objectives

This study aims to encourage teachers to use ChatGPT effectively by training the AI and discussing the real-world problems it generates. The impact is evaluated quantitatively using TAM factors (PE, PU, PEU, and BI) and qualitatively through teachers' feedback on the accuracy and relevance of ChatGPT-generated problems.

2. Research design

In this study, teachers followed a two-stage process to train and utilize ChatGPT:

Stage 1: Teachers used prompts to train ChatGPT to solve real-world problems in the Algebra section of the *10th-grade Mathematics* textbook from the *Chan Troi Sang Tao* series, which is widely used in Ho Chi Minh City.

Stage 2: Teachers used prompts to instruct ChatGPT to generate real-world problems, discuss these problems, and request improvements from the AI.

2.1. The Process of Training and Utilizing ChatGPT to Solve and Generate Real-World Problems

The training and utilizing ChatGPT to solve and generate real-world problems, as adapted from Nguyen and Le (2024), was introduced to teachers to influence their perceptions of ChatGPT (see Appendix 1). This process required teachers to prepare real-world problems from textbooks. In this study, real-world problems were selected from the Algebra section of the *10th-grade Mathematics* textbook (*Chan troi sang tao* series) and categorized into six topics, as shown in Table 1.

The selected problems, called input problems, were rewritten in a format suitable for input into ChatGPT's chatbox and supplied to participants for use during the experiment.

Table 1. *Topics in the textbook*

Topic	Code
Sets	S1
Linear inequations and Systems of linear inequations	S2
Functions and Graphs	S3
Quadratic inequations	S4
Addition rules and Multiplication rules	S5
Permutations, Arrangements, and Combinations	S6

Participants used this process to train and utilize ChatGPT to solve and generate real-world problems that matched the content of the six topics listed above. In addition to guiding teachers on how to use ChatGPT as a problem-solving and problem-generating tool, teachers were required to verify all of ChatGPT's responses. The process specified that ChatGPT's responses must be correct or appropriate before moving to the next step.

2.2. Research questions

Two research questions were formulated to achieve the study's objectives:

RQ1: Do teachers' perceptions of using ChatGPT improve after the intervention?

RQ2: How do teachers evaluate ChatGPT's ability to solve and generate real-world problems?

To address RQ1, a quantitative research method was employed. Data on teachers' perceptions were collected, focusing on the four factors PE, PU, PEU, and BI of the Technology Acceptance Model. To answer RQ2, a qualitative research method was used. Teachers' feedback was gathered throughout their engagement with the ChatGPT-based process

2.3. Participants

The study was conducted with 33 mathematics teachers over 5 weeks, from November 9 to December 8, 2024. These teachers were graduate students at the Ho Chi Minh City University of Education. A pre-experiment survey revealed that 32 out of 33 participants had previously used ChatGPT and were aware that it is an AI-based tool. Their primary purposes for using ChatGPT included supporting their studies, preparing lesson plans, solving math problems, searching for information, and answering various questions. They also expected that ChatGPT could further support math teaching and provide more accurate responses.

During the experiment, participants registered for and used the free version of ChatGPT-4o. When they exhausted the daily usage limit, they had to wait for it to reset before continuing.

2.4. Data collection instruments

2.4.1. Measuring the factors of the TAM Model

Pramana's (2018) research provided items to measure factors influencing technology acceptance among teachers. We adapted these items to assess perceptions related to ChatGPT, focusing on the four TAM factors: PE, PU, PEU, and BI. Each factor was measured using a 5-point Likert scale, where: 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree, and 5 = Strongly Agree. Each factor contained four items, as shown in Table 2.

Table 2. *Questionnaire for PreTest and PostTest*

Factors	Items
Perceived Enjoyment (PE)	PE1 ChatGPT makes me feel good
	PE2 ChatGPT is interesting
	PE3 I have fun using ChatGPT
	PE4 Using ChatGPT is enjoyable
Perceived Usefulness (PU)	PU1 I find ChatGPT useful in my learning
	PU2 Using ChatGPT enables me to accomplish learning activities more quickly
	PU3 Using ChatGPT increases my learning productivity
	PU4 If I use ChatGPT, I increase my chances of getting a better grade
Perceived Ease of Use (PEU)	PEU1 My interaction with ChatGPT is clear and understandable
	PEU2 It is easy for me to become skillful at using ChatGPT
	PEU3 I find ChatGPT easy to use
	PEU4 Using ChatGPT is easy for me
Behavioral Intention (BI)	BI1 If ChatGPT is available to me in the future, I would like to use it
	BI2 Whenever I have the opportunity, I will use ChatGPT
	BI3 If possible, I plan to use ChatGPT in the future
	BI4 I would like to use ChatGPT again in the future

The questionnaire included participants' names and was administered twice: before introducing the ChatGPT training and utilizing process (PreTest) and immediately after completing the experiment (PostTest). This paired-sample design allowed us to assess changes in perceptions after the intervention.

