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Effect of Formative Assessment Methods on Mastery of Mathematics Course Content by Junior Secondary School Students in Obio-Akpor LGA of Rivers State

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Abstract: *Formative assessment remains one of the most regular assessment tools which most teachers adopt in the process of assessing the performance of students. However, apart from just providing insight to the teacher, these methods over the years remain controversial on its ability to help students in gaining mastery of course content. Hence, the study focus on effect of formative assessment methods on mastery of mathematics course content by junior secondary school students in Obio-Akpor LGA of Rivers state. The study adopted the pretest-posttest quasi-experimental research design. Three specific objectives and corresponding hypotheses guided the study. The population of the study consisted of 14,350 junior secondary school students in public schools in Obio-Akpor LGA of Rivers State. The sample size included eighty (80) participant drawn using multi-stage sampling process. The "Junior Secondary Mathematics Test" (JSMT) was used as instrument for data collection. Table of specification was used to validate the test while KR_{21} was used in determining a reliability index of 0.88. Participants were randomized into three experimental groups and one control group. Specifically, group A, B and C consisted of 20 participants who were given class test, take home assignments as well as engaging in class discussions respectively. Group D was tagged as the control group. In determining the cut off score for mastery of JSMT, the Angolf method was used by sending JSMT to five judges. From the average, the overall percentage for the five judges stood at 67.7% indicating that for any students to be considered and mastering the "Junior Secondary Mathematics Test" (JSMT), it is required that 34 of 50 test items must be correct. Mean, standard deviation and independent t-test was used in data analysis.*

Keywords: formative assessment, class test, assignments, class discussion, mastery, mathematics.

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INTRODUCTION

Testing in schools is usually thought to serve only the purpose of evaluating students and assigning them grades. Roediger, Putnam and Sumeracki (2011) maintained that those are important reasons for tests. Unfortunately, most teachers view tests (and other forms of assessment, such as homework, essays, and papers) as necessary evils. Traditional education systems often identify the gaps in knowledge without any plan or process to fill them. Mastery learning adheres to the principle that students must demonstrate proficiency or mastery in knowledge, content, and skills. If a student is not able to demonstrate mastery, he or she is provided with additional and differentiated support to first re-learn the material and is then reassessed on it. Mastery refers to having great skill at something or total dominance over something mastery learning aims to address the limitations of teacher-centered approaches. It requires students to completely comprehend a lesson, regardless of the time and resources needed, before moving to the next level (Chargois, 2013). Furthermore, with the complexities of the human mind as explored by the information processing model, this educational model necessitates teachers to personalize the students' learning experience, allowing some learners to have additional time to understand the lesson or develop a particular skill. In a manner, mastery learning empowers students to progress at their own pace. Although the movement to adopt mastery-based approaches in education systems gained momentum only in recent past decades, the concept of mastery learning theory is not new. Its practice was first outlined by Benjamin Bloom in the 1960s, stating that students can master any task given the right conditions (Kampen, 2019). Bloom's Learning for Mastery (LFM) strategy evolved and was later on implemented in primary and secondary school settings. Its basic features are as follows (McNeil, 1969, as cited in Chargois, 2013). At its core, mastery learning presumes that students can truly gain mastery over the subject or high levels of mastery in any academic content if they are provided with favorable learning conditions. As researchers and educators alike continuously propose new ways to improve the application of mastery-based approaches in schools, research has consistently linked effective instruction and learning to the six elements of mastery learning model (Guskey, 2010).

Mathematics as a core subject in the curriculum has been a problem for many students except few as reported by Obinna (2009). Student's performance in mathematics is the extent to which student master the subject matter. Students at different point or the other may record high achievement in mathematics. At some point, they may as well record very poor grades. Infact, as noted by the Joint Admission and Matriculation Board (JAMB, 2012), only 18% of candidates sitting for JAMB make a pass mark in mathematics at first sitting. This remark is however very alarming and gives ground for urgent concern. Student's academic performance in Mathematic could be measured through the use of test procedures. Over the years, the outcome of such measurement has given scholars cause for concern. According to Ali (cited in Tei-Firstman, (2011) majority of students find it difficult to master mathematics. This trend is even worsened by the hate developed by

students towards the subject. In a similar opinion, Dike (2012) noted that mathematics as a subject scares many students. Some develop negative attitude towards the subject and their teachers and this has a subsequent negative effect on their performance both in terminal as well as external examinations. Dike (2012) also added that there are so many factors that militate against student's performance in the subject. Factors like environment which comprise both the immediate (home) and the school, the teachers, peer group etc, were all identified as forces behind student's underachievement in mathematics.

