EFFECT OF INTERACTIVE INSTRUCTIONAL STRATEGY (TAVI) ON JUNIOR SECONDARY SCHOOL STUDENTS' MATHEMATICS ACHIEVEMENT

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Abstract

The study investigated the effect of Interactive Instructional Strategy (TAVI) on Junior Secondary School Students' Mathematics Achievement in Ogun state. A 2x2x2 non-randomised control group Pre-test and Post-test quasi-experimental factorial design was adopted. A purposive sampling procedure was used to select four government-owned JSS and an arm of intact class JSS II students was selected. Two validated instruments (MAT & ISP) were used for data collection. Data analysis involved Analysis of Covariance at P < 0.05. The results showed that Treatment ($F_{(1,247)} = 14.13$); Possession of Textbooks ($F_{(1,247)} = 51.21$) and Family Size ($F_{(1,247)} = 34.13$) had significant main effects on Students' Achievement in Mathematics. Possession of Mathematics Textbooks and Family Size ($F_{(1,247)} = 3.87$) had a significant interaction effect on Students' Achievement in Mathematics. Hence, it is recommended that Mathematics teachers should be encouraged through seminars to teach their students using TAVI to improve students' achievement.

Keywords: Interactive Instructional Strategy (TAVI), Textbooks, Family Size and Students' Achievement.

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Background to the problem

In contemporary Nigeria, greater emphasis is being placed on industrial and technological developments. Thus, Mathematics is a universally recognized and accepted as indispensable to self-reliance and sustainable economic development of any nation because of the perceived functional utility. Despite these, there is ample evidence of continued poor performance in the Mathematics by Nigerian Students (Salami & Popoola, 2017; Imoko, & Agwagah, 2014; Tsay, & Miranda, 2010) because of the method of teaching Mathematics at all levels. Some researchers Zakaria and Yusoff (2010) attribute low achievement in Mathematics to the nature of the subject, poor teaching methods, shortage of qualified teachers, shortage of teaching facilities and textbooks, the high workload of Mathematics teachers and poor image of Mathematics in our society amongst other factors. Therefore, it has been observed that strategies for teaching and learning of Mathematics at both the primary and secondary school levels are still not encouraging. Alio and Anibueze (2017); Hassan (2002) attribute students' poor performance to factors as poor methods of teaching Mathematics or lack of Mathematics laboratory and lack of incentive.

Furthermore, the most re-occurring factor in all these studies is the teaching strategy used by the teacher, which cannot inculcate a lifelong learning skill in learners. This, therefore, necessitates further research and a need to search for more effective and

proactive teaching and learning strategies that are more likely to improve learning outcomes in secondary school especially in Mathematics curriculum contents. The strategy of teaching could be regarded as the vehicle through which a message is delivered to the learners or determine the approach a teacher may take to achieve learning objectives. Strategies can be classed as direct, indirect, interactive, experiential, or independent (Teed, Mcdaris & Roseth, 2012).

Besides, Mathematics learning outcomes are influenced by the internal and external factors of the students. One of the influencing external factors is interaction instructional strategy with teacher-student interaction, student-student interaction, the use of audio, visuals, video and hands-on demonstrations and exercises (Ajai, 2018). In modern learning, the learning is student-centred, so student interaction is needed to learn about certain basic competence. Potential and motivation of students in learning are expected to develop with good interaction instructional strategy to get maximum results. Interaction instructional strategy is an important aspect of learning Mathematics because students are actively involved with their learning process. According to Bruce and Marsha (2000), Interactive Instructional Strategy is the strategy that discussion and sharing provide students with opportunities to react to the ideas, experience, insights, and knowledge of the teacher or peer learners and to generate alternative ways of thinking and feeling. Students can learn from peers and teachers to develop social skills and abilities, to organize their thoughts, and to develop rational arguments. Examples of Interactive instruction strategy are Debates, Panels, Brainstorming, Peer Partner Learning, Discussion, Think, Pair, Share, Cooperative Learning, Problem Solving, Tutorial Groups and Team-Assisted Visual Instruction (TAVI) (Richard, 2001; Bruce & Marsha, 2000).

