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Effect of timing dimension of assessment feedback on secondary school students' self-efficacy and academic achievement in mathematics in Anambra State

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Abstract
The purpose of the study was to investigate the effect of timing dimension of assessment feedback on secondary school students' self-efficacy and academic achievement in Mathematics in Anambra State. Quasi-experimental research design was used for the study. The population of the study consisted of the 10, 436 public senior secondary school two (SS 2) students in the six education zones in Anambra State. The sample of study consisted of 75 SS 2 students drawn through simple random sampling technique and purposive sampling technique. Mathematics Achievement Test (MAT) and Mathematics Self-Efficacy Questionnaire (MSEQ) were used to collect data for the study. MAT and MSEQ were validated by five experts. The reliabilities of MAT and MSEQ were established using inter-rater/scorer and Cronbach Alpha Statistics for MAT and MSEQ respectively. Coefficients of 0.84 and 0.71 were respectively obtained for MAT and MSEQ. Data collected were analyzed using mean, standard deviation, and MACOVA. The findings of the study revealed that secondary school students exposed to delayed feedback had higher mean achievement score than those exposed to immediate feedback in Mathematics. Additionally, the findings of the study showed that secondary school students exposed to delayed feedback were more self-efficacious than that of those exposed to immediate feedback in Mathematics. Based on the findings of the study, it was recommended among others that secondary school students should continually take assessment feedback seriously so as to enhance their academic achievement and self-efficacy in Mathematics.

Keywords: Timing domain, feedback, academic achievement, self-efficacy and mathematics

Introduction

The performance of secondary school students in Mathematics has been unsatisfactory despite the concerted efforts that are being made by government and other relevant stakeholders in secondary education. Anambra State students have been topping others in general performance in WAEC but when taken specifically, one discovers that they do not perform so well in mathematics which is a core subject. The evidence of this unsatisfactory performance is reflected in WAEC results of secondary school students in Anambra State for three consecutive years of 2021, 2022 and 2023. The trend of poor achievement of secondary school students has been a source of worry. This is coupled with the low self-efficacy with which secondary school students approach Mathematics in testing situations as intently observed by the researcher over the years as a Mathematics teacher.

The observed poor academic performance and low self-efficacy of students in Mathematics seems to highlight the fact that students have difficulties in understanding the concept of Mathematics as a subject. This is rather worrisome and spurred Anambra State Government to employ more qualified Mathematics teachers in 2021 and 2023. More so, the State Government has made conscious efforts towards digitalizing instruction via the purchase of computer and the training of teachers in the use of digital tools for instruction. Inspite of these efforts, the academic achievement of students in Mathematics has not significantly improved even though Anambra State performs better than other states of the federation in Mathematics. The trend of unsatisfactory students' academic achievement in Mathematics could be as a result of many other factors rather than teacher quality. Among these factors, worthy of investigating is assessment feedback mechanisms employed in instructional delivery.

Assessment feedback mechanism is a means of improving the performance of students as well as the system. Agu (2023) [1] defined assessment feedback mechanism as different feedback routes by which students acquire knowledge regarding their performance. Agu added that assessment feedback mechanism encapsulates the procedures utilized in providing feedback (feedback model); the type of feedback given as well as the timing of the feedback. This could affect students' performance given that a student who is unaware of areas they should pay more attention to for improved academic performance is bound to repeat similar mistakes in subsequent assessment. Similarly, Ahmed, Akhtar and Aslam (2020) [2] asserted that students' poor performance in final examination is attributable to lack of proper formative assessment and feedback practices. The cardinal feature for formative assessment is feedback for the monitoring of students' learning progress (Ugodulunwa, 2020) [13]. Thus, for assessment feedback to be deemed meaningful, it has to be effective. Instructively, assessment feedback can be categorized based on timing (delayed or immediate) and behavioural domain (cognitive or affective) dimensions. However, the focus of the current study is on the timing dimension of feedback.

The timing of feedback is at the core of assessment. This is to the extent that some students' performance could be impacted upon by the timing of feedback. Regarding the timing of giving feedback, feedback could be immediate or delayed. Immediate feedback refers to the feedback that is given by a teacher to a learner as soon as a learner has responded to a question or performed a task. It is expected that feedback should be given as soon as a task is performed

by a student so as enable the student take prompt action that will make for effective understanding of learned material. In similar vein, Byrnes (2021) [4] noted that the longer one waits between individual's activities and the provision of feedback, the less relevant the feedback comments become. Immediate feedback is one that is administered by the teacher on the students before the commencement of the next lesson after students' response to the items in a classwork, homework or test. In the context of the current study, it is administered after a students' response to a test. Thus, immediate feedback has the capacity to foster retention of learned contents in a student's memory.

