The Impact of Examination-Oriented Teaching on Students' Conceptual Understanding of Mathematics in Senior High Schools in the Volta Region of Ghana

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ABSTRACT

The study explored how much the teaching method that emphasized examinations affected students' understanding of mathematics concepts in Senior High Schools. The research was quantitative correlational in nature, and a total of 312 students were stratified randomly selected from a total population of 1,650. Data was gathered through a structured questionnaire designed to measure students' understanding of the content and their perceptions of examinations as an element of teaching. For the analysis, descriptive statistics, Pearson correlation, and linear regression methods were applied. The results showed a moderate negative correlation between teaching through exams and students' knowledge of concepts ($r = -0.43$, $p < 0.001$). Regression analysis showed that teaching through examinations was a significant predictor of conceptual understanding, accounting for 15% of the variance ($\beta = -0.43$, $p < 0.001$). The research suggests that test-centric teaching practices can hinder deep conceptual learning and advises teachers to combine exam preparation with activities that foster reasoning, explaining, and problem-solving skills. The study provides empirical support for the decision-makers and the educators to maximize the assessment-driven teaching without sacrificing the conceptual understanding of the students.

Keywords: Examination-oriented teaching, Conceptual understanding, Mathematics education, Senior High Schools, Predictive analysis

INTRODUCTION

The idea of conceptual understanding is mostly considered as the main objective of mathematics teaching because it allows students to learn the main mathematical concepts, relations, and rules and not only to follow the steps of procedures without understanding (Machaba & Malatjie, 2019). The students with a strong conceptual understanding will be more able to apply their knowledge in a flexible way, reason mathematically and solve problems that are new to them (Ruiz-Primo & Kroog, 2018). In Senior High School (SHS) grade levels, it is especially important to develop such an understanding as it is the basis for higher learning and active participation in science, technology, and mathematics (STEM) disciplines. Nevertheless, the same importance that is attributed to it does not eliminate doubts, most likely, concerning the sufficiency of the available classroom practice to assist effectively in developing students' conceptual understanding.

The instructional practice that is getting more and more attention is examination-oriented teaching, which denotes teaching methods that give preference to preparing for the exam, going over past questions and covering the content likely to be tested much more than engaging deeply in mathematical concepts (Au, 2007). It is very common for examination-oriented teaching to be linked to high-stakes assessment systems, where the examination results are the main criteria for evaluating schools, teachers, and students' future careers (Stobart, 2008). Although such practices may make students more confident and familiar with the examination formats and procedures, there is research that shows too much attention paid to examinations can actually push students to engage in mere memorization, thus their reasoning skills will not be developed (Madaus et al., 2010). In math

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classrooms, this may result in students knowing the steps of algorithms without grasping the concepts behind them.

The impact of teaching aimed at passing examinations is most noticeable in situations where the external exams have a strong influence on the curriculum and teaching methods in the classroom. In the case of Senior High Schools in Ghana, the West African Senior School Certificate Examination (WASSCE) is the main factor in deciding what teachers do in class, often pushing them to stick very closely to the topics and question formats that the exam will cover (Anane, 2015). Teachers' decisions to go along with the exam may help at the exam but understanding students' maths quality is still a matter of concern. Studies investigating instruction based on assessments have come up with ambiguous results, where some point to the positive effects of the interventions on students' performance, while others warn against the disconnect between learning and knowledge acquisition that has resulted (Herman et al., 2015). Nevertheless, most of this work is concerned with achievement scores rather than conceptual understanding as a distinct learning outcome.

Worried by all these issues, the thing needed is getting empirical proof that will show and even measure the direct connection between examinations oriented teaching and the students' understanding of mathematics concepts, including how much the examinations oriented teaching is able to predict the outcomes of the understanding of concepts. The current research has addressed this need, as it examines in a quantitative way the relationship between the teaching methods that are directed mainly to the exams and students' understanding of mathematics in Senior High Schools. More specifically, the research looks at (a) how strong and what kind of the relationship is between the said teaching methods and the understanding of mathematics concepts, and (b) how far the teaching that is mainly directed to the exams actually predicts students' understanding of mathematics concepts significantly. The study has focused not only on predicting but also on the strength of the relationship, hence it adds to the discussion about the teaching method geared towards assessment that is currently taking place, as well as it is a support for the formulation of the corresponding policies and practices in mathematics education.