However, for this study, the researcher is interested in Team-Assisted Visual Instruction on the Students' Achievement in Mathematics. Team-Assisted Visual Instruction (TAVI) is an interactive instruction that relies heavily on discussion and sharing among participants. That is, the participants are not more than three and learning materials such as charts, pictures must be provided in the lesson. In the interactive instruction, students are given opportunities to react to the ideas, experience, insights and knowledge of the teachers or peer learners and to generate ways of thinking and feeling. Moreover, students can learn from peers and teachers to develop social skills and abilities, to organise their thoughts and to develop rational arguments (Tobih, 2017, Imoko & Agwagah, 2014). Moreover, this paper involved instructional use of three students in each group working together to maximise their own and each other's learning. The students, in a team setting, are expected to help, discuss and argue with one another, assess one another's knowledge, fill noticed gaps in one another's understanding and instructional materials are presented. The choice of TAVI for instruction in this study is based on the assumption that students learn Mathematics both independently and through collaboration and that, collaborative learning enhances social interaction as well as the spirit of cooperation among learners.

The students' possession of Mathematics Textbooks plays a vital role in achievement school subjects. In other words, Textbooks have a significant impact on the ability of learners to achieve their learning objectives (Omoniyi, 2007). Mathematics Textbooks are printed teaching and learning materials in bound form, the contents of which are properly organised and intended for use in schools' curricula (Johansson, 2006). The

place of good, relevant and adequate number of Mathematics Textbooks in the improvement of secondary school Mathematics cannot be overemphasized. Fajemidagba (2000) and Ale (2001) point out that the paucity of relevant Mathematics Textbooks stands as a basic factor, which affects the teaching and learning of Mathematics in Nigerian secondary schools. Ohanusi (2011) reports that a relatively small amount of the Textbooks are not specifically written for the Nigerian child. She also explains that the authors of the books assume a foundation, which does not conform to the Nigerian primary school pupils. She also states that classroom teaching ought to be related to life situations and must not be theoretically based on the use of Textbooks alone. Johansson (2006) and Monaghan (2006) also find that many Mathematics Textbooks used in secondary schools in Nigeria are difficult concerning the mental level of the secondary school students who use them in their study of Mathematics. Moreover, the results of the study show that generally, less than 40% of the pupils had basic Textbooks and writing materials while teachers' guides were not available even for the World Bank books (Ojim & Nyim, 2012).

Apart from the influence of possession of textbooks, family size is another factor that has been shown to exert considerable influence on students' learning outcomes. Family Size may be considered from two perspectives. At the individual (micro) level, it defines one aspect of an individual's family background or environment. As such, it represents a potential influence on the development and accomplishments of family members. At the societal (macro) level, Family Size is an indicator of societal structure that may vary over time, with concomitant implications for individual development and social relations in different cohorts. Studies on birth order, Family Size and achievement by Akinleke (2017) reveal that Economists, Psychologists and Sociologists have become increasingly aware of the role that the family plays in the future success of children. However, this study presents the effect of Family Size on Learning Outcomes on Junior Secondary School Mathematics.

Statement of the Problem

The difficulties and frustrations encountered by the students in learning Mathematics are often blamed on poor methods of teaching. To foster and enhance teaching for the understanding of the basic concepts in Mathematics, some modern techniques and strategies emerged to meet the Students' needs in Mathematics. The study investigated the effect of Team-Assisted Visual Instruction on Students' Achievement in Junior Secondary School (JSS) Mathematics. The study would also investigate the moderating effects of Students' Possession of Textbooks and Family Size on Achievement in Mathematics

Hypotheses

Based on the stated problem, five hypotheses were tested as follows:

Ho_1: There is no significant main effect of (a) treatment; (b) students' possession of Textbooks; (c) Family Size on Students' Achievement in Mathematics.

Ho_2: There is no significant interaction effect of treatment and students' possession of Textbooks on Students' Achievement in Mathematics.

Ho_3: There is no significant interaction effect of treatment and Family Size on Students' Achievement in Mathematics.

Ho_4: There is no significant interaction effect of Students' Possession of Textbooks and Family Size on Students' Achievement in Mathematics.

Ho_5: There is no significant interaction effect of treatment, Students' Possession of Textbooks, and Family Size on Students' Achievement in Mathematics.

Research design

For this study, the researcher employed a 2x2x2 non-randomised control group Pre-test and Post-test quasi-experimental factorial design. It consisted of one independent variable (treatment) and two moderating variables (Possession of Textbooks and Family Size).