The extent of mastery of mathmatics vis-a-vis academic achievement of students in schools subject has been a great concern to teachers, parents, educational administrator and government. Irrespective of the Despite all their efforts, it is observed that many students are finding it too difficult to pass mathematics judging by their learning outcomes in both internal and external examinations (Adebule, 2014) The reasons for this difficulty may vary but could be ascribed to the type of formative assessment practices adopted by teachers to test their mastery level. For instance, Adeagbo, Mafikuyomi and Oluwafemi (2015) in Oluwafemi, et'al (2019). observed that poor academic performance of students is caused by poor strategies and approaches of teaching, lack of instructional materials as well as poor or wrong assessment strategies.

Assessment according to Huba and Freed (2000) is the process of gathering and discussing information from multiple and diverse sources in order to develop a deep understanding of what students know, understand, and can do with their knowledge as a result of their educational experiences; the process culminates when assessment results are used to improve subsequent learning. Opara and Uwah (2017) stated that it is the systematic basis for making inferences about the learning and development of students. It is the process of defining, selecting, designing, collecting, analyzing, interpreting, and using information to increase students' learning and development. There are various forms of assessment and one of such is formative assessment.
Formative assessments are administered throughout the year, usually by classroom teachers. Their primary purpose is to inform teachers about how their students are progressing, where gaps exist in students' learning, and how their instruction needs to be adjusted to improve student learning, possibly by slowing down the pace, repeating instruction, or even challenging some students with new and potentially more difficult tasks. Abdulahi (2013) observed that formative assessments do not have to be formal tests. They often also include informal activities like hand signals, brain dumps, etc. which gives teachers informal and immediate feedback on student learning. They are often embedded as learning activities such as using concept maps or journal entries which means this can be assessment **as** learning. Even though some of these are very informal (like a thumbs up or thumbs down), teachers can use this data (be it quantitative or qualitative) to adjust their instructional groupings or reteach specific skills to students who seem to need help.
An assignment is a piece of (academic) work or task. It provides opportunity for students to learn, practice and demonstrate they have achieved the learning goals. Assignment method has to do with investigation and solving of problems either by an individual or a group of individuals. It provides

the evidence for the teacher that the students have achieved the goals. The output can be judged using sensory perception (observing, reading, tasting etc.). Olojo (2023) stated that one cannot overstate the importance of homework in educational environments. In addition to helping students become more motivated learners, homework also gives students a chance to connect their educational experiences with those of their families, gives parents and teachers a chance to observe and provide comments, and helps students get ready for upcoming sessions. For the Teachers (2017) maintained that students learn best when instruction is appropriately challenging, based on real world problems and situation, purposeful, meaningful, interesting and gives them chance to practice what is being taught in a meaningful and interesting context. One of the ways to actualize this is assignment method. Assignment method is a method that allows learners to decide how they will demonstrate that they have learned the required information or skills in a manner of ways either by writing, speaking, drawing, illustrating and building (Jones & Bartlett, 2014).

In addition, students can engage in independent study thanks to homework, which encourages them to pursue their own interests outside of class. In addition to preparing students for upcoming classes, homework also allows instructors and parents to reflect on students' work and provide comments (Chaya, 2021; Haq, et al., 2020). There is still some debate on whether or not homework is beneficial to students' education, despite the positives that have been cited. Proponents of homework argue that it helps students learn and perform better in the classroom; opponents point out that it can have unintended consequences such as increased stress, less time spent with loved ones, a heavier workload, technical difficulties, student dishonesty, a lack of parental oversight, and a wider gap in academic achievement. Whether or whether assigning homework to students in secondary school improves their performance in computer science is now the most pressing issue in this field. Assignments have contributed to a significant aspect of academic education since old age. It is incorporated so that students can and should pay attention to their tasks. According to academic influencers, the growth of humans is directly proportional to the utilization of the brain. So, doing an assignment again and again increases the percentage of brain activity. So, if students put in more effort, they can automatically lead their future to succeed. Assignments and homework help students to aid their future success and demonstrate the achieved goals in front of others to motivate them. Even during study in School and university, students learn the process to complete their syllabus before the exam within the stipulated time.