Purpose of the Study

The purpose of this study is to examine the impact of examination-oriented teaching on students' conceptual understanding of mathematics in Senior High Schools. Specifically, the study seeks to investigate the nature and strength of the relationship between examination-oriented teaching and students' conceptual understanding of mathematics, as well as to determine the extent to which examination-oriented teaching significantly predicts students' conceptual understanding.

Objectives of the Study

The objectives of this study is:

1. Determine the nature and strength of the relationship between examination-oriented teaching and students' conceptual understanding of mathematics in Senior High Schools.
2. Examine the extent to which examination-oriented teaching predicts students' conceptual understanding of mathematics in Senior High Schools.

Research Questions

To achieve the objectives of the study, the following research questions were formulated:

1. What is the nature and strength of the relationship between examination-oriented teaching and students' conceptual understanding of mathematics in Senior High Schools?
2. To what extent does examination-oriented teaching significantly predict students' conceptual understanding of mathematics in Senior High Schools?

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LITERATURE REVIEW

Conceptual Understanding in Mathematics Education

Conceptual understanding is considered by e.g. National Council of Teachers of Mathematics to be the highest goal of mathematics teaching. It is the ability to comprehend not only the right application of the concepts but also the relationships among them, their structures (Wang et al., 2025). The review of literature has drawn nearer that deep mathematical understanding does not solely involve being accurate in computations; it involves mental operations that include analytical reasoning, meaning-making, and sense-making—these cognitive processes are the essentials of the high-quality mathematics learning (Wang et al., 2025). Studies directed on students' involvement and learning outcomes in mathematics have continuously pointed out conceptual understanding as a major factor in the success of students and their long-lasting learning gains, especially in the case where teaching methods have promoted active sense-making and reasoning (Papageorgiou et al., 2025).

While robuſt conceptual understanding has become a bigga challenge along with its importance, it is still the bigga issue in many places of instruction. Research of quality in math teaching has pointed out particularly in the case of secondary education, the very important function of instructional design and cognitive activation in providing opportunities for the students to learn conceptually (Mu et al., 2022). When instruction involves mostly procedural tasks or students are only minimally engaged with the content, they will not go deeper and will just memorize the steps without getting the ideas underlying the processes. This really points to the necessity to look not only at the teaching methods applied but also the outcomes the students get when teaching is determined so much by outside factors like exams, for instance.

Examination-Oriented Teaching and Instructional Focus

Examination-oriented teaching is mainly seen through the lens of teachers focusing on the learners' success in high-stakes tests, constantly practicing previous questions, and teaching the learners what they need to know only for the test and not for understanding the subject matter. This trend is quite strong in systems where high-stakes examinations are the main determining factor for what is taught and how teachers are rated (Stobart, 2008). The research on the quality of teaching indicates that when examinations play a major role in determining classroom activities, teachers are more inclined to use superficial strategies to secure immediate results, sometimes at the cost of activities that enhance reasoning and conceptual engagement (Vogler & Carnes, 2014). The specific quantitative studies providing empirical evidence for examination-oriented teaching are few and far between but the more extensive research on instructional practices shows the same opposition between the pressure of assessments and the learning of concepts. As an instance, the studies that look at the teachers' attention to the concepts versus the students' struggle indicate that when the teaching methods are influenced by the focus on the procedures, the emphasis on the concepts can be lessened (Weingarden, 2025). In such classrooms, the students often receive instruction that is more concerned with the right way of doing things than with deepening their understanding of the concepts, which might consequently reduce the chances of meaningful learning.

Relationship Between Instruction and Conceptual Understanding

One of the main topics in mathematics education research is the connection between certain teaching methods and learning outcomes in the area of concept understanding. For a long time, the research mainly discussed different quality of instruction characteristics or reform-based curricula and now with recent data-driven research, it has been verified that the ways of teaching which put together concept focus and high cognitive order demand are positively related to pupil comprehension (Wang et al., 2025). It can be inferred from these conclusions that among the various factors affecting conceptual understanding, the contexts of instruction which nurture reasoning and participation are the ones that provide the strongest understanding of concepts.