Sampling Procedure and Sample

A purposive sampling method was used to select four Government-owned Junior Secondary Schools (JSS) in Ijebu-Ode Local Government Areas, Ogun state. The purposive sampling method was applied due to time factor, cost-effective and administrative convenience. For this study, an arm of intact class JSS II students was selected from each selected school. JSS II students were chosen because they are not being prepared for any external examination that might distract their attention from full participation in the study. The four selected classes were assigned to experimental and control groups. That is, two classes were for the experimental group and the other two classes were to participate as a control group.

Instrumentation

Mathematics Achievement Test (MAT): This instrument was used to determine the level of the Students' Achievement in Mathematics. It consisted of four essay test items drawn by the researcher following due process of essay test construction. Students were expected to solve four questions in the test showing necessary detail workings on the answer booklet provided within 45 minutes. The test was specifically drawn to cover four topics on Geometry such as Angles in a triangle; Angles in a quadrilateral; Total surface Area of cuboids and Total surface area of a cylinder. In scoring the MAT, a marking guide that shows the solution to the problem or questions in the test and the marks attached to each step using the Bonus (B); Method (M); and Accuracy (A) for steps were provided. Hence, a test-retest method was adopted to determine the reliability of this instrument and it was found to be 0.91 using Pearson's Product-Moment Coefficient of Correlations

Instructional Strategies Packages (ISP): The ISP represents the model lesson Plan for the experimental and control groups.

Method of Data collection: The study was carried out as follows:

The teachers of the classes that formed the treatment groups were used as the research assistants for the study. They were trained for a week on the use of the ISP. The following steps guided the treatment in both the experimental and control groups:

A. Experimental group

I. After taking permission from the school's authority concerned. The students in this group were made to respond to the instrument (MAT). This was done in the first week of the treatment period.
II. The research assistants presented the materials using the lesson Plan model for the experimental group as well as the visual instructional materials based on the instructions received from the researcher.
III. Students in this group were organised by the research assistants into teams comprising three students of mixed-sex in each team after instruction. Furthermore, appropriate exercises to test students' understanding of the lesson were then presented to the students. The research assistants gave the class-wide solution and the students' scripts were marked. Research assistants in this group ensured that the students worked on the exercises as a team throughout the treatment period.
IV. Treatment in this group lasted for five weeks covering the prepared topics in the instructional package.
V. The sixth week was used for post-testing. During this week, the students were made to respond again to the instrument.

B. Control group

I. After taking permission from the school's authority concerned. The students in this group were made to respond to the instrument (MAT). This was done in the first week of the treatment period.
II. The research assistants presented the materials using the lesson Plan model for the control group. In this group, there was no use of the visual instructional materials based on the instructions received from the researcher.
III. Students in this group were not organised by the research assistants into teams.
IV. Treatment in this group lasted for five weeks covering the prepared topics in the instructional package.
V. The sixth week was used for post-testing. During this week, the students were made to respond again with the instruments.

Data Analysis procedures

The procedure for data analysis involved the use of descriptive and inferential statistics (Analysis of Covariance).

Results and Discussion

Table 1: Analysis of Covariance (ANCOVA) of Post-test mean scores by treatment, possession of Textbooks and Family Size of achievement in Mathematics