2.4.2. Teachers' opinions on the effectiveness of ChatGPT

To address RQ2, we collected teachers' qualitative feedback immediately after they used ChatGPT to generate real-world problems in each topic. Participants responded to eight questions per topic, including structured and open-ended items.

The structured questions consist of two parts. In Part 1 (Q1 and Q2), teachers were asked to assign a score from 1 to 5, corresponding to their evaluation of the effectiveness of the products generated by ChatGPT, ranging from "very poor" to "very good." Part 2 (Q3, Q4, Q5, and Q6) requires teachers to rate their level of agreement with the appropriateness of the products created by ChatGPT, ranging from "strongly disagree" to "strongly agree."

Q1) How do you rate ChatGPT's ability to solve real-world problems in this topic?

Q2) How do you rate ChatGPT's ability to generate real-world problems in this topic?

Q3) The real-world problems and solutions generated by ChatGPT align with the topic.

Q4) The context (i.e., real-life situations, other scientific disciplines, economics–finance) of the practical problems generated by ChatGPT in this topic is appropriate (i.e., age-appropriate, ethically sound, non-discriminatory, free from sensitive content).

Q5) The practical problem generated by ChatGPT in this topic can be used for my teaching.

Q6) I intend to use ChatGPT to create additional practical problems.

Questions 7 and 8 are unstructured.

Q7) Please indicate whether the context of the practical problems generated by ChatGPT differs from the context of problems in the textbook. If yes, what is the context?

Q8) What improvements would you like to see in ChatGPT?

In addition, the participants also sent the research team the conversation transcripts between themselves and ChatGPT.

3. Results and discussion

3.1. Quantitative result

To address RQ1, we analyzed data from the PreTest and PostTest surveys using SPSS. The scores for Perceived Enjoyment (PE), Perceived Usefulness (PU), Perceived Ease of Use (PEU), and Behavioral Intention (BI) were calculated as the mean of responses to the respective items for each participant. Table 3 presents the mean and standard deviation for these four factors across 33 participants before and after the intervention. Notably, the mean scores for all factors were higher in the PostTest compared to the PreTest.

Table 3. *Descriptive statistics data*

PreTest	Mean	Standard Deviation	PostTest	Mean	Standard Deviation
PE	3.71	0.580	PE	4.36	0.552
PU	3.86	0.600	PU	4.40	0.583
PEU	3.51	0.498	PEU	4.03	0.621
BI	4.15	0.593	BI	4.41	0.569

The data indicate that all factors of the TAM model improved following the experiment.

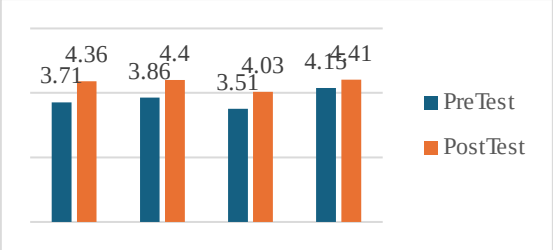

Figure 1. *Means of PreTest and PostTest*

The data distribution was then examined using the Shapiro-Wilk test in SPSS. The significance levels are shown in Table 4.

Table 4. *Shapiro-Wilk test*

PreTest	Sig.	PostTest	Sig.
PE	0.329	PE	0.004
PU	0.76	PU	0.001
PEU	0.331	PEU	0.064
BI	0.30	BI	0.001

For PEU, both PreTest and PostTest data met the normality assumption ($p > 0.05$), justifying the use of the paired t-test. Conversely, PE, PU, and BI did not meet the normality assumption ($p < 0.05$) for the PostTest. Thus, the Wilcoxon signed-rank test was employed for these factors.

Table 5 summarizes the statistical test results. All factors showed significance levels below 0.05, indicating statistically significant improvements. Given that the PostTest means were higher than the PreTest means, it can be concluded that the ChatGPT training and the utilization process influenced PE, PU, PEU, and BI among the teachers.