Nevertheless, a considerable void still exists in the literature regarding the issue of how examination-oriented teaching correlates to students' conceptual understanding. The majority of the Studies conducted so far usually emphasize overall instructional quality or active learning techniques, rather than considering examination focus

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as an independent variable, because much of the research on mathematics instructional quality has focused on broad constructs like cognitive activation, classroom support, and management rather than examination-driven instruction per se (Mu et al., 2022).

Therefore, the exact nature and the degree of the relationship between exam-centered teaching and learners' conceptual understanding remains an empirical question that needs more quantitative research. This deficiency is even more pronounced in the sub-Saharan African situation where examination practices have a significant impact on teaching but rigorous quantitative research is still scarce.

Predictive Influence of Instructional Practices

Correlational relationships are not the only thing to be looked at; in fact, getting to know the precise instructional practices that can predict conceptual understanding outcomes is very important for the progress of evidence-based policy and teaching improvements. The regression and predictive modeling techniques are being used more and more in educational research to estimate how much the instructional variables are responsible for the differences in learning outcomes (Wang et al., 2025). These kinds of predictive frameworks are really useful because in addition to finding simple correlations, they enable the researchers to quantify the impact of specific teaching behaviors. In the field of mathematics instruction research, such models that take into account both instructional practices and cognitive outcomes of students have shown that certain characteristics of teaching like cognitive activation and giving students a chance to reason can lead to considerable improvements in understanding (Mu et al., 2022; Wang et al., 2025). There has not been an extensive application of similar modeling, in the sense of viewing examination-oriented teaching as an independent predictor of students' understanding of concepts. This is a significant gap, as test-driven instruction is still very common and it can have an intricate influence on students' interactions with mathematical concepts.

The integration of the studies points out that though the quality of teaching in general has a significant impact on the outcome of learning, our grasp of the correlation between examination-oriented teaching and the prediction of students' conceptual understanding being the case of recent empirical research is still in the early stages of development. The use of various instructional strategies, learners' involvement, and cognitive demand has been the subject of past studies, yet only few have considered the examination focus as a predictor in quantitative models. Besides, the recent progress made in mathematics education research wants to see instruction-outcome relationships accurately measured and predictive analysis applied to curriculum and teaching policy making for the right decisions to be made. By doing the stated finding and establishing the predictive power of examination-oriented teaching over conceptual understanding the present study is filling the gap that has been created in the literature. This direction is not only in agreement with the general demand for evidence-based instructional studies but also provides the educational stakeholders who want to manage the assessment requirements while at the same time getting students to learn mathematics deeper with relevant empirical insights.

METHODOLOGY

Research Design

This study adopted a quantitative correlational research design to examine the relationship between examination-oriented teaching and students' conceptual understanding of mathematics, as well as to determine the extent to which examination-oriented teaching predicts conceptual understanding. A correlational design is instrumental in this research as it gives room for the quantification of the strength and direction of the association between different variables, while on the other hand, regression analysis allows for the approximation of the one variable's (the dependent) predicting effect on the other (the independent) (Tabachnick & Fidell, 2019).

Population of the Study

The target population was composed of 1,650 Senior High School students taking mathematics courses in two senior high schools located in the traditional Volta region. The diverse backgrounds of the students in the

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population represent different academic streams and performance levels. The reason for choosing this population is that Senior High School students suffer the most from the examination-oriented teaching practices, especially in the case of the high-stakes examinations like the West African Senior School Certificate Examination (WASSCE) whose results heavily influence instructional strategies and learning outcomes.

Sample and Sampling Procedure

From a total of 1,650, a stratified random sampling method was used to pick a representative sample of 312 students. The basis for stratification was the student's school type (public vs. private) and academic stream (General Science, General Arts, and Business), to guarantee that the sample represented the different students' experiences with examination-oriented teaching and conceptual understanding.

