

# Exploring the Roles of ChatGPT in Probability Education

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**Abstract:** Probability is a fundamental yet challenging topic in mathematics, often misunderstood due to its abstract and random nature. This paper examines the roles of ChatGPT as a supportive tool in probability education from both teacher and student perspectives. We analyzed responses, conducted in temporary chat mode using the GPT-4o mini model, to 27 text-based prompts based on 7 common educational tasks to explore how ChatGPT responds to these prompts. For teaching tasks, ChatGPT can assist with lesson planning, concept explanation, question generation and basic simulation in the probability classroom. For learning tasks, it offers opportunities for personalized learning, simulation exploration, and multilingual support. We also discuss limitations, common errors and future directions for effectively integrating AI into probability education.

**Keywords:** probability education, ChatGPT, AI in education, teaching tools

## Introduction

Probability literacy is an essential skill for decision-making in everyday life. Although it is often confused with statistical literacy, the two are distinct. People begin to develop an understanding of probability through early encounters with randomness such as tossing a coin and continue to encounter probabilistic ideas in the classroom, news media and real-world scenarios. These include evaluating the chances of winning a lottery, interpreting health risks or making decisions about finance and the environmental situation (Iddo, 2005).

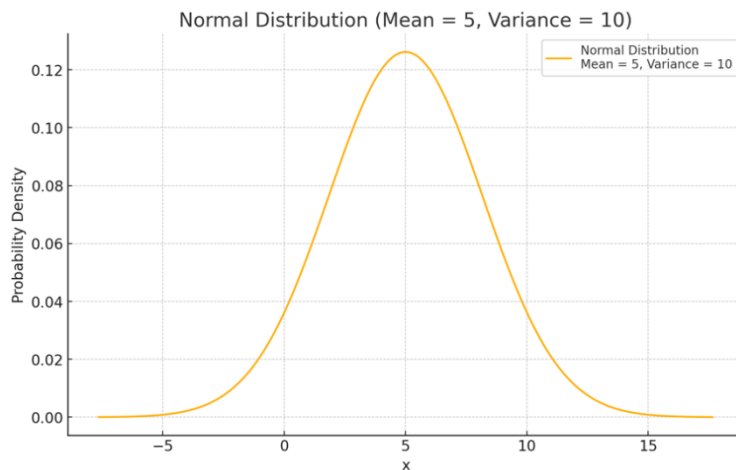
Teaching probability involves more complicated skills due to the random nature. Teachers deal with several obstacles when teaching probability including:

1. The random nature of probabilistic concepts makes them more difficult for students to understand compared to deterministic ideas in other areas of mathematics.
2. There are multiple approaches to define probability (e.g., classical, frequentist, mathematical), some of which rely on different levels of mathematical ideas that may not be immediately intuitive to students.
3. The effective use of technological tools is essential but can be difficult for teachers without sufficient training or resources.
4. The use of the descriptive phrases (e.g. “1 in 100 people is affected by a newly emerging disease”). This can be challenging for non-English speakers. Different languages may affect how probabilistic expressions are understood, creating language barriers for learners when interpreting such information.

In the rising era of generative AI tools, particularly OpenAI’s ChatGPT, educators are exploring their potential to support education (Kim & Adlof, 2024). Recent studies highlight ChatGPT’s promise in helping students develop conceptual understanding of mathematical topics (Fardian et al., 2025; Rane, 2023; Wardat et al., 2023).

In the context of probability classroom, both teachers and students can use AI tools to support their teaching and learning experiences. For example, ChatGPT can create a plot of

a normal distribution function using just the user prompt, as illustrated in Figure 1. This represents one of the many ways AI can be used to facilitate teaching and learning in probability education.



**Figure 1.** Normal distribution function generated by ChatGPT

Despite the growing use of artificial intelligence in education, its role in supporting the teaching and learning of probability remains underexplored. Traditional instruction often relies on static examples or pre-designed simulations, which may not fully address individual learning needs or language-related barriers.