The effects of homework on academic achievement have been studied by academics. In their research on computer science education in junior high schools in Ado-Ekiti, Ekiti State, Ajayi and Okoh (2021) discovered no indication of a substantial association between take-home assignments and students' academic achievement. Furthermore, Ojo and Oyewole (2019) found no significant difference in the performance of high achievers in the three groups before and after assigned homework. The average performance across the three groups was also not significantly different before and after homework was assigned. Last but not least, they found no appreciable change in low-performing students' grades across the three groups either before or after the distribution of

homework assignments. This suggests that the experimental area did not suffer any unfavourable effects from homework. To the best of this researcher's knowledge, no studies on computer science have been done in Ikere Local Government Area, despite studies on homework and student performance having been done in other Local Government Areas in the state of Ekiti.

Furthermore, by doing assignments, students can lead themselves towards improvement and higher excellence. They can also enhance their learning ability and skill-driven potentialities. The assignment helps children to brainstorm at home or after school hours which are needed to keep them focused and it also helps to learn new things continuously. So, this educational system greatly benefits and encourages students to be better prospects. The roles of assignments in supporting learning are many, and these help students implement and incorporate different aspects in their academic careers. Also, the structural design of jobs builds the foundation of every student's educational journey. Many tasks seem terrestrial, but these block a student's future. Most importantly, assignments help students to develop learning processes throughout their life. They start to think and innovate new ideas, topics, questions, and research skills to produce unique aspects of specific content from their agenda. A quality teaching and learning system is the key signature of practical education.

According to Ghafar (2024) stated that the use of classroom debate as an instructional technique is prevalent, particularly in secondary and higher education. He also noted that there have been several studies examining the effects of classroom discussion in areas such as second language acquisition, philosophical thinking, psychology, and pure science, there is a lack of particular research in the subject of administrative science. According to Burns and Joyce (1997), speaking is a communication activity that focuses on meaning-building and entails the creation, acquisition, and processing of information. Discussion on the other hand, refers to the capacity for accurate, precise, and useful verbal communication in the target language. Discussion is a crucial ability and the primary means of communication for instructors. According to Rebecca (2006) youngsters use discussion to learn a language. Discussion has a significant role in driving changes in a language and encompasses a substantial part of daily engagement in language-related activities for almost all individuals. Gafar (2024) argued that discussion serves to develop proficiencies in critical thinking, analysing, synthesising, and spontaneous speaking. According to Krieger (2005), several students demonstrated significant improvement in their capacity to articulate and justify their views by engaging in discussion and debate exercises.

Furthermore, the students often and promptly identified the shortcomings in one another's arguments. This talent is regarded as a fundamental aspect of critical thinking abilities, whereby students are anticipated to review and scrutinise the information they acquire in a critical manner**.** According to Nisbett (2003), discussions and debate is a significant educational technique that helps develop analytical thinking abilities and encourages individuals to critically evaluate the

validity of their views. Facione and Facione (2008) stated that critical thinking abilities consist of analytic thinking skills and the ability to consciously reflect on and monitor one's own ideas trough discussion. In the conventional method of instruction, such as using a chalkboard and lecturing, students adopt a passive role and receive lectures from their educators. Thus, learners have limited opportunities to actively engage in the learning process, express their perspectives, and enhance their critical thinking skills. From this premise, it therefore means that giving student class discussion may play a part in determining the extent to which they aster course content.