Table 5. *Statistical test results*

Factors	Significance level (2-tailed)	Test
PE	0.001	Wilcoxon signed-rank test
PU	0.001	Wilcoxon signed-rank test
PEU	0.001	Paired T-test
BI	0.016	Wilcoxon signed-rank test

3.2. Qualitative result

Table 6 provides the average ratings for participants' responses to questions Q1 through Q6 across six topics.

Table 6. *Average ratings of teachers*

Question	S1	S2	S3	S4	S5	S6
Q1	4.5	2.9	3.6	4.0	4.5	4.6
Q2	4.0	3.6	3.8	3.8	4.4	4.5
Q3	4.7	3.8	4.0	4.3	4.6	4.6
Q4	4.4	4.1	4.2	4.5	4.6	4.6
Q5	4.4	3.6	3.8	4.0	4.3	4.4
Q6	4.5	3.5	3.8	4.0	4.3	4.4

The chart in Figure 2 facilitates a comparison.

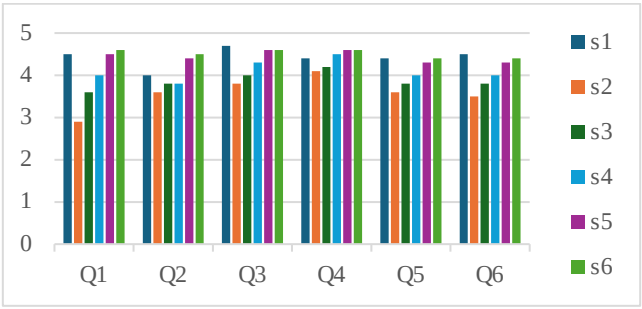

Figure 2. *Teachers' ratings across different topics*

We examined the responses to Q1 regarding ChatGPT's capability to solve real-world problems. The results indicated that participants highly rated ChatGPT's ability to solve real-world problems in S1, S5, and S6. This aligns with their classroom reports, where input problems in these topics were solved correctly without the need to use Prompt 2 (Appendix 1) to correct errors in ChatGPT's solutions. The problem-solving capability in S3 and S4 was rated lower. During classroom presentations, teachers encountered incorrect solutions for the same problem. ChatGPT's problem-solving capability in S2 received the lowest ratings. Participants reported that ChatGPT struggled with problems involving complex systems of inequalities. Another reason cited was the limited usage quota of ChatGPT for generating solutions that include graphical representations of solution sets for systems of inequalities. Teachers had restricted access to GPT-4o, hindering their ability to effectively guide the AI to provide accurate and consistent solutions.

Based on the responses to Q2, participants highly appreciated ChatGPT's capability to generate real-world problems in topics S5 and S6. Its performance in the remaining four topics was less favorable. Teachers reported that ChatGPT merely altered numerical values from the input problems without creating new problems with real-world contexts as they had expected.

Regarding teachers' evaluations of the generated real-world problems, two key criteria were considered: whether the problem content and solutions were appropriate to the topic, and whether the problem context was suitable for students (Nguyen & Le, 2024). Responses to Q3 and Q4 indicated a high level of agreement among teachers that the generated

problems and solutions were aligned with the intended topics and that the problem contexts were appropriate for students.

Responses to Q5 showed that teachers strongly agreed that real-world problems generated by ChatGPT in S1, S5, and S6 could be effectively used in their teaching. The level of agreement was lower for problems in the other three topics. Additionally, responses to Q6 were nearly consistent with those for Q5, suggesting that teachers using ChatGPT-generated problems are likely to continue utilizing this AI tool to create additional real-world problems.

Table 7 presents the number of participants who responded 'yes' to Q7 and summarizes the new contexts in real-world problems generated by ChatGPT as reported by the users.

Table 7. *The new contexts of problems* generated *by ChatGPT*

Subject	Number of yes responses	New context
S1	5	Life
S2	12	Life, Economics, Science fiction
S3	8	Life
S4	6	Economics, Physics
S5	8	Life, Science fiction
S6	14	Life, Film-related context

In general, the number of teachers who identified problems with new contexts was relatively low. Among these problems, some were automatically generated by ChatGPT when users applied Prompt 5 (Appendix 1), while others resulted from teachers flexibly using Prompt 6 to guide ChatGPT in creating problems with desired contexts. The contexts requested and effectively generated include science fiction scenarios (Figure 3) and film-related settings (Figure 4).