The aim of this study is to provide some initial response to the above question. We present a study to explore issues such as:

1. how ChatGPT can assist teachers in lesson planning, explaining probabilistic concepts and conducting formative assessments;
2. how ChatGPT can support students in understanding probability through guided exploration, personalized learning pathways and multilingual interaction.

By examining these issues through representative educational tasks, we aim to explore the potentials and limitations of using ChatGPT in probability education from both teaching and learning perspectives.

## Literature Review

This section reviews key ideas related to teaching and learning probability including cognitive challenges, curricular contents and modern technological tools.

### *Cognitive Challenges in Learning Probability*

Some students misinterpret random events by relying on intuition rather than formal reasoning. Research by Garfield and Ahlgren (1988) shows that students often hold misconceptions about randomness and struggle to connect probabilistic concepts to everyday experiences.

Teachers also face distinct challenges when teaching probability, as the subject involves uncertainty and differs in nature from other areas of mathematics. One common misunderstanding is the gambler's fallacy: if a coin lands on the same outcome several times in a row, students may believe that the opposite outcome is now more likely. Such misconceptions reflect an example of fundamental misunderstanding of the concept of independence in probability events.

## Probability in the School Curriculum

Children begin developing probability literacy at a young age by using language to describe events as certain, likely, unlikely, or impossible. Over time, they gradually connect these ideas to formal mathematical concepts. However, probability remains a conceptually challenging area due to its abstract and non-deterministic nature (Batanero et al., 2016). The development of probabilistic thinking has been also studied by Jones et al. (1997) and Batista et al. (2022). To better support learning, effective instruction must align probability content with developmentally appropriate pedagogical strategies and technological tools that promote active exploration and visualization (Bargagliotti, 2020; Zieffler et al., 2008). Table 1 summarizes key probability concepts taught at the primary, secondary and high schools along with corresponding teaching approaches and technologies based on insights drawn from previously mentioned works.

**Table 1** Probability education by level

Level	Content	Pedagogical Method	Technology support
Primary	Describing probabilities (Certain, possible, impossible etc.),  Simple outcomes (coin, die)	Storytelling,  Hands-on experiments	Physical objects
Secondary	Simple sample space,  Relative frequency	Simulation activities,  Gamification	Spreadsheet,  Websites/Web applets
High School	Compound events,  Independent/dependent events,  Basic distributions (e.g. binomial, normal),  Permutations and combinations	Problem-based learning,  Simulation-based learning	Statistical software,  Coding (R, Python),  Scientific calculators

## Technology in Probability Education

The Pre-K-12 Guidelines for Assessment and Instruction in Statistics Education II (GAISE II) (Bargagliotti, 2020) report by the American Statistical Association (ASA) emphasizes the importance of using simulations, hands-on activities and real-life examples rather than abstract notations to support students' conceptual understanding of probability and statistics.

A wide range of technological tools is now available to support the teaching of probability from statistical software to interactive web applets. The main purpose of these tools is to help students grasp the concept of chance without relying solely on repetitive use of physical tools, for example rolling a real die 1,000 times might not be a great idea. A notable example of using technology is the Rossman/Chance Applet Collection (Allan & Beth, 2021) which provide visual and interactive learning experiences.

Recently, the creating of own web-based teaching tools has regained popularity due to the R Shiny package by Posit (<http://shiny.posit.co/>). Usually, a Shiny web applet requires two main components: the User Interface (UI), which provides the layout and elements visible to the user and the Server, which contains the functions that make the UI interactive.

While R Shiny enables users to build and share interactive web applets with ease, creating a functional applet to address specific problems can be challenging for newcomers or users unfamiliar with coding. Stratton et al. (2021) demonstrated that R Shiny can enhance students' conceptual understanding while providing teachers with innovative tools to present abstract mathematical concepts visually. Overall, technology not only supports student learning but also empowers teachers to deliver more engaging and interactive lessons.