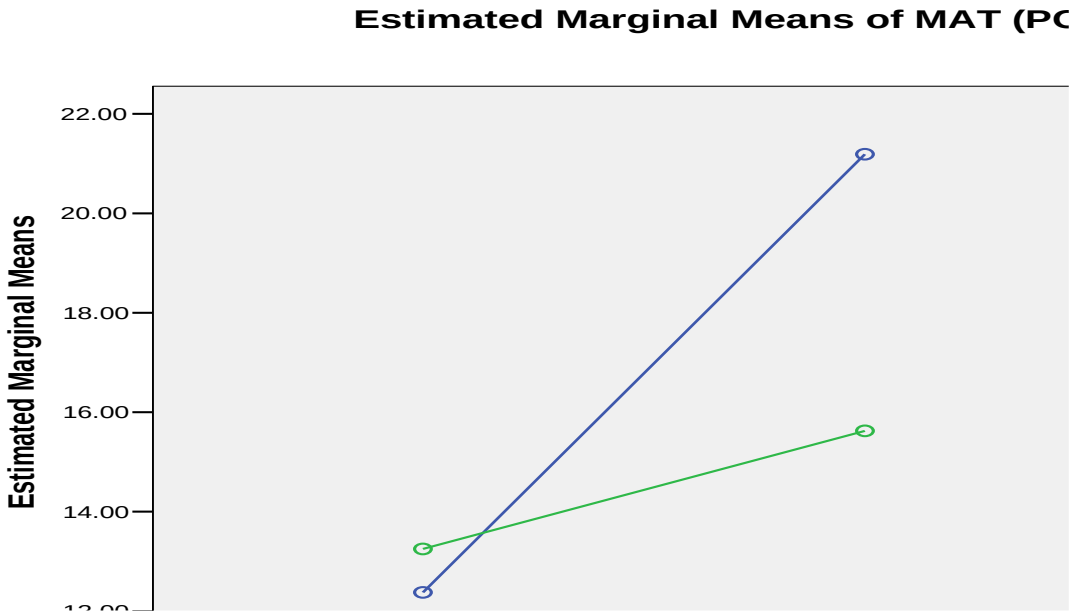
Sources of variation	Sum of squares	Df	Mean square	F ratio value	F sign.
Covariates	858038	1	858.038	13.815	.000*
Main effects (combined)	5241.242	3	1747.081	28.129	.000*
Treatment	877.816	1	877.816	14.134	.000*
Possession of textbook	3180.835	1	3180.835	51.214	.000*
Family Size	2131.978	1	2131.978	34.327	.000*
2-way interactions	583.543	3	194.514	3.132	.026*
Treatment x Possession	212.984	1	212.984	3.429	.065
Treatment x Family Size	1.661	1	1.661	0.027	.870
Possession x Family Size	240.396	1	240.396	3.871	.000*
3-way interactions					
Treatm x Possession x Family	264.511	1	246.511	4.259	.040*
Model	6947.333	8	868.417	13.982	.008*
Residual	14843.986	239	62.109		
Total	**21791.319**	**247**	**88.224**		

Significant effect (P < 0.05).

Table 2: Multiple Classification Analysis (MCA) of Students' Achievement Mathematics according to treatment, possession of Textbooks and Family Size

Grand mean = 16.198

Variable + Category	N	Unadjusted deviation	Eta	Adjusted for indep + cov deviation	Beta
Treatment	135	2.595	.303	1.859	.217
Experimental	113	-3.100		-2.221	
Control					
Possession					
Non-textbook	82	-4.368	.328	-5.557	.417
Possessed textbook	166	2.158		2.745	
Family Size					
Small	138	-1.516	.181	-2.826	.338
Large	110	1.902		3.545	
Multiple R squared	.280				
Multiple R	.529				



Small size = Blue Large Size = Green

Figure 1: Interactive effect of students' possession of Textbooks and Family Size on Students' Achievement in Mathematics

Hypothesis 1: There is no significant main effect of: (a). treatment; (b). students' possession of Textbooks; (c). Family Size on Students' Achievement in Mathematics.

To test for Hypothesis 1 in respect of the main effects of Treatment, students' possession of Textbooks and Family size on Students' Achievement in Mathematics, the results of the Analysis of covariance (ANCOVA) as presented in Table 1 was used. The result in Table 1 revealed a significant outcome in respect of the main effect treatment on achievement in Mathematics ($F_{(1,239)} = 14.13$; $P < 0.05$). This implies that there is a significant main effect of treatment on the Students' Achievement scores in Mathematics. To determine the magnitude of the mean achievement scores of students' exposed to the treatment conditions, the results of the Multiple Classification Analysis (MCA) presented in Table 2 was used. The results revealed that with a grand mean of 16.198, the experimental group (TAVI) had an adjusted mean score of 18.057 (16.198+1.859) while the control group (TGM) had an adjusted mean score of 13.977 (16.198-2.221). This shows that the experimental group is significantly better than the control group concerning Students' Achievement in Mathematics. The table also presents a value of Beta for the treatment as 0.217 which implies that the treatment accounts for 4.709 per cent $(0.217)^2$ x100% of the variation in the observed achievement in Mathematics. Hence, it shows that the experiment group is significantly affecting the Students' Achievement in Mathematics. This outcome of finding is in support the assertion of Akinsola and Igwe (2002) that framing strategy can promote students' achievement significantly in subject content because the strategy guides learners better in their learning and assists them in recalling important information with less anxiety. The team assisted individualized instruction was found to be more effective than the traditional method in this study because students had the opportunity to work together in teams, share views and opinions, and engage in brainstorming on problems which aided their achievement in Mathematics (Akinsola & Tella, 2003).