The researchers observed that the common conventional teaching methods do not sufficiently fit the demand of present-day students whose motive is to seek freedom and creativity because the methods do not give them the opportunity to participate in the classroom and therefore do not acquire skills and knowledge they require. Moreover, Umar, Abdulahi and Hassan (2015) asserted that students-centered strategy which assignments, classwork and discussion are capable of improving academic achievements in school subjects significantly than the conventional teaching methods. Hence, the aim of the study is to investigate the effect formative assessment methods on mastery of course content by secondary school students in Rivers state. Specifically, the study intends to;

1. Investigate the effect of class test on mastery of course content among secondary school students in Rivers State.
2. Find out the effect of assignments on mastery of course content among secondary school students in Rivers State.
3. Find out the effect of class discussion and interaction on mastery of course content among secondary school students in Rivers.

The following research questions guided the researchers in the study;

1. What is the effect of class test on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups?
2. What is the effect of take home assignments on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups?
3. What is the effect of class discussion and interaction on mastery of mathematics course content among secondary school students in Rivers as compared between the experimental and control groups?

The following hypotheses were also formulated to guide the study;

1. There is no significant difference in the effect of class test on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.
2. There is no significant difference in the effect of take home assignments on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

3. There is no significant difference in the effect of class discussion and interaction on mastery of mathematics course content among secondary school students in Rivers as compared between the experimental and control groups.

METHODS

We adopted the pretest-posttest quasi-experimental research design. Three specific objectives and corresponding hypotheses guided the study. The population of the study consisted of junior secondary school students in public schools in Obio-Akpor LGA of Rivers State. Data available in the Rivers state Secondary School Board showed that they are 14,350 junior secondary school students in the 21 public schools in Obio-Akpor. We drew eighty (80) junior secondary school students across the 21 public schools in the area using multi-stage sampling process as participants in the study. At stage one, we used simple random sampling by ballot to select four schools from Obio-Akpor. All the names of the public schools in the area were written in pieces of paper, they were folded and with blindfold, we handpicked four pieces which revealed the names of the schools to be used. At the second stage of the sampling, purposive sampling technique was used to focus only on JSS2. This was so because the we did not want to use either JSS1 students who are quite new and still familiarizing with the system neither did we want to use JSS3 who definitely were busy in preparation for their junior WASSCE. At stage three, we used stratified non-proportionate sampling technique to select twenty (20) JSS2 students from each of the schools giving a total of eighty students in all. We developed and used the "Junior Secondary Mathematics Test" (JSMT) as the instrument for data collection. The JSMT is 50 items 4-option multiple-choice mathematics test. We used table of specification to validate the test in line with the syllabus while KR_{21} was used in determining a reliability index of 0.88. In terms of the experimental procedure, the researcher randomized the students into three experimental groups tagged "A, B and C" and one control group tagged "D".

Specifically, group A was made up of 20 participant who were given class test frequently as a means of assessment. Group B was made of 20 participants who were assessed frequently using take home assignments while group C was made of 20 participants who were frequently assessed using class discussions and interaction. Finally group D was also made up of 20 participants who were not given any formative assessment prior to the final or summative exams. We collaborated with the classroom teachers of the participant and alongside their normal classes. Prior to the treatment, we administered the JSMT as a pretest across the experimental and control groups in order to assess level mastery level. After this, the treatment was applied to the participant in the three experimental groups. This treatment was carried out for one full term (3^{rd} term) after which we re-administered the JSMT to them as a posttest. Mean, standard deviation as well as independent sample t-test was adopted as method of data analysis. Again, simple percentage was also adopted in the process of setting the cut-off scores. Furthermore, in determining the cut off score for mastery of JSMT, the Angolf method was used. After the administration, the JSMMT

was sent to five judges who used the item-based Mastery Angoff method without prior examinee performance information to put a cut-off on the test. The judges comprised of experienced junior mathematics teachers from five various schools within the area of study but whose school did not form part of the assessment process. Judges were asked to set standards for each pretest and posttest items. Judges were asked to provide new judgments in in terms of the percentage which each testee must attain. The judges subsequently reevaluated the test items after receiving baseline data about the pre-testing and posttest. The Judges' percentages for both the pretest and posttest are shown in the Table 1 below.