Building on this technological trend, recent advances in AI including the educational chatbots powered by large language models offer new opportunities to enhance mathematics education including the topics in probability through personalized tutoring, interactive explanations, real-time feedback, and dynamic content generation tailored to both students and teachers (Luckin et al., 2016; Liu et al., 2022).

## **Methodology**

We explored how AI can support key educational tasks in teaching and learning probability. Rather than comparing multiple AI tools, we focus solely on OpenAI's ChatGPT due to its widespread use, accessibility, and versatility in both classroom and self-learning contexts. At the time of this research, the freely accessible version available to users was based on the GPT-4o mini model. To reduce potential influence from the author, all the interactions with ChatGPT were conducted using the temporary chat mode.

To evaluate the effectiveness of ChatGPT, we selected 7 common tasks based on user needs in probability education. These tasks were categorized into two main perspectives: teacher and student use cases. For each group, ChatGPT's responses were examined according to the following criteria:

*Correctness:* The extent to which the AI provides logically valid and pedagogically sound responses.

*Clarity:* The degree to which the explanations are clearly presented and appropriate for the intended audience.

*Usefulness:* The extent to which the AI responses meaningfully support teachers or learners in delivering or understanding probability concepts.

These criteria served as interpretive lenses rather than quantitative scoring rubrics. They helped the author reflect on the responses' strengths and limitations without assigning formal scores.

The seven tasks were selected by the author based on prior experience and their pedagogical relevance to instructional activities in probability education. The prompts were also crafted to simulate real classroom questions, simulations, and explanations at educational levels from primary to high school. Additionally, we also included prompts in Thai to assess ChatGPT's ability in supporting non-English-speaking learners.

Since we explored in the temporary chat mode, we have to clarify the role (e.g., high school teacher, secondary student) at the beginning of the communication with ChatGPT. The later samples of prompts we assumed that this assumption already used.

### ***Using ChatGPT for Teaching Probability (Teacher Perspective)***

In order to investigate how ChatGPT can assist educators, we selected 3 main categories for teacher-facing tasks: lesson planning, concept visualizing, and assessment designing. These categories also align with findings which emphasized the importance of pedagogical strategies, tools and evaluation methods specific for the non-deterministic nature of probability (Batanero et al. 2016).

***Teacher Task Group 1: Lesson Planning (3 prompts)***

Teachers can ask ChatGPT to generate lesson ideas, example problems that aligned to different student levels. For instance, a teacher might prompt:

*“Give me 3 real-world examples of conditional probability suitable for high school students.”*

***Teacher Task Group 2: Creating Visual and Simulating Content (3 prompts)***

Presenting probability often requires proper visualizations or simulations. Teachers might ask ChatGPT to generate a simple simulation code (e.g., in R or Python) of coin tosses or random walks. With comments included, teachers can easily modify the codes to suit their classroom contents.

Some teachers who wish to create interactive web-based applets can also leverage ChatGPT to assist with R Shiny development. By simply prompting the AI with a request such as

*“Create an R Shiny web applet to teach students about die tossing”.*

***Teacher Task Group 3: Designing Formative Assessment (3 prompts)***

Teachers can ask ChatGPT to assist in formative assessments such as multiple-choice or true/false questions. For example:

*“Give me 5 multiple-choice questions about expected value with 1 question about a common student misconception.”*

***Using AI Tools for Learning Probability (Student Perspective)***

Typically, students who use ChatGPT would ask question that they want to know the answer and then move on to next topics. Sometimes they might want to assess their current knowledge. Since ChatGPT usually responds based on users, this may allow ChatGPT to become a personal tutor. More than that we also examine how students use ChatGPT as a practice assistant, or a simulator helper while studying and learning probability.

