International Journal of Scientific Engineering and Science
Volume 8, Issue 6, pp. 1-6, 2024. ISSN (Online): 2456-7361

Integrating Agricultural Concepts into Probability Lessons

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Abstract— *This study sought to develop and evaluate contextualized lessons using agricultural concepts in teaching probability for Grade 8 students primarily from farming backgrounds due to families' involvement in agriculture. The study employs a descriptive research design and follows the ADDIE instructional design model —analyze, design, develop, implement, and evaluate — to develop these contextualized lessons. The lessons, rated 'excellent' by three evaluators, employ a comprehensive teaching process, including posting scenarios, mathematical prompts, discussions, think-pair-share activities, group activities, and assessments. Feedback from students indicated a significant increase in engagement and understanding through collaborative learning activities and agricultural concepts. This study recommends further integrating practical and real-world contexts into the lessons to enhance student learning outcomes, allow them to see the application of mathematics in the world, and continuously enhance the comprehensive teaching process outlined in the study.*

Keywords— *ADDIE Instructional Design Model, Agricultural Concepts, Contextualized lesson.*

I. INTRODUCTION

Students in rural areas, where agriculture is an integral part of the economy, face unique educational challenges. They are exposed to farming activities early due to their families' involvement in agriculture. However, providing education in rural areas presents challenges such as insufficient infrastructure, inadequate learning resources, and a need for more quality teachers (Echazarra & Radinger, 2019). Hence, teachers in these areas must use agricultural concepts to make the teaching and learning process relevant to students. Mathematics teachers should integrate reality and develop teaching scenarios that are mathematically beautiful and increase the interest and participation of the students (Fang et al., 2023). Agricultural education teaches students various practical skills, such as problem-solving, critical thinking, teamwork, leadership, and entrepreneurship, which are beneficial across various careers (Lawankar, 2023). Moreover, integrating agricultural concepts or practices into school curricula can raise students' understanding of farming practices and sustainability problems (Sy, 2022).

On the other hand, in mathematics, students often encounter challenges in solving probability problems and applying different probability concepts. These difficulties are categorized into understanding probabilistic problems, selecting appropriate strategies, and completing computation processes. Errors arise from misidentification of unknowns, misconceptions about probability, and inaccuracies in arithmetic operations (Memnum, 2019; Arum et al., 2018).

Contextualization is used for mathematics curriculum design within lesson plans and as a pedagogical practice in face-to-face classes. It also refers to teaching mathematics problems that emphasize real-life situations (Valenzuela, 2018). In mathematics education, contextualization refers to placing the target mathematical concept in a realistic setting to make the learning process meaningful to the students (Orozco & Pasia, 2021). These methods, which emphasize the value of localization and contextualization in teaching and learning processes, are fully compliant with the K–12 curriculum in the Philippines (Rafael & Tamban, 2022). Furthermore, research has proven the highly positive impact of interdisciplinary and contextualized lessons on students' problem-solving skills, cultural awareness, and capability to connect ideas from numerous disciplines (Balantes & Tonga, 2020). Moreover, real-life scenarios in problem-solving exercises of contextualized lessons helped students learn and perform better on the achievement test. Teachers may use it to improve academic performance in math classrooms (Buan et al., 2021).

For these reasons, the research aimed to develop and evaluate contextualized lessons using agricultural concepts in probability. Moreover, it aimed to present a comprehensive process of developing contextualized lessons. This study and the one carried out by Buan et al. (2021) are comparable, which developed contextualized lessons in Measurement, and Jackaria et al. (2018), which developed contextualized lesson plans integrating writing in mathematics using Sinama, the pupil's mother tongue. Both studies followed the backward approach to curriculum design in developing the lessons. However, this study followed the ADDIE instructional model.

II. METHODOLOGY

This study utilized descriptive research design for the researchers to develop and evaluate contextualized lessons in probability using agricultural concepts for Grade 8 students. Additionally, the contextualized lessons in this study were developed using the ADDIE Model, which stands for Analyze, Design, Develop, Implement, and Evaluate. The study participants were one section of Grade 8 students in one of the public schools in Pantao Ragat, Lanao del Norte, during the school year 2023-2024, who predominantly come from farming backgrounds due to their families' involvement in agriculture. This study was conducted at Pantao Ragat, Lanao del Norte, Philippines. The school is the sole Junior and Senior High School in the municipality. It is governed by Republic Act 7014, which was approved and signed by former President Corazon C Aquino on May 20, 1991.