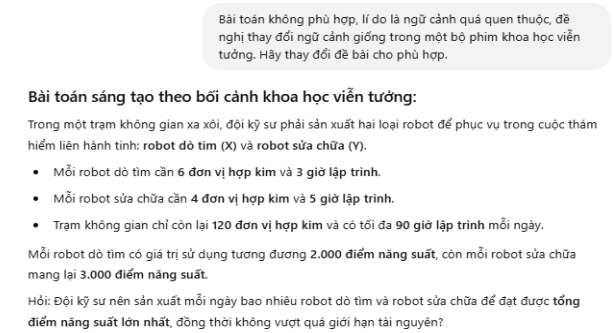

Figure 3. *Real-world problem with a science fiction context in Topic S1*

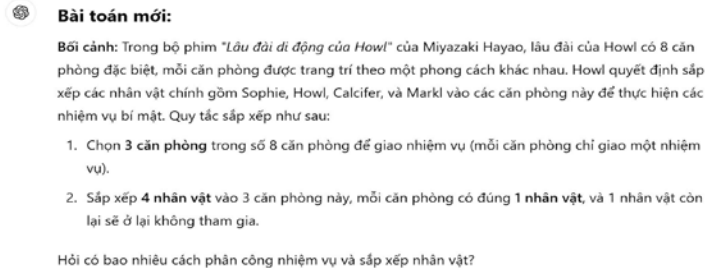

Figure 4. *Real-world problem with a film-related context in Topic S6*

Across all topics, the need for ChatGPT to create new problems with diverse, student-friendly contexts was frequently highlighted (Table 8 for Q8). This suggests that, beyond ensuring content and context alignment with student needs, teachers expect ChatGPT to exhibit greater creativity to help them develop engaging real-world problems. They also emphasized the need for more randomized data in problems, rather than relying on simple or rounded numbers. Additionally, teachers expressed the need for improvements in ChatGPT's problem-solving capabilities, particularly in topics S2, S3, and S4.

Table 8. *Teachers' suggestions for ChatGPT improvements*

Subject	Teachers' feedback
S1	Create more diverse contexts; generate more varied data; faster response time with more human-like presentation and fewer steps
S2	Develop problems closer to students' experiences with more variety; improve accuracy in solving input problems; learn from errors to enhance future problem-solving; increase usage limits and reduce recovery wait times.
S3	Generate more diverse problems; improve accuracy in solving input problems
S4	Create diverse contexts suitable for students; establish sufficient inequalities for accurate problem-solving
S5	Develop problems with diverse, student-friendly contexts
S6	Generate problems with diverse, student-relevant contexts; no further improvements are needed

4. Conclusions and recommendations

The study demonstrates that the process of training and utilizing ChatGPT to solve and generate real-world problems has had a positive impact on mathematics teachers' perceptions, as evidenced by significant increases in the factors of Perceived Enjoyment, Perceived Usefulness, Perceived Ease of Use, and Behavioral Intention within the Technology Acceptance Model. Teachers highly appreciate ChatGPT's capability to support the creation of real-world problems aligned with instructional content; however, they also desire improvements in accuracy, diversity, and relevance to real-world contexts.

This highlights the potential of AI applications in supporting mathematics instruction, though it emphasizes the need for teacher oversight and guidance to ensure effectiveness. Consequently, it is essential to enhance teacher training in integrating AI into teaching practices while developing improved AI versions that better meet educators' needs. Additionally, expanding research to other subjects and conducting experiments with more diverse participant groups will contribute to increasing the practical value of AI applications in education.

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THÚC ĐẨY GIÁO VIÊN SỬ DỤNG CHATGPT: TRƯỜNG HỢP TẠO RA CÁC BÀI TOÁN THỰC TIỄN TRONG DẠY HỌC CHỦ ĐỀ ĐẠI SỐ LỚP 10