***Student Task Group 1: Exploring Probability Concepts (3 prompts)***

Students can directly ask ChatGPT to explain probabilistic concepts in a personalized and conversational manner. For example:

*“Why is the expected value of rolling a fair die equal to 3.5?” or  
“How can I check if a die is fair?”.*

***Student Task Group 2: Self-Testing and Practice (3 prompts)***

Before or after a lesson, students may request for practice problems with answers. For example:

*“Give me 3 practice problems on permutations and combinations with solutions.”*

***Student Task Group 3: Simulating and Visualizing Probability Events (3 prompts)***

Students can engage directly with the world of randomness by asking ChatGPT for simulated outcomes. For example:

*“Simulate tossing two coins 100 times and show the outcomes.”*

#### **Student Task Group 4: Using AI in Multilingual Contexts (9 prompts)**

For non-English-speaking learners, ChatGPT is often prompted in their native languages. To assess ChatGPT's multilingual support, the equivalent set of student prompts were rewritten in Thai, enabling evaluation of the tool's capacity to assist non-English-speaking learners. For instance:

“อธิบายเรื่องความน่าจะเป็นแบบง่าย” (Translation: Explain probability in a simple way).

## **Results**

We collected the ChatGPT responses across a range of common educational tasks and organized them into two categories: teacher and student use cases. Examples of the prompts and their responses are shown in Table 2 and Table 3.

**Table 2** Sample responses from ChatGPT from teachers' tasks (prompts and their responses have been truncated due to space limitations)

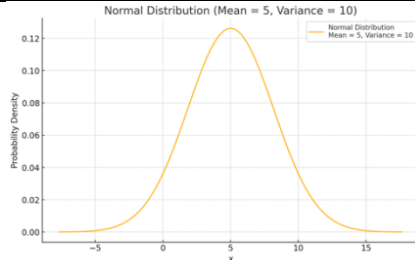
Prompts	Responses by ChatGPT
How to teach students probability? Answer me in 1 paragraph.	<i>To teach students probability effectively, start with real-life contexts and hands-on activities that make abstract concepts tangible—like flipping coins, rolling dice, or drawing colored balls from a bag. Introduce basic terms such as outcomes, events, and probability as a ratio or fraction, emphasizing the idea of likelihood on a scale from 0 to 1. Use visuals like probability trees and number lines to support understanding, and encourage students to make predictions and test them through experiments. Gradually incorporate more complex ideas like dependent/independent events or theoretical vs. experimental probability, always connecting back to everyday situations to keep learning relatable and engaging.</i>
How to explain the expectation concept? Answer me in 1 paragraph.	<i>Expectation, in probability and statistics, is the average or mean value you would expect from a random process if you repeated it many times. It's like the long-run average outcome. Mathematically, for a discrete random variable, you calculate it by multiplying each possible value by its probability and summing the results. For example, if you roll a fair six-sided die, the expectation is <math>(1+2+3+4+5+6)/6 = 3.5</math>. Though you never roll a 3.5, it represents the average result over many rolls. Expectation helps us predict outcomes and make informed decisions under uncertainty.</i>
Idea for simulation tools for teaching normal distribution?	<i>Here are 5 concise ideas for simulation tools to teach normal distribution:</i> 1. <i>Interactive Normal Curve Generator: A tool that allows users to adjust the mean and standard deviation and immediately see how the normal distribution curve changes. Users can interact with the curve to visualize probabilities and areas under the curve.</i> 2. <i>Sampling Simulation with Histograms: Users can draw random samples from a normal distribution, and the tool will display a histogram of the sample data. As the sample size increases, users see how the histogram approximates the normal distribution.</i> 3. <i>Z-Score Calculator: A tool where users input a data point and see its Z-score in a normal distribution. The tool would also show the corresponding area under the curve (probability) for that Z-score.</i> 4. <i>Central Limit Theorem Demonstrator: A tool where users can take repeated samples from any distribution (normal or not) and observe how the distribution of sample means converges to a normal distribution as sample size increases.</i> 5. <i>Percentile Finder: Users input a percentile (e.g., 90th percentile), and the tool calculates and displays the corresponding value from the normal distribution, helping them understand the concept of percentiles and cumulative probability.</i>