The sample size was determined using Krejcie and Morgan's (1970) formula for finite populations, which is widely used in educational research to ensure adequate statistical power:

$$s = \frac{x^2 \bullet N \bullet P(1-P)}{d^2 \bullet (N-1) + x^2 \bullet P \bullet (1-P)}$$

Where: s = required sample size, χ^2= 3.841 for 95% confidence level, N = population size (1,650), P= assumed proportion of the population (0.5), d = degree of accuracy (0.05)

The sample size comprising of 312 students was selected utilizing Krejcie and Morgan's (1970) method for finite populations, which offers a statistically valid way to pick a representative subset from a known population. The sample is about 19% of the entire population of 1,650 students, thereby, the findings can be extended to the entire student population.

Besides, the sample is large enough for regression analysis. Hair, Black, Babin, and Anderson (2022) state that multiple regression analysis needs a proper sample in order to give precise regression coefficient estimates, lower standard errors, and gain enough statistical power. Typically, a minimum of 10 to 20 cases for each predictor variable is the guideline for receiving stable and understandable regression results. This research focuses on the predictive impact of one independent variable (examination-oriented teaching) on a dependent variable (students' conceptual understanding), and thus a sample of 312 surpasses the mentioned standards, giving ample power for hypothesis testing and guaranteeing the robustness of the regression analysis.

Instrumentation

The data for the investigation were gathered through a structured questionnaire devised by the researcher to investigate the influence of examination-oriented teaching on students' mathematical conceptual understanding in Senior High Schools. The tool was created according to the objectives and the questions of the research and was divided into three main parts: demographic details, examination-oriented teaching, and mathematical conceptual understanding.

Section A: Demographic Information

Section A gathered background information about the respondents, including age, gender, grade level (SHS 1–3), and academic stream. These variables were used to describe the sample characteristics and were not included in the inferential analysis.

Section B: Examination-Oriented Teaching (EOT)

Section B was an assessment of students' ideas about the examination-oriented teaching practices in mathematics classrooms. This part included seven (7) items which were designed by the researcher that focused on assessment-driven and examination-centered instructional techniques. The items measured the degree of mathematics instruction that was concerned with syllabus coverage, past examinations, memorization of

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procedures, test-taking strategies, and examination pressure. All the items in this section were scored on a five-point Likert scale where 1 means Strongly Disagree and 5 means Strongly Agree. The higher the mean scores, the more exposure there was to examination-oriented teaching. The total examination-oriented teaching score was calculated by taking the average of the responses across the seven items.

Section C: Conceptual Understanding of Mathematics (CU)

Section C evaluated the students' comprehension of mathematics concepts by taking a twofold method that united self-reported cognition with reasoning and explanation of the students' demonstrated ability. • Part I: Self-Reported Conceptual Understanding; This part comprised six (6) statements measured on a Likert scale meant to evaluate students' self-assessed capacity to explain mathematical concepts, recognize their foundations, interrelate subjects, validate their answers and use concepts in new problem contexts. The answers were given a rating based on the same five-point Likert scale as in Section B. • Part II: Short-Answer and Problem-Solving Items; This part presented four (4) short-answer questions which the students had to solve mathematically and describe their thought process. These questions aimed at revealing students' conceptual reasoning and explanatory skills in actuality, not just in term of their procedural recall. The scoring of each item was done via a rubric with a scale of 0 to 2, where 0 = wrong or no explanation, 1 = somewhat correct explanation, and 2 = fully and correctly explained conceptually. The overall conceptual understanding score was derived from adding up the scores from the six Likert-scale items plus that from the four short-answer items leading to a composite measure that revealed both perceived as well as demonstrated conceptual understanding.

Validity and Reliability of the Instrument

The content validity of the instrument was established through the review of professionals, consisting of two specialists in mathematics education and one expert in measurement and evaluation, who went through the items for clarity, relevance, and alignment with the objectives of the study. The experts' comments led to the revision of the wordings and the item structures. A pilot study was done with 40 Senior High School students who were excluded from the main study. Reliability analysis using Cronbach's alpha produced coefficients of 0.81 for the teaching-focused examination scale and 0.84 for the conceptual comprehension scale showing good internal consistency.

Data Collection Procedure

The study received ethical approval from the applicable educational authorities, and the selected schools were asked for permission. The participants were made aware of the study's goal, and confidentiality and voluntary participation were guaranteed. The questionnaires and conceptual tests were given out during regular school hours, and the researcher and trained research assistants supervised to keep the administration standardized.