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III. Results and Discussions

Process of Development of Contextualized Lessons

The development of contextualized lessons in this study followed the ADDIE Instructional Design Model developed by Florida State University. This model provides a flexible guideline that instructional designers can use to build adequate support resources in five (5) phases: analysis, design, development, implementation, and evaluation (Razali et al., 2015). Each phase was carefully executed to ensure the lessons were well-designed, implemented, and evaluated for their effectiveness in teaching probability using agricultural concepts.

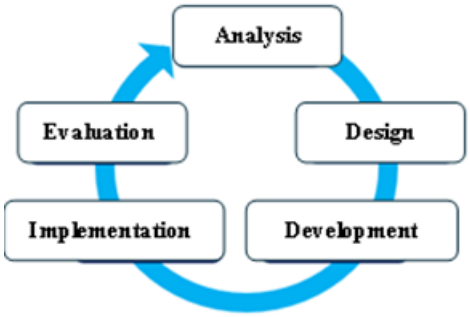


Fig. 1. Process of Development of Contextualized Lesson Plans

A. Analysis Phase

The researchers gathered substantial information about the target participants. Since students primarily come from farming backgrounds, the researchers recognized the need to make mathematical concepts such as probability relatable and applicable to their everyday lives. Moreover, contextualization is essential for improving students' understanding of the lessons. The researchers aimed to make abstract mathematical concepts more concrete and relevant to the student's personal and community experiences by incorporating agricultural examples and scenarios into the lessons.

Moreover, the researchers identified specific topics and learning objectives that can be contextualized using agricultural concepts. Probability, a topic covered in the fourth quarter of Mathematics 8 according to the K–12 Mathematics Curriculum Guide: Most Essential Learning Competencies (MELCs), was selected focusing on the three (3) competencies covering the following topics: (1) Illustrating an experiment, outcome, sample space, and event, (2) Introduction of Probability, (3) Probability of Simple Event, and (4) Theoretical Probability and Experimental Probability. This choice was based on its potential to be practically illustrated through agricultural contexts, thereby aiding students in developing skills directly related to their families' livelihoods.

The researchers also assessed the students' proficiency levels using their previous quarterly grades in mathematics. The average grades of the two quarters were the basis for the students' categorization. Based on the collected data, 38.88% of the students were classified as developing proficient, while 22.22% were approaching proficient students. These proficiency levels, which are lower than the average, underscore the necessity of a curriculum specifically designed to address and support the students' diverse learning needs.

B. Design Phase

Researchers focus on making probability lessons more relatable for students from farming backgrounds and enhancing engagement and understanding by connecting abstract mathematical concepts to real-world experiences through integrating agricultural contexts into the lessons. The researchers included problem-solving, think-pair-share, and group activities as instructional strategies designed to serve specific purposes and methodologies tailored to the student's context. The researchers designed scenarios, activities, and word problems that provided students with real agricultural problems, such as determining the optimal time for planting crops based on weather forecasts.

The researchers designed think-pair-share activities that promote collaborative learning and deepen understanding through peer interaction. In these activities, students analyze a problem or picture individually, discuss it with a partner to exchange their findings and present their conclusions to the entire group. Furthermore, the think-pair-share activities employed a systematic pairing of students, whereby those with higher proficiency paired with those with lower proficiency to promote a cooperative exchange of ideas and provide mutual support.

Acknowledging the importance of diversity within student groupings and collaborative learning, the researchers designed group activities in each lesson. They ensured that these small groups with 5 to 6 members consisted of students with different proficiency levels, such as advanced, proficient, approaching proficient, and developing proficient students. The process enabled collaboration, enhanced communication skills, and promoted a deeper understanding of the lessons.

Using these instructional strategies, the researchers aimed to enhance students' understanding and achievement by integrating agricultural concepts and making probability concepts more practical and relevant.