Create 5 multiple choice questions for teaching a dice tossing	<p>Here are 2 multiple-choice questions designed to teach dice tossing: —</p> <p>Question 1: What is the probability of rolling a number greater than 4 on a fair six-sided die?</p> <p>A) <math>1/6</math> B) <math>1/3</math> C) <math>1/2</math> D) <math>1/2</math></p> <p>Question 2: When rolling two six-sided dice, what is the probability that the sum of the dice is 8?</p> <p>A) <math>1/36</math> B) <math>5/36</math> C) <math>1/12</math> D) <math>1/6</math></p> <p>These questions focus on calculating the probability of specific outcomes when tossing a die or multiple dice.</p>
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**Table 3** Sample responses from ChatGPT from students' tasks (prompts and their responses have been truncated due to space limitations)

Prompts	Responses by ChatGPT
As an elementary student, explain the Bernoulli distribution step-by-step	<p>Sure! Let's break down the Bernoulli distribution in a simple way:</p> <p><b>1. What is a Bernoulli trial?</b></p> <p>A Bernoulli trial is a random experiment that has only two possible outcomes. These outcomes are usually called:</p> <ul style="list-style-type: none"> <li>• <b>Success (1)</b></li> <li>• <b>Failure (0)</b></li> </ul> <p>For example, flipping a coin:</p> <ul style="list-style-type: none"> <li>• <b>Heads</b> could be a "success" (1).</li> <li>• <b>Tails</b> could be a "failure" (0).</li> </ul> <p>So, a Bernoulli trial is like a simple yes/no or true/false question.</p> <p><b>2. What is the Bernoulli Distribution?</b></p> <p>The Bernoulli distribution is a way to describe the outcome of a Bernoulli trial. It tells you the probability of getting a "success" (1) and the probability of getting a "failure" (0).</p> <ul style="list-style-type: none"> <li>• If you flip a coin, there are two outcomes: heads or tails.</li> <li>• The Bernoulli distribution gives us the <b>probability</b> of getting heads (success) or tails (failure).</li> </ul> <p><b>3. The Formula</b></p> <p>The probability of getting a success (1) is called <b>p</b>, and the probability of getting a failure (0) is called <b>1 - p</b>.</p> <ul style="list-style-type: none"> <li>• <b>P(success) = p</b> (probability of success)</li> <li>• <b>P(failure) = 1 - p</b> (probability of failure)</li> </ul> <p><b>4. Example</b></p> <p>Let's say you are flipping a fair coin. The probability of heads (success) is 0.5, and the probability of tails (failure) is also 0.5. So, the Bernoulli distribution for this coin flip would look like:</p> <ul style="list-style-type: none"> <li>• <b>P(success) = 0.5</b> (probability of heads)</li> <li>• <b>P(failure) = 0.5</b> (probability of tails)</li> </ul> <p><b>5. Key Points to Remember</b></p> <ul style="list-style-type: none"> <li>• The Bernoulli distribution is used for situations where you only have two outcomes: success or failure.</li> <li>• The distribution is determined by the probability <b>p</b> of success.</li> <li>• The two possible outcomes are labeled 1 for success and 0 for failure.</li> </ul> <p><b>6. Why is it Useful?</b></p> <p>The Bernoulli distribution helps us understand simple random events, like flipping a coin, answering a yes/no question, or passing/failing a test.</p> <p>So in short:</p> <ul style="list-style-type: none"> <li>• A Bernoulli distribution is just a way to describe the outcome of a random event with two outcomes: success (1) or failure (0).</li> <li>• You can figure out the chances of success (p) and failure (1 - p) using the Bernoulli distribution.</li> </ul>
Simulate 10 random positive integers with two digits	<p>Here are 10 random positive integers with two digits:</p> <p>18, 33, 23, 69, 45, 11, 97, 90, 35, 68.</p>