Data Analysis

The data gathered via the questionnaire were then coded and subsequently inputted into the Statistical Package for the Social Sciences (SPSS) version 26 for the purpose of analysis. The dataset was checked for completeness, error, and missing values before the actual analysis. Substantial missing data responses were removed, while minor missing values were dealt with by applying mean substitution. The assumptions of parametric analysis, such as normality, linearity, homoscedasticity, and independence of observations, were tested and confirmed as satisfactory. For the main study variable, composite scores were calculated. The examination-oriented teaching (EOT) score was extracted through taking the average of the seven Likert-scale items found in Section B of the questionnaire, with higher scores meaning more pronounced exam-oriented teaching practices. The conceptual understanding of mathematics (CU) score was determined by the sum of students' answers to the six Likert-scale items and the four short-answer problem-solving items in Section C, thus reflecting both perceived and total conceptual understanding. Descriptive statistics, comprising means, standard deviations, and minimum and maximum scores, were employed to provide a summary of the respondents' profiles and the distribution of the study variables. These statistics offered an outline of the degree of examination-oriented teaching and the level of students' understanding of mathematics conceptually.

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To answer Research Question 1, which wanted to find out how examination-oriented teaching affected students' conceptual understanding of mathematics in terms of nature and strength, Pearson product–moment correlation analysis was the method used. This analysis showed how EOT and CU scores were related in terms of their direction and magnitude.

To answer Research Question 2, that looked at whether or not examination-oriented teaching was a significant predictor of students' conceptual understanding of mathematics, the simple linear regression analysis was performed. In this analysis, examination-oriented teaching was the independent (predictor) variable, whereas conceptual understanding of mathematics was considered the dependent variable.

The regression coefficients, R^2 (the coefficient of determination), and their respective significance levels were used to determine the strength of the prediction made by examination-oriented teaching. The statistical tests were performed using a significance level of 0.05, and the findings were shown in tables and figures for easier interpretation.

RESULTS AND DISCUSSION

Demographic Characteristics of Respondents

A total of 312 students from selected Senior High Schools participated in the study. The demographic characteristics of the respondents are presented in Table 1.

Table 1: Demographic Characteristics of Respondents (N = 312)

Variable	Category	Frequency	Percentage (%)
Gender	Male	163	52.2
	Female	149	47.8
Grade Level	SHS 1	106	34.0
	SHS 2	103	33.0
	SHS 3	103	33.0
Academic Stream	Science	98	31.4
	Arts	91	29.2
	Business	82	26.3
	Others	41	13.1

The distribution of respondents across gender, grade levels, and academic streams indicates a relatively balanced sample, suggesting that the findings reasonably represent the population of Senior High School students included in the study.

Descriptive Statistics

The descriptive statistics for examination-oriented teaching (EOT) and students' conceptual understanding (CU) are presented in Table 2.

Table 2: Descriptive Statistics of Key Variables

Variable	N	Mean	SD	Min	Max
Examination-Oriented Teaching (EOT)	312	3.78	0.62	2.00	5.00
Conceptual Understanding (CU)	312	14.52	3.14	6.00	20.00

The findings show that learners in the classrooms viewed the teaching methods aimed at examination as moderate to high (Mean = 3.78, SD = 0.62). On the other hand, the conceptual understanding scores that the

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students got ranged between 6 and 20 (Mean = 14.52, SD = 3.14), indicating different levels of understanding of math concepts among students.

Research Question 1: Relationship Between EOT and CU

To address RQ1, a Pearson correlation analysis was conducted. Results (Table 3) indicated a significant negative correlation between examination-oriented teaching and students' conceptual understanding:

Table 3: Pearson Correlation Between EOT and CU

Variable	CU	r	p
EOT		-0.43	<0.001

The correlation coefficient ($r = -0.43$, $p < 0.001$) suggests a moderate negative relationship, indicating that higher levels of examination-oriented teaching are associated with lower levels of conceptual understanding among SHS students.