C. Development Phase

The researchers developed the instructional materials needed for each lesson, including visual aids, learning activity sheets, scenarios, and word problems. The researchers embed agricultural examples and real-world scenarios into the lessons to contextualize the probability concepts. The evaluators evaluated the developed contextualized lessons using the evaluation scale adapted from Simbulan (2001) and Padagas (2011). The panel of evaluators is composed of three public school mathematics teachers with diverse backgrounds and experiences. Two teachers have nearly two decades of teaching experience in the agricultural municipality where the study was conducted, bringing extensive knowledge of the curriculum and student needs. The third teacher, born and raised in the same municipality and a graduate of the school where the study was implemented, is a graduate of a Master of Science in Education major in Secondary Mathematics and has been teaching for five years. The average ratings of the panel of evaluators given on the four (4) contextualized lessons developed were interpreted using a 4-point Likert

scale. The computation of the mean ranges assumed that the evaluator's average responses fell within an interval rather than the four distinct values. The study defined the mean ranges and interpretations for the evaluators' ratings of the contextualized lessons. The range of mean scores between 3.51 and 4.00 was classified as "excellent," while the range of mean scores between 2.51 and 3.50 is "satisfactory." A mean range of 1.51 to 2.50 was classified as "below satisfactory," while a mean range of 1.00 to 1.50 is "poor."

The three evaluators rated the lessons as outstanding, good, satisfactory, or below satisfactory based on their agreement on the lesson plan's organization, contextualization, and usefulness.

Based on the computed mean scores, the evaluators rated all lesson plans 'Excellent' regarding organization, contextualization, and usefulness to other teachers. These are lesson plan 1 (M = 3.91, SD = 0.10), lesson plan 2 (M = 3.98, SD = 0.04), lesson plan 3 (M = 3.93, SD = 0.03), and lesson plan 4 (M = 3.98, SD = 0.04).

Overall, the evaluators gave the developed contextualized lessons using agricultural concepts an "excellent" rating (M = 3.94, SD = 0.05) for their organization, contextualization, and usefulness.

Sample Scenarios and Learning Activity Sheets

Students appreciated the real-life applications of probability through agricultural examples. They found these lessons relevant to their daily lives and future applications, enhancing their understanding and retention and making the lessons more relatable and easier to understand.

"*Oo, ito ay kawili-wili dahil ang mga scenario dito ay na experience na naming in real life. Bukod dito mas madaling maintindihan dahil nasanay kami sa agrikultura." (Yes, it is interesting because the scenarios given are something we also experience in real life. It is easier to understand because here in our place, we are used to agriculture)*- D8

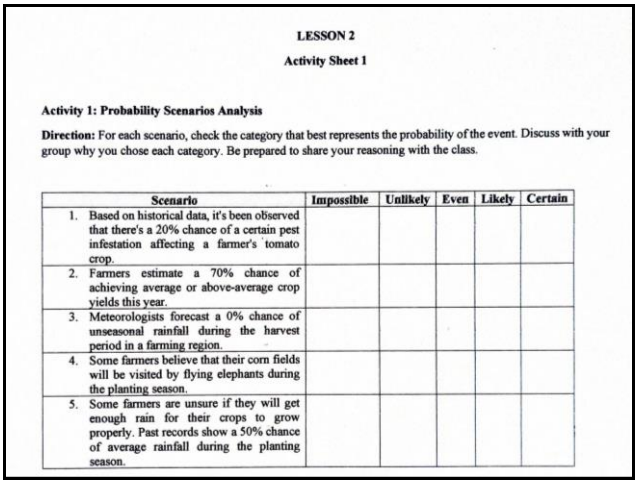
The story problems and scenarios used in the developed lesson plans were contextualized by relating them to the local setting. This is based on the idea that students learn better mathematical concepts by working with things of their culture and the language he is familiar with (Hafiz & Farik, 2016; Njoroge, 2017).

Fig. 2 is one of the scenarios used in the study. This scenario is about Norjannah and her son Asraf cultivating and replanting sakurab bulbs, a main ingredient in the Maranao traditional dish palapa. They were unsure if the bulbs would grow, but they planted them anyway. To their delight, 120 of the 150 bulbs they planted turned into healthy plants. Norjannah wanted to know the success rate of the replanted bulb, which could aid her in future planting endeavors.