<p>Plot the distribution function of a normal distribution with mean 5 and variance 10</p>	<div data-bbox="735 192 1150 450">  </div> <p>Here's the plot of the normal distribution with a mean of 5 and a variance of 10. The curve represents the probability density function (PDF) of this distribution.</p>
<p>Give me 5 multiples choice problems about Poisson distribution</p>	<p>Here are 5 multiple-choice problems related to the Poisson distribution:</p> <p><b>Problem 1:</b> If the average number of emails a person receives per hour is 3, what is the probability that the person receives exactly 5 emails in an hour, assuming the number of emails follows a Poisson distribution? A) 0.1008 B) 0.2500 C) 0.1404 D) 0.2201</p> <p><b>Problem 2:</b> The number of accidents that occur at a certain intersection follows a Poisson distribution with a mean of 4 accidents per week. What is the probability that exactly 2 accidents occur in a given week? A) 0.1954 B) 0.0183 C) 0.0939 D) 0.0574</p> <p><b>Problem 3:</b> A factory produces an average of 2 defective items per hour. What is the probability that no defective items are produced in the next hour, assuming the number of defective items follows a Poisson distribution? A) 0.1353 B) 0.1350 C) 0.2707 D) 0.4060</p> <p><b>Problem 4:</b> The number of customer arrivals at a store during a 10-minute period follows a Poisson distribution with a mean of 3 customers per 10 minutes. What is the probability that 0 customers arrive in the next 10 minutes? A) 0.0498 B) 0.0907 C) 0.1112 D) 0.0494</p> <p><b>Problem 5:</b> If the average number of calls a call center receives per hour is 8, what is the probability that the call center receives more than 10 calls in an hour? A) 0.2188 B) 0.3437 C) 0.4001 D) 0.4847</p> <p>Let me know if you'd like to go over the solutions!</p>

We summarized how ChatGPT performed across key educational tasks in the probability education. These tasks were divided into those supporting teachers and those supporting students. The summary is based on the authors' subjective analysis using criteria such as "correctness," "clarity," and "usefulness" to evaluate the responses. While these criteria provide a general sense of performance, the assessment may still contain biases due to the authors' individual judgment and the specific responses generated by ChatGPT at the time of the study, which may vary in different contexts, over time or different ChatGPT models.

### ***Findings in Teaching Tasks***

ChatGPT has shown to be effective in assisting teachers with various instructional tasks, including the preparation of teaching materials, simulation codes and assessment design. In lesson planning, ChatGPT was able to generate example problems, lesson ideas and customizable teaching templates upon request. For instance, when prompted with "Give me 3 examples of real-world conditional probability", the AI responded with scenarios related to medical testing, weather forecasting and customer behavior in retail. It also demonstrated the ability to delivery explanations to different age groups, such as simplifying the distinction between independent and dependent events for a 10-year-old or a high school



student. These AI-generated resources can be reviewed and adapted by teachers for both in-person and online instruction.

In terms of creating visual and simulation-based content, ChatGPT could produce R Shiny applet codes including both the user interface and server components. This enabled educators with limited coding experience to develop customized interactive tools that engage students through simulations, sliders, and other dynamic visualizations. Such tools are particularly effective in promoting hands-on and exploratory learning in probability.

Additionally, ChatGPT supported assessment generation both by creating multiple-choice and open-ended questions filled with answer keys. In some cases, the AI even included distractors informed by common misconceptions for example the frequent confusion between mutually exclusive and independent events.

### ***Finding in Learning Tasks***

ChatGPT offered substantial support for several independent learning activities that benefit students studying probability. For conceptual understanding, students could ask questions such as “Why is the expected value of a fair die 3.5?” then receive clear and coherent responses. When given more specific instructions, the AI was also capable of providing step-by-step reasoning, analogies, and alternative explanations to help students overcome common conceptual obstacles.

In terms of supporting self-learning, users who asked ChatGPT to generate self-tests often received questions suited to their current level of knowledge, promoting self-directed learning with immediate and personalized feedback. Furthermore, ChatGPT supported simulation-based learning by generating samples for common probability problems such as coin tosses or random numbers from a normal distribution although these can be done using available online tools, ChatGPT is more flexible in the terms of non-fixed commands. Students could even give follow-up instructions to manipulate or analyze the generated data, a process that would typically require programming knowledge.