Concerning the main effects of possession of Mathematics Textbooks on Students' Achievement in Mathematics, the result revealed that the outcome was significant ($F_{(1,239)} = 51.24$; $P < 0.05$). To determine the magnitude of the mean achievement scores of students' possession of Textbooks conditions, the results of the Multiple Classification Analysis (MCA) presented in Table 2 was used. For the main effect of possession of Mathematics Textbooks, the non-possession of Textbooks had an adjusted mean score of 10.641 (16.198 - 5.557), while possession of Textbooks group had an adjusted mean score of 18.943 (16.198 + 2.745). This shows that the students who also possessed Mathematics Textbooks significantly performed better than the students' without Mathematics Textbooks concerning achievement in Mathematics. The value of Beta for the possession of Mathematics Textbooks as 0.417 which implies that possession of Mathematics Textbooks only accounts for 17.389 per cent $(0.417)^2$ x100% of the variation in the Students' Achievement in Mathematics. The result of this finding is in line with Valverde, Bianchi, Wolfe, Schmidt, and Houang (2002) believe that the use of mathematics textbooks had a significant impact on students' achievement. They also found that the form and structure of textbooks advance a distinct pedagogical model and thus embody a plan for the particular succession of educational opportunities (Valverde et al., 2002). The pedagogical model only becomes effective when the textbook is used. Therefore, mathematics textbooks should not be a subject to analysis detached from its use. It is an interactive part within the activities of teaching and learning mathematics To develop a better understanding of the role of the mathematics textbooks within the activities of teaching and learning mathematics an activity theoretical model was developed (Rezat, 2006a). Besides, Sebastian (2009) asserts that mathematics textbook should be implemented as an instrument at all three sides of the triangle: teachers use textbooks in the lesson and to prepare their lessons, by using the textbook in the lesson teachers also mediate textbook use to students. Fajemidagba (2000) and Ale (2001) ascertain that relevant Mathematics Textbooks affect the students' success in the classroom.

Concerning the main effects of Family Size on Students' Achievement in Mathematics, the result revealed that the outcome was significant ($F_{(1,239)} = 34.327$; $P < 0.05$). To determine the magnitude of the mean achievement scores of students' Family Size conditions, the results of the Multiple Classification Analysis (MCA) presented in Table 2 was used. For the main effect of Family Size, the small Family Size group had an adjusted mean score of 13.372 (16.198 - 2.826) while the large Family Size group had an adjusted mean score of 19.743 (16.198 + 3.545). This revealed that students who came under large Family Size had better performance than students under small Family Size for achievement in Mathematics. Table 2 also indicates a Beta value of 0.338 for the Family Size which implies that the Family Size alone accounted for 11.42 per cent $(0.338)^2$ x 100% of the variation in Students' Achievement in Mathematics. However, this is the result is in line with some previous studies that as the family size that is, the number of family members increases, children's academic results become worse and also revealed that family size has an important impact on predicting high academic achievement (Akinleke, 2017 & Peter, 2016)

Besides, Ibeawuchi and Ekechukwu (2017) also found that the association between family size and academic underachievement was very low and also not significant. The t-test analysis was also not statistically significant again a confirmation that there is no significant association between family size and academic underachievement.

This finding re-affirms the works of Adeyemi and Adeyemi (2014) who opined that a child underachieving in school as nothing to do with his family background including how large the family he/she came from. However, the finding by Ella, Odok and Ella (2015) is in discordant with the present one. Their finding showed a positive and significant relationship between students' academic underachievement and students' family background.

This outcome contradicted the findings of Black, Devereux and Salvaries (2010) that large Family Size harms child learning outcomes. That is, children from large families have lower average education levels. Also, Black, Devereux and Salvaries (2010) reported the extent to which children from different-sized families influence educational attainment. He also found that children from smaller families were more likely to spend time in intellectual and cultural pursuits, to spend time playing alone, to have been read to, and to have had music or dance lessons. Hence, the three variables when combined (treatment, possession of Textbooks and Family Size) jointly accounted for 28.0% of the variation obtained in the students' school in Mathematics.