Fig. 3 shows the sample think-pair-share learning activity sheet used in the study. This is utilized in lesson 2. This activity is focused on analyzing probability scenarios within an agricultural context. Students are presented with five scenarios related to farming and are asked to categorize each scenario based on its probability of occurrence: Impossible, Unlikely, Even, Likely, or Certain. The scenarios cover various aspects of farming, such as pest infestation, crop yields, weather forecasts, and speculative events. By discussing and justifying their choices with their pair, students engage in critical thinking and apply their understanding of probability to real-world agricultural situations.

Norjannah made a traditional maranao dish called palapa with sakurab as the main ingredient. Her son Asraf helped by cleaning and cutting the sakurab bulbs. He asked if he should throw them away, but Norjannah planted them in the garden instead. There were 150 bulbs, and after planting, 120 of them grew into healthy plants. She now wants to determine the success rate of replanted bulbs, which will help her in future planting endeavors.

Fig. 2. Sample Scenario



LESSON 2

Activity Sheet 1

Activity 1: Probability Scenarios Analysis

Direction: For each scenario, check the category that best represents the probability of the event. Discuss with your group why you chose each category. Be prepared to share your reasoning with the class.

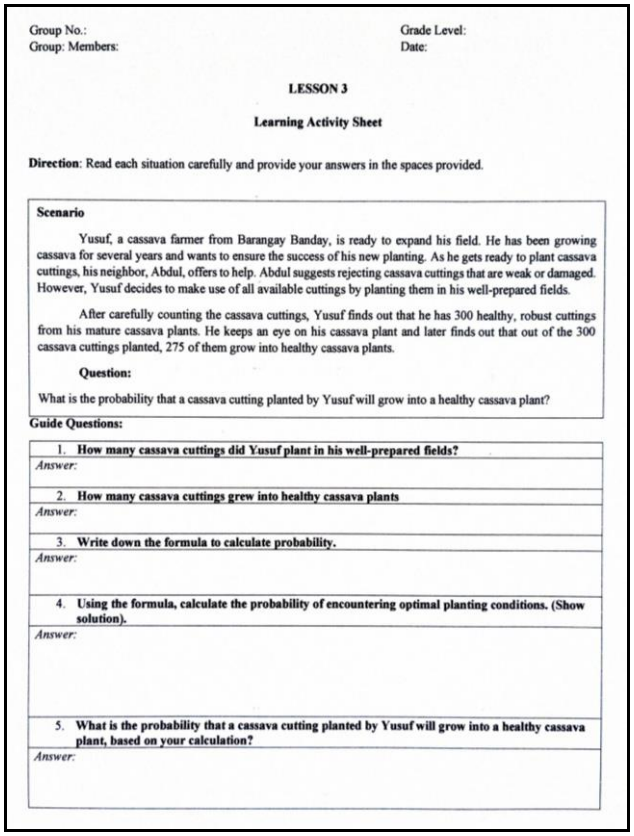
Scenario	Impossible	Unlikely	Even	Likely	Certain
1. Based on historical data, it's been observed that there's a 20% chance of a certain pest infestation affecting a farmer's tomato crop.					
2. Farmers estimate a 70% chance of achieving average or above-average crop yields this year.					
3. Meteorologists forecast a 0% chance of unseasonal rainfall during the harvest period in a farming region.					
4. Some farmers believe that their corn fields will be visited by flying elephants during the planting season.					
5. Some farmers are unsure if they will get enough rain for their crops to grow properly. Past records show a 50% chance of average rainfall during the planting season.					

Fig. 3. Sample Think Pair Share Learning Activity Sheet

Fig. 4 shows the sample learning activity sheet used in this study. This activity is from lesson 3 and is used for the group activity. This story is about Yusuf, a cassava farmer who wants to expand his field. Instead of rejecting any weak or damaged cassava cuttings, he decides to use all the ones he has, even though his neighbor suggests otherwise. He ends up with 300 healthy cuttings and plants them. Later, he discovers that 275 of them have grown into healthy cassava plants. The question is how likely it is for a cassava cutting planted by Yusuf to grow into a healthy plant. It is like asking, out of all the cuttings Yusuf planted, what is the chance one of them will become a healthy cassava plant?

Revision of the Developed Lessons Based on the Based on the Panel of Evaluators Suggestions

The contextualized lessons underwent pilot testing in one section of Grade 8 students. Aside from the numerical ratings, evaluators also provided comments and suggestions for improving the contextualized lessons.