Additionally, ChatGPT demonstrated its ability to reduce language barriers by responding accurately and understandably in languages other than English. For example, when prompted in Thai (e.g., “อธิบายเหตุการณ์อิสระ” or “Explain independent events”), the AI produced explanations that were comparable in clarity and accuracy to its English responses, thereby making abstract probabilistic content more accessible to non-English-speaking learners.

### ***Limitations and Unexpected Findings from the Experiments***

In addition to the expected outcomes observed from several ChatGPT’s responses, we highlight some challenges that may be overlooked in seemingly successful tasks:

- *Inability to perform direct Simulations:* While the simple random outcomes can be generated, ChatGPT does not conduct simulations directly for complicated problems. Instead, it provided code in Python therefore users must execute code by themselves. This can be a barrier for many students who primarily use ChatGPT on smartphones or tablets, where running computer code is not straightforward.
- *Minor file naming in generated code:* Another minor issue emerged when we asked ChatGPT to generate a code of Shiny app for teaching the concept of expectation. The AI named the output file “expectation\_app.R” instead of the conventional “app.R”. This mistake caused an initial error when users run the app. This is a reminder that users must critically verify AI-generated computer code especially when working with third-party tools or frameworks.
- *Noticeable grammatical errors:* While the content of ChatGPT’s responses was generally useful, grammatical errors were observed in the generated outputs.

On a positive note, ChatGPT demonstrated an impressive ability to identify user input errors beyond grammatical issues. For example, when provided with invalid probability values (e.g. less than 0 or greater than 1), it correctly detected the error and advised users to revisit their inputs. This highlights the potential of integrating ChatGPT API in a helpful tutor-like AI chatbot.

## **Discussion**

In this paper, we explored many roles of ChatGPT that can be used to support the teaching and learning of probability. Through wide range of common tasks, we found that in the text-based responses, ChatGPT offers valuable supportive feedback in teaching and learning probability.

For common teaching tasks, ChatGPT serves as a practical tool for generating examples, designing assessment items, and simplifying abstract concepts. It enables quick lesson planning and supports differentiated instruction across students' levels.

For common learning tasks, it functions well as a personal tutor by not just only providing short answers and it even has an ability to give step-by-step explanations. Learners can gain the knowledge from generated problems suitable for their levels and performances. In multilingual support, ChatGPT responds in Thai as well as in English.

However, some noticeable challenges remain. ChatGPT can perform simple simulations, such as generating 10 normally distributed random numbers but it struggled with more complex or large-scale inputs. For example, when asked to simulate 10,000 numbers, it suggested using other software instead. It may also present incorrect answers with high confidence, which could mislead students who are not guided appropriately. For example, it may calculate results without checking the validity of the inputs first. Therefore, it should be used as a supplemental tool not a replacement of teachers.

Like in other mathematics topics, ChatGPT has the potential to be tailored specifically for probability education. With thoughtful integration and proper guidance from teachers, ChatGPT can enrich both teaching and learning in probability, making complex concepts more accessible and engaging for diverse learners.

Future research should be focused on the improvements the following topics:

- Improving the AI's ability to detect and respond to errors in student input, particularly those involving invalid probability values or misconceptions about probabilistic rules;
- Embedding generative AI API into interactive web platforms or chatbots allowing seamless and guided learning experiences within educational applications;
- Expanding the scope of generative AI tools to support more advanced topics in probability via image or videos inputs and outputs;
- Investigating the capabilities of generative AI tools to cover more advanced probability topics, including the use of image or video inputs and outputs;
- Investigating learning differences between ChatGPT users and non-users to explore potential inequalities in access to support, performance and engagement in probability education;
- Comparing ChatGPT with other traditional teaching tools or other AI-powered chatbots, and assessing learning outcomes between users and non-users to examine potential inequalities in educational access or performance;
- Collaborating with real teachers and students to validate the representativeness and relevance of selected educational tasks, ensuring broader alignment with

instructional goals.

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