Delayed feedback refers to a form of assessment feedback that is administered by a teacher to a student at a later time or withheld for a short or extended period of time. Feedback is delayed when a teacher gives some time after a student's response to a question or completion of a test or an academic task before giving a feedback. Operationally, delayed feedback is a form of assessment feedback whereby the teacher takes one week after students have responded to the items in a test. Delayed feedback could improve students' learning to the extent that the time lag between performance and assessment feedback is capable of arousing the students' curiosity. Following instruction with immediate feedback constitutes massed instruction whereas delaying feedback or separating feedback from instruction can be considered spaced instruction (Quinn & Nakata, 2017) [11]. Massed instruction imposes more cognitive burden on learners than spaced instruction and is therefore less ideal (Nakata & Suzuki, 2019) [10].

There are certain studies done on timing dimensions of feedback and students' academic performance. For instance, Fu and Li (2020) [5] explored the differential effects of immediate and delayed corrective feedback (CF) on the acquisition of the English past tense in China. Fu and Li found that immediate CF was more facilitative of L2 development than delayed CF. In contrast, Masadeh and Elfeky (2017) [8] looked at the effect of immediate and delayed feedback via the use of Blackboard in promoting English language student teachers' lesson plan implementation in Egypt and found that delayed feedback was more effective in promoting respondents' skills in lesson plan implementation than immediate feedback. More so, Fyfe and Rittle-Johnson (2017) [6] examined the effects of timing of feedback in Italy and found that immediate feedback and delayed feedback yielded similar results. A look at the foregoing studies revealed that much as timing dimensions of feedback and students' academic performance were alluded to, none of the reviewed studies specifically focused on Mathematics as a secondary school subject. In addition, none of the studies captured self-efficacy as a dependent variable. It is in view of the foregoing that the researcher deemed it expedient to investigate the effect of timing dimension of assessment feedback on secondary school students' self-efficacy and academic achievement in Mathematics in Anambra State. Specifically, the study sought to determine the

1. Mean Mathematics academic achievement scores of secondary school students before and after exposure to immediate feedback and delayed feedback.
2. Mean Mathematics self-efficacy scores of secondary school students before and after exposure to immediate feedback and delayed feedback.

Research Questions

This research question was posed to give direction to the study

1. What are the mean Mathematics academic achievement scores of secondary school students before and after exposure to immediate feedback and delayed feedback?
2. What are the mean Mathematics self-efficacy scores of secondary school students before and after exposure to immediate feedback and delayed feedback?

Null Hypotheses

The following null hypotheses were tested at 0.05 level of significance

1. There is no significant difference in the mean Mathematics academic achievement scores of secondary school students before and after exposure to immediate feedback and delayed feedback.
2. There is no significant difference in the mean Mathematics self-efficacy scores of secondary school students before and after exposure to immediate feedback and delayed feedback.

Method

Research Design: The study utilized quasi-experimental research design. Specifically, non-randomized pre-test post-test group design was used. Budert-Waltz, Kowalczyk and Levitas (2022) [3] pointed out that this research design is employed to establish cause and effect relationships between two or more variables.

The design is presented in Figure 1

Group	Pretest	Treatment	Post-test
E_1	O_1	X	O_2

Fig 1: Symbolization (procedure of research)

Where

E_1 = Experimental Group I

O_1 = Pre-test

O_2 = Post-test

X = Treatment 1: Timing Dimension of Assessment Feedback (TDAF).

The choice of this design is justified by the fact that intact classes were used as there was no disruption of class activities in the course of experimental treatment.

Procedure: The population of the study consisted of the 10, 436 public senior secondary school two (SS 2) students in the six education zones in Anambra State. The sample of study consisted of 75 SS 2 students drawn using simple random sampling and purposive sampling techniques. Mathematics Achievement Test (MAT) and Mathematics Self-Efficacy Questionnaire (MSEQ) were used to collect data for the study. MSEQ was adapted by the researcher from Sources of Middle School Mathematics Self-Efficacy Scale (SMMSES) by Usher and Pajares (2009) [14] and Student Self-Efficacy Scale (SSES) by Rowbotham and Schmitz (2013) [12]. Some statements were re-worded to suit the purpose of my study. A total of 30 items were used to measure the self-efficacy of the respondents. The response format ranged from Strongly Agree (SA) = 4, Agree (A) =3, Disagree (D) =2 to Strongly Disagree (SD) = 1. MAT was selected from WAEC past questions. MAT and MSEQ were

validated by five experts. The reliabilities of MAT and MSEQ were tested using inter-rater/scorer reliability estimate and Cronbach alpha method respectively to obtain reliability indices of 0.74 and 0.82.
The experiment lasted for six weeks. One week for briefing of the Mathematics teachers, five weeks for actual teaching and provision of feedback. Experimental procedure involved the following stages:

Data Analysis: Mean and standard deviation were used for analysis of data that were obtained from research questions. The use of mean and standard deviation were justified given that data obtained from research questions are at interval level. For the null hypotheses, Analysis of Covariance (ANCOVA) was used to test them at 0.05 level of significance. In taking decision, the null hypothesis (Ho) was retained if the probability (P) value is greater than or equal to 0.05 and the null hypothesis (Ho) was rejected if the p-value was less than 0.05 (P<0.05).