Group No.: Grade Level:
Group: Members: Date:

LESSON 3

Learning Activity Sheet

Direction: Read each situation carefully and provide your answers in the spaces provided.

Scenario

Yusuf, a cassava farmer from Barangay Banday, is ready to expand his field. He has been growing cassava for several years and wants to ensure the success of his new planting. As he gets ready to plant cassava cuttings, his neighbor, Abdul, offers to help. Abdul suggests rejecting cassava cuttings that are weak or damaged. However, Yusuf decides to make use of all available cuttings by planting them in his well-prepared fields.

After carefully counting the cassava cuttings, Yusuf finds out that he has 300 healthy, robust cuttings from his mature cassava plants. He keeps an eye on his cassava plant and later finds out that out of the 300 cassava cuttings planted, 275 of them grow into healthy cassava plants.

Question:

What is the probability that a cassava cutting planted by Yusuf will grow into a healthy cassava plant?

Guide Questions:

1. **How many cassava cuttings did Yusuf plant in his well-prepared fields?**

Answer:

2. **How many cassava cuttings grew into healthy cassava plants**

Answer:

3. **Write down the formula to calculate probability.**

Answer:

4. **Using the formula, calculate the probability of encountering optimal planting conditions. (Show solution).**

Answer:

5. **What is the probability that a cassava cutting planted by Yusuf will grow into a healthy cassava plant, based on your calculation?**

Answer:

Fig. 4. Sample Think Pair Share Learning Activity Sheet

In lesson 1, evaluator 1 suggested not directly presenting the definitions of basic terms in probability. Instead, ask questions first to elicit prior knowledge. Furthermore, it is essential to provide detailed instructions for the think-pair-share and group activities. Each group should respond to two scenarios rather than just one in the group activity. Aside from that, Evaluator 2 suggested adding guide questions to the think-pair-share and group activity sheets. Finally, evaluator 3 suggested changing the multiple-choice assessment to identify the experiment's outcomes, sample space, and event. In lesson 2, evaluator 1 recommended simplifying the language in the scenario, making it more straightforward, avoiding complex vocabulary and lengthy descriptions, and substituting a different plant for the tomato in statement 2. While evaluator 3 suggested choosing another more appropriate test, like identification, In lesson 3, evaluator 1 suggested making the scenario short and more straightforward. To make the scenario more concise and engaging, remove unnecessary details and repetitive information and include a picture of Sakurab. Moreover, Evaluator 2 provides a brief overview of a simple scenario to enhance comprehension, simplifies the scenario by making it more concise and easier to understand, and modifies the terms "germinated" and "germination" to facilitate students' understanding of problem 2 in lesson 4.

The lesson plans were revised based on the pilot testing results and suggestions from the panel of evaluators.

D. Implementation Phase

After completing the first three phases, the four lesson plans were ready to be implemented with the chosen participants of the study, following the outlined sequence of activities and engaging students in active learning experiences. Before and after implementation, the researchers administered pretest and posttest to measure student levels of achievement in probability topics. A mathematics teacher at the school facilitated the teaching and learning process throughout the implementation period. The researchers observed the class and monitored student progress and engagement during the implementation phase. These contextualized probability lessons employ a comprehensive teaching process to maximize student engagement and learning outcomes. This process entails posting scenarios to engage students with real-life scenarios, using mathematical prompts to guide understanding, facilitating discussions to deepen comprehension and learning of concepts, think-pair-share activities and group activities to foster collaborative learning, and assessing student learning through formative and summative assessments.

1. *Posting Scenario*

Every lesson begins with scenarios developed by the researchers. The researchers ensured that each scenario was easy to understand and relatable to the students. This scenario sets the stage for the lesson by presenting a real-world problem that requires the application of probability concepts.

2. *Mathematical Prompts*

Mathematical prompts guide students in analyzing the scenarios and the lessons' subject matter. After posting the scenarios, the teacher poses follow-up questions that allow students to identify critical elements of the problem and begin thinking about how to solve it.

3. *Discussion*

In response to the mathematical prompts, a class discussion is facilitated. During this discussion, students share their initial thoughts and solutions, ask questions, and explore various approaches to the problem. The teacher guides by asking questions to ensure that key concepts are understood and misconceptions are addressed. This process is crucial for learning as students improve their understanding, receive feedback, and express their ideas.