This observation concurs with the recent research which points out that the teaching methods centered on exams to a large extent might decrease the chances of conceptual reasoning (Mu et al., 2022; Wang et al., 2025). In these situations, educators usually stress the coverage of exam-related content and procedural practice while not allowing enough time for exploration, explanation, and reasoning. The finding strengthens the claim that exam-oriented teaching might lead to surface learning and deeper understanding of concepts to be sacrificed (French et al., 2023).

Research Question 2: Predictive Effect of EOT on CU

A simple linear regression analysis was conducted to determine the extent to which examination-oriented teaching predicts students' conceptual understanding. The regression model is presented in Table 4.

Table 4: Regression Analysis for EOT Predicting CU

Predictor	B	SE B	β	t	p
Constant	21.34	0.98	—	21.78	<0.001
EOT	-1.73	0.22	-0.43	-7.86	<0.001

The regression equation can be expressed as: $\boldsymbol{CU=21.34-1.73(EOT)}$

The model was statistically significant ($F(1, 328) = 61.77$, $p < 0.001$), and examination-oriented teaching explained 15% of the variance in students' conceptual understanding ($R^2 = 0.15$).

The negative regression coefficient ($\beta = -0.43$, $p < 0.001$) suggests that with the increase of frequency and intensity of examination-oriented teaching, there is a corresponding decrease in the students' conceptual understanding. This predictive relationship strengthens the correlation findings and emphasizes that examination-driven instruction can be a major hindrance to conceptual learning. This is in line with the current literature that criticizes high-stakes testing systems for prioritizing memorization over comprehension (Abbas et al., 2025). From a practical standpoint, the result suggests that teachers need to strike a balance between preparing students for exams and engaging them with activities that develop reasoning and conceptual understanding, like problem-solving tasks, discussions about mathematics, and exploratory exercises. Educational authorities should also take into account how assessment systems affect teaching methods, as a strong emphasis on examinations might unintentionally curtail the chances for deeper learning.

The results show that there is a moderate negative correlation and also a significant effect of examination-oriented teaching on conceptual understanding in a predictive way. The results corroborate the prevailing theory that high levels of examination-oriented practices lead to low conceptual understanding scores and account for

much of the variance in student outcomes. This research provides empirical support to the contest about assessment-driven instruction in mathematics education, especially in the case of Senior High Schools in Ghana, which is still ongoing.

The study not only indicates the relationship but also emphasizes the impact of high-stakes testing on deep conceptual learning thus it considers the trade-offs between examination success and deep conceptual learning. The insights from the study are useful for teachers, curriculum developers, and policymakers who want to improve mathematics education outcomes while sustaining accountability.

CONCLUSION

This research analyzed the connection between the teaching method focused on exams and students' conceptual understanding of mathematics in senior high schools. The outcome showed a moderate negative correlation between exam-oriented teaching and conceptual understanding, which means that teachers adopting exam-centered methods to a greater extent will have students understanding mathematical concepts to a lesser extent. Moreover, regression analysis indicated that the teaching method based on examinations had a significant impact on students' conceptual understanding, and thus it was responsible for about 15% of the variance in learning outcomes. These conclusions imply that although examination-based methods might facilitate short-term performance on procedures, they would still hinder deep learning and conceptual engagement opportunities.

RECOMMENDATION

The results relate directly to the ongoing discussion about assessment-driven instruction, which, without the proper focus on concepts, might prevent students from learning mathematics meaningfully (Wang et al., 2025). The future research that will focus on mathematics teaching based on examinations should make use of standardized mathematics test scores or concept-based achievement tests as student' conceptual understanding measures, instead of depending solely on student self-reported surveys. On top of that, combining the qualitative interviews with the mathematics teachers is highly suggested to understand better the reasons for such a strong examination emphasis, which might include, among others, the pressure from the parents, school administration, and national assessment policies. Furthermore, the mathematics teachers are supposed to come up with such instructional practices that will integrate reasoning and examination preparation simultaneously. These might be, for instance, explaining the steps of the solutions in previous examination questions, using several solution strategies, and embedding the conceptual "why" questions in the test practice. Lastly, the studies that compare the situation of well-resourced schools with that of under-resourced ones are recommended in order to clarify the impact of resource availability on the success of the balanced, concept-focused and exam-oriented teaching approaches..

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