Hypothesis 2: There is no significant interaction effect of treatment and students' possession of Textbooks on Students' Achievement in Mathematics

To test for Hypothesis 2 in respect of the interaction effects of treatment and, students' possession of Textbooks on Students' Achievement in Mathematics, the result of the Analysis of covariance (ANCOVA) as presented in Table 1 was used.

The result in Table 1 revealed no significant outcome in respect of the interaction effect of treatment and students' possession of Textbooks on Students' Achievement in Mathematics ($F_{(1,239)} = 3.429$ at $P > 0.05$). This implies that there is not significantly affected by the interaction effect of treatment (TAVI and TGM) and possession of Textbooks on the Students' Achievement scores in Mathematics.

Hypothesis 3: There is no significant interaction effect of treatment and Family Size on Students' Achievement in Mathematics.

To test for Hypothesis 3 in respect of the interaction effects of treatment and Family Size on Students' Achievement in Mathematics, the result of the Analysis of covariance (ANCOVA) as presented in Table 1 was used.

The result in Table 1 revealed no significant outcome in respect of the interaction effect of treatment and Family Size on the Students' Achievement in Mathematics, the result in Table 1 revealed no significant outcome in respect of the interaction effects on the Students' Achievement in Mathematics ($F_{(1,239)} = 0.027$, $P > 0.05$). Therefore, there seem to be no significant interaction effects of treatment and Family Size on the Students' Achievement in Mathematics.

Hypothesis 4: There is no significant interaction effect of Students' Possession of Textbooks and Family Size on Students' Achievement in Mathematics.

To test for Hypothesis 4 in respect of the interaction effects of students' possession of Textbooks and Family Size on Students' Achievement in Mathematics, the result of the Analysis of covariance (ANCOVA) as presented in Table 1 was used.

The result in Table 1 revealed there is a significant interaction effect on the possession of Textbooks and Family Size on Students' Achievement in Mathematics (($F_{(1,239)} = 3.871$; $P < 0.05$). Moreover, Figure 1 revealed the mean of interaction effect on the possession of Textbooks and Family Size on Students' Achievement in Mathematics. It also indicated that students who had Mathematics textbooks performed better than those who did not have Mathematics Textbooks in the small Family Size. However, Figure 1 showed that students with Mathematics Textbooks performed lower than students without Mathematics Textbooks in the large Family Size.

Hypothesis 5: There is no significant interaction effect of treatment, Students' Possession of Textbooks, and Family Size on Students' Achievement in Mathematics.

To test for Hypothesis 5 in respect of the interaction effect of treatment, students' possession of Textbooks and Family Size on Students' Achievement in Mathematics, the results of the Analysis of covariance (ANCOVA) as presented in Table 1 was used.

The result in Table 1 revealed a significant outcome in respect of the interaction effect of treatment, students' possession of Textbooks and Family Size on Students' Achievement in Mathematics ($F_{(1,239)} = 4.259$ at $P < 0.05$). This implies that treatment (TAVI and TGM), possession of Mathematics Textbooks and Family Size have a significant influence on the Students' Achievement in Mathematics.

Conclusion

This study is an extension of the frontiers of knowledge in the use of TAVI. The outcome of the study revealed that TAVI is an effective strategy of learning Mathematics and could be generalized to other school subjects. It can motivate the students to learn, help them to become creative and to make the learning situation productive if teachers handling effectively.

In conclusion, the results showed that Treatment, possession of Textbooks and Family Size had significant main effects on Students' Achievement in Mathematics. And also, possession of Textbooks and Family Size had a significant interaction effect on Students' Achievement in Mathematics

Recommendations

It is found that TAVI is to be more effective in promoting Students' Achievement in Mathematics. Therefore, Mathematics teachers are to be encouraged through seminars to teach their students Mathematics using TAVI and students should be encouraged by their teachers to purchase relevant Textbooks when they use TAVI irrespective of Family Size. This will facilitate uniformity in teaching, learning and assessment. It will also help students to gain knowledge of the subject matter and aid the development of good problem-solving culture.

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