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TÓM TẮT

Ứng dụng AI, đặc biệt là ChatGPT, đang được nghiên cứu rộng rãi trong giáo dục nhằm tạo nội dung mới, hỗ trợ học tập cá nhân hóa và tự học. Với mục tiêu thúc đẩy giáo viên sử dụng ChatGPT tạo ra các bài toán thực tiễn, chúng tôi đã hướng dẫn giáo viên thực hiện quy trình huấn luyện ChatGPT dựa trên các prompt và các bài toán thực tiễn trong một quyển sách giáo khoa Đại số lớp 10. Sau đó, giáo viên sẽ dùng các prompt để tạo ra và cải thiện các bài toán thực tiễn kèm lời giải theo từng chủ đề đại số. Việc thảo luận về hiệu quả của ChatGPT trong từng chủ đề nhằm giúp giáo viên cải thiện việc sử dụng ChatGPT cho mục tiêu tạo ra các bài toán thực tiễn. Kết quả nghiên cứu trên 33 giáo viên Toán trong 5 tuần cho thấy các yếu tố ảnh hưởng đến sự chấp nhận công nghệ mới và sự chấp nhận ChatGPT của giáo viên theo mô hình Technology Acceptance Model đều tăng và có ý nghĩa thống kê. Tuy còn hạn chế nhất định trên mẫu đã lựa chọn, nhưng nhìn chung giáo viên đồng ý ở mức cao với các bài toán do ChatGPT tạo ra và bước đầu biết cách huấn luyện Chatbot này phù hợp với hoạt động dạy học. Họ cũng cho thấy dự định sẽ dùng ChatGPT trong tương lai.

Từ khoá: Đại số lớp 10; bài toán thực tiễn; ChatGPT; đào tạo giáo viên

APPENDIX

We introduced a two-stage process to teachers, each stage has different prompts to use ChatGPT.

Stage 1: Training ChatGPT to solve real-world problems

Teachers use the process in Figure 5 with the prompts presented in Table 9 to instruct ChatGPT to solve real-world problems, referred to as input problems.

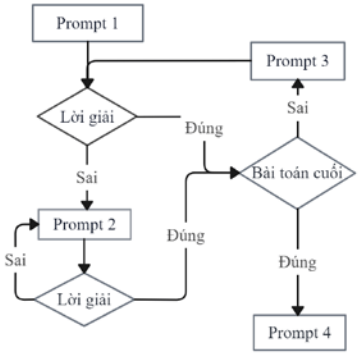

Figure 5. *Stage 1*

Table 9. *Prompts for stage 1*

Prompt	Structure
Prompt 1	Tôi là giáo viên dạy toán lớp [khối lớp đang dạy] đang soạn bài [tên chủ đề]. Sau đây là bài toán thực tiễn trong sách giáo khoa. Hãy giải bài toán sau bằng cách phù hợp với bài học. [Đề bài, hình vẽ (nếu có)]
Prompt 2	Đáp án đúng là [đáp án], lời giải bị sai [lỗi sai]. Hãy giải lại bài toán cho đúng.
Prompt 3	Lời giải trên đã đúng. Hãy tiếp tục giải bài toán sau. [Đề bài, hình vẽ (nếu có)]
Prompt 4	Tất cả các bài toán đã giải đúng. Hãy ghi nhớ để hỗ trợ tôi tạo ra các bài toán mới trong tương lai.

Ghi chú: Nội dung trong ngoặc vuông […] thay đổi do giáo viên nhập

Stage 2: Training ChatGPT to generate real-world problems

After training ChatGPT to solve the input problems, teachers use the process in Figure 6 with the prompts presented in Table 10 to instruct ChatGPT to generate new math real-world problems.

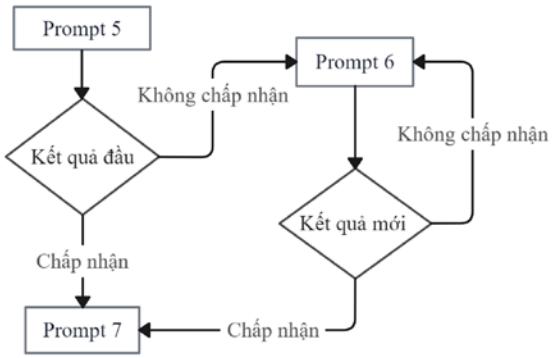

Figure 6. *Stage 2*

Table 10. *Prompts for stage 2*

Prompt	Structure
Prompt 5	Tôi là giáo viên dạy toán lớp [nhập khối lớp đang dạy] đang soạn bài [tên chủ đề]. Dựa vào những bài toán thực tiễn đã giải đúng phía trên, hãy tạo ra một bài toán thực tiễn phù hợp với nội dung bài học [tuỳ chọn: bằng cách thay thế số liệu trong bài toán gốc]. Tạo lời giải đi kèm với bài toán để tôi kiểm tra lại.
Prompt 6	Bài toán không phù hợp, [nêu lí do, đề nghị thay đổi]. Hãy thay đổi đề bài cho phù hợp.
Prompt 7	Tôi sử dụng bài toán này.