Table 1; Percentage distribution of judges in pretest and posttest level of JSMT

Judge	**Pretest (%)**	**Posttest (%)**	**Average (%)**
1	70%	70%	70%
2	70%	70%	70%
3	70%	70%	70%
4	67%	70%	68.5%
5	55%	65%	60%
Total			**67.7% (34 Items)**

Three judges (1, 2 and 3) set the standard on 70% at both the pretest and posttest judgment. This required getting 35 of 50 items right at the posttest. The forth judge set at 67% and 70% at pretest and posttest level with an average of 68.5% which required getting 34 out of the 50 items correct at the posttest. Finally, the last judge set the standard at 55% and 65% at the pretest and posttest level with an average of 60% meaning that at the posttest level, at least 30 items out of 50 should be gotten right. From the average, the overall percentage for the five judges stood at 67.7% indicating that for any students to be considered and mastering the "Junior Secondary Mathematics Test" (JSMT), it is required that 34 of 50 test items must be correct.

RESULTS

Research Question One: What is the effect of class test on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups?

Hypothesis One: There is no significant difference in the effect of class test on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Table 2: showing Independent sample t-test of the effect of class test on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Groups	N	Pretest		Post test		Mean diff	df	t	Sig	Result
		x̄	St.d	x̄	St.d					
Group A	20	14.85	8.31	35.73	4.33	20.88	18	2.35	0.000	Significant
Control	20	15.71	2.84	18.01	5.82	2.23				

Table 2 shows that participants in the experimental group who were given class test had a pretest mean and standard deviation values of 14.85 and 8.31 while those in the control had a mean and standard deviation of 15.71 and 2.84. At the posttest level, those in the experimental group had a mean and standard deviation score of 35.73; 4.33 and 18.01; 5.82 respectively. The means difference or mean gain for those in the experimental group is 20.88 while that of the control is 2.23. These mean gain showed that giving class test as part of formative assessment has a positive effect on the mastery level of students. When subjected to independent t-test, calculated t of 2.23 was realized and a sig value of 0.000. Since sig ($p=0.000<0.05$) is less than 0.05 alpha, the null hypothesis is rejected meaning that there is a significant difference in the effect of class test on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Research Question Two: What is the effect of take home assignments on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups?
Hypothesis Two: There is no significant difference in the effect of take home assignments on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Table 3: showing independent sample t-test of the effect of take home assignments on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Groups	N	Pretest		Post test		Mean diff	df	t	Sig	Result
		x̄	St.d	x̄	St.d					
Group B	20	13.55	3.71	22.85	4.01	9.30	18	2.04	0.038	Significant
Control	20	15.71	2.84	18.01	5.82	2.23				

Table 3 shows that participants in the experimental group B who were given take home assignments had a pretest mean and standard deviation values of 13.55 and 3.71 while that of the control remained of 15.71 and 2.84. At the posttest level, those in the experimental and control groups had a mean and standard deviation score of 22.85; 4.01 and 18.01; 5.82 respectively. The

means difference or mean gain for those in the experimental group is 9.30 while that of the control is 2.23. The mean gain showed that giving take home assignment as part of formative assessment has a positive effect on the mastery level of students. A calculated t-value of 2.04 was realized and a sig value of 0.038. Since sig ($p=0.038<0.05$) is less than 0.05 alpha, the null hypothesis is rejected meaning that there is a significant difference in the effect of take home assignments on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Research Question Three: What is the effect of class discussion and interaction on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups?

Hypothesis Three: There is no significant difference in the effect of class discussion and interaction on mastery of mathematics course content among secondary school students in Rivers as compared between the experimental and control groups.