4. *Think-Pair-Share*

Think-Pair-Share followed the discussion process, which promotes individual thinking, peer discussion, and group exchange of ideas to reinforce learning and provides opportunities for the students with higher proficiency levels to share their understanding and help their pairs who are at a lower level of proficiency. The systematic pairing ensures that both of them will benefit as the student with a high proficiency level can master the subject matter by helping their pair. At the same time, the one with a lower proficiency level gets a chance to clarify their confusion and get help from their pair. Moreover, this process involves students thinking about the topic, answering it independently, and pairing up with a classmate to discuss their ideas and answers. Finally, they present their answers to the activity to the entire class. This strategy promotes a more profound understanding by having students clarify their ideas through discussion and obtain insights from their peers.

5. *Group Activity*

The group activities allow students to use learned concepts collaboratively, reinforcing their understanding through practical application. Students work together in groups to solve problems or scenarios that involve the application of learned concepts. Group activities also provide opportunities for students categorized as lower level to get help, as the group members have different proficiency levels.

Collaborative activities were particularly engaging based on the participants' responses to the perception questionnaire. Participants enjoyed the group and pair activity.

"*Miyababaya ako ko mga activity group at by partner activity bapiya igira na pkar'gnan ako. " (Even though I occasionally found the group and pair activities challenging, I still enjoyed them) –D6*

"*It is fun. The group activity made me happy when we talked about probability. When my answers are wrong, my group members help me correct them, which was good."- D5.*

These findings are supported by Ardiyani et al. (2019), who studied the Think Pair Share cooperative learning model and found that it positively impacted group establishment, learning environment, achievement, participation, information exchange, and interpersonal relations. Moreover, Kocak et al. (2009) emphasized that group activities can improve students' critical thinking, problem-solving skills, and ability to express themselves effectively.

6. Assessment

The last step in the teaching process is the assessment, which assesses the student's understanding and ability to apply the probability fundamentals acquired and informs the teacher of future actions. The lessons have both formative and summative assessments. Formative assessments are carried out during the lesson by continuous observations and questioning, and at the end of the lessons, through a short quiz, allowing the teacher to check understanding and provide immediate feedback. Summative assessments are administered after implementing the four lessons to measure students' overall understanding of the subject matter.

E. Evaluation Phase

A thorough evaluation was conducted during the assessment phase to gauge how well the contextualized lessons, including agricultural concepts in probability lessons, worked. Following each lesson, the teacher reflected using the DepEd-prescribed lesson plan style, which included various relevant questions. These questions included determining the number of students who received an 80% on the formative assessment, identifying students who needed additional remediation activities, evaluating the effectiveness of remedial lessons in helping students catch up, and determining the number of students who still needed remediation. The teacher got insights into instructional methods that resonated well with students by examining which strategies produced favorable results and why they were successful. In addition, any challenges experienced were noted. These reflections gave the researchers vital insight into the instruction's efficacy, allowing for appropriate changes.

Furthermore, the evaluation phase incorporates qualitative data from the students collected via a perception questionnaire after the four lessons end. The questionnaire gathered feedback from students on their experiences of learning probability topics, the benefits of employing agricultural scenarios, difficulties faced, and overall interest in the lessons. Subsequently, selected participants were interviewed briefly, with follow-up questions based on their questionnaire responses, allowing for a more in-depth study of their experiences and opinions.

IV. Conclusions and Recommendation

The developed contextualized lesson aligned with the K–12 Mathematics Curriculum Guide: Most Essential Learning Competencies (MELCs). The evaluators regarding organization, contextualization, and usefulness gave the contextualized lessons developed using the ADDIE Instructional Model an 'Excellent' rating. The study presents a comprehensive teaching process followed in implementing the contextualized lessons, which entails 1) posting, (2) using mathematical prompts, (3) discussions, (3) think-pair-share activities, (4) group activities, and (5) assessment. The researchers recommend that mathematics teachers may further integrate practical, real-world contexts into the lessons, such as agricultural concepts that reflect students' experiences and interests, allowing them to see the application of mathematics in the world, especially in everyday experiences, and to further optimize student engagement and learning outcomes in teaching probability using contextualized lessons, The researchers recommend to enhance the comprehensive teaching process outlined in the study continuously.

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