Table 4: showing independent sample t-test of the effect of class discussion and interaction on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

Groups	**N**	**Pretest**		**Post test**		**Mean diff**	**df**	**t**	**Sig**	**Result**
		$\bar{x}$	**St.d**	$\bar{x}$	**St.d**					
Group C	20	14.01	5.22	15.17	3.11	1.16	18	1.16	1.13	Insignificant (Retain H0)
Control	20	15.71	2.84	18.01	5.82	2.23				

Table 4 shows that participants in the experimental group C who were engaged in class discussion and interaction had a pretest mean and standard deviation values of 14.01 and 5.22 while that of the control remained of 15.71 and 2.84. At the posttest level, those in the experimental and control groups had a mean and standard deviation score of 15.17; 3.11 and 18.01; 5.82 respectively. The mean difference or mean gain for those in the experimental group is 1.04 while that of the control is 2.23. The mean gain showed that engaging students in class discussion and interaction as part of formative assessment has little positive effect on the mastery level of students. A calculated t-value of 1.16 was realized and a sig value of 1.13. Since sig ($p=1.13>0.05$) is greater than 0.05 alpha, the null hypothesis is retained meaning that there is no significant difference in the effect of class discussion and interaction on mastery of mathematics course content among secondary school students in Rivers State as compared between the experimental and control groups.

DISCUSSION OF FINDINGS

Findings one revealed that there is significant difference in the effect of class test on mastery on course content by students between those in the experimental group that were given the test and those in the control who were not given the test. This finding means that class tests have a positive impact and are effective tool for improving student learning outcomes. It also connotes that the significant difference between the two groups shows that testing itself contributes to better understanding and retention of course material and that formative assessment influences student mastery and subsequent performance. In a more general sense, it also means that incorporating class tests into teaching methods can lead to improved student outcomes, and educators may consider adopting this approach to enhance student learning. The finding of the study is not very surprising to the researcher because Abdullahi (2013) also reported similar findings that class test has significant effect on academic performance of students.

From research finding two, it is shown that that there is significant difference in the effect of take home assignment on mastery on course content by students between those in the experimental group that were given take home assignment and those in the control who were not given assignment. This implies that take-home assignments have a positive impact as the experimental group, which received the take-home assignments, showed a greater mastery of course content compared to the control group. This again suggests that take-home assignments are an effective tool for improving student learning outcomes. The reason for this finding could be that this assessment format gives room for autonomous which has further confirm its effectiveness meaning that students who worked on take-home assignments are able to learn and understand the course material more effectively through autonomous learning than those who do not. It also means that assignments enhance understanding and retention of course material leading to improved mastery. The finding of the study once again is expected by the researcher as majority of other findings like that of Chaya (2021) as well as Ajayi and Okoh (2021) have revealed significant effect of assignments on academic performance of students.

Finally, findings three revealed that there is no significant difference in the effect of class discussions on mastery on course content by students between those in the experimental group that were engaged in class discussion and those in the control who were not engaged. It means that class discussions may not be as effective in improving student learning outcomes as expected. It also means that other factors such as individual study habits, prior knowledge, or teaching methods, may have a greater impact on student mastery of course content than class discussions. It may also be that class discussions may not be engaging enough or in the experimental process, the experimental group may not have been engaged enough in the class discussions, or the discussions may not have been facilitated effectively, leading to minimal impact on learning outcomes. This finally means that alternative teaching methods may be needed.

However, the finding of the study is surprising to the researcher and it differs from that reported by other researchers like Gafar (2024) and Krieger (2005) have all reported significant influences of class discussion or discussion method in improving students learning.

Recommendations

Based on the findings, it is recommended that:

1. Teachers should continue to adopts class tests as a regular assessment tool to measure student understanding and progress. They should as well consider increasing the frequency or variety of class tests to further enhance student learning. They should finally analyze test results to identify areas where students need additional support or review.

2. Teachers should continue to use take-home assignments as a valuable teaching tool to promote autonomous learning and understanding.

3. Teachers and educators should re-evaluate the effectiveness of class discussions and consider alternative teaching methods, such as group projects or interactive activities. Where necessary, they should modify class discussions to increase student engagement, interaction, and participation.

CONCLUSION

Formative assessment remains one of the most suitable assessment methods that teachers adopts. Specifically, class tests and take-home assignments are great techniques in improving student mastery of course content. By incorporating regular class tests and take-home assignments, educators can create a supportive learning environment that fosters student success in mathematics. Further research can explore optimal implementation strategies and potential modifications to class discussions to enhance their effectiveness

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