Results

Mean Achievement and Standard Deviation Scores of Secondary School Students Before and After Exposure to Immediate Feedback and Delayed Feedback in Mathematics.

Table 1

Pre-test			Post-test			Mean Gain Score
Feedback	**Mean**	**SD**	**N**	**Mean**	**SD**	
Immediate	23.86	5.49	37	57.59	12.09	33.75
Delayed	24.87	5.00	38	64.11	12.62	39.24

Data in Table 1 show that the pre-test and post-test mean achievement scores of secondary school students exposed to delayed feedback are 24.87 and 64.11 with a mean gain score of 39.24 while the pre-test and post-test mean achievement scores of those exposed to immediate feedback in Mathematics are 23.86 and 57.59 with a mean gain score of 33.75. This shows that the mean achievement score of students on exposure to delayed feedback is higher than their mean achievement score on exposure to immediate feedback. Similarly, the pre-test standard deviations of 5.49 and 5.00 for those exposed to immediate and delayed feedback respectively show that the students' responses are more homogenous on exposure to delayed feedback than immediate on pre-test. In contrast, the post-test standard deviations of 12.09 and 12.62 for those exposed to immediate and delayed feedback respectively show that the students' responses are more homogenous on exposure to immediate feedback than delayed feedback on post-test.

Table 2: Mean Self-efficacy and Standard Deviation Scores of Secondary School Students Before and After Exposure to Immediate Feedback and Delayed Feedback in Mathematics. Mean Self-efficacy and Standard Deviation Scores of Secondary School Students Before and After Exposure to Immediate Feedback and Delayed Feedback in Mathematics

Pre-test			Post-test			Mean Gain Score
Feedback	**Mean**	**SD**	**N**	**Mean**	**SD**	
Immediate	39.78	11.50	37	40.65	12.40	0.87
Delayed	35.47	13.14	38	41.00	8.67	5.53

Data in Table 2 show that the pre-test and post-test mean self-efficacy scores of secondary school students exposed to delayed feedback are 35.47 and 41.00 with a mean gain score of 5.53 while the pre-test and post-test mean self-efficacy scores of those exposed to immediate feedback in Mathematics are 39.78 and 40.65 with a mean gain score of 0.87. This shows that the mean self-efficacy score of students on exposure to delayed feedback is higher than their mean achievement score on exposure to immediate feedback. Similarly, the pre-test standard deviations of 11.50 and 13.47 for those exposed to immediate and delayed feedback respectively show that the students' responses are more homogenous on exposure to immediate feedback than delayed on pre-test. In contrast, the post-test standard deviations of 13.14 and 8.67 for those exposed to immediate and delayed feedback respectively show that the students' responses are more homogenous on exposure to delayed feedback than immediate feedback on post-test.

Table 3: Pair-Wise Comparison of the Mean Mathematics Academic Achievement Scores of Secondary School Students Exposed to Immediate Feedback and those that are Exposed to Delayed Feedback after Assessment.

I (group)	*J (group)*	*Mean diff (I-J)*	Std. Error	*Sig*
Immediate	Delayed	-5.101	2.582	.399

Table 3 shows that at 0.05 level of significance, the P-value of .399 is greater than 0.05. Thus, there is no significant difference in students' Mathematics academic achievement on exposure to immediate and delayed feedback. The null hypothesis was therefore, not rejected.

Table 4: Pair-Wise Comparison of the Mean Mathematics Self-Efficacy Scores of Secondary School Students Exposed to Immediate Feedback and those that are Exposed to Delayed Feedback after Assessment

I (group)	*J (group)*	*Mean diff (I-J)*	Std. Error	*Sig*
Immediate	Delayed	-4.258	2.573	.650

Table 4 shows that at 0.05 level of significance, the P-value of .650 is greater than 0.05. Thus, there is no significant difference in students' Mathematics self-efficacy on exposure to immediate and delayed feedback. The null hypothesis was therefore not rejected.

Discussion

Effect of Timing Dimension of Feedback on Secondary School Students' Mathematics Academic Achievement

The findings of the study revealed that mean achievement score of secondary school students exposed to delayed feedback is higher than the mean achievement score of those exposed to immediate feedback in Mathematics. Additionally, the findings of the study revealed that there is a significant difference in students' Mathematics academic achievement on exposure to immediate and delayed feedback in favour of delayed feedback. This could be traceable to the fact that given the analytical nature of Mathematics, students need time to reflect on what they have done before feedback is provided to them. Thus, delayed feedback could improve students' learning to the extent that the time lag between performance and feedback is capable of arousing the students' curiosity. This is corroborated by Molloy and Boud (2013) [9] who observed that delayed feedback can allow for reflection and evaluation on the learner's end. More so, providing feedback immediately after an assessment may seem

cumbersome for some students. Consistent with this is the position of Quinn and Nakata (2017) [11] that instruction with immediate feedback constitutes massed instruction whereas delaying feedback or separating feedback from instruction can be considered spaced instruction. Put differently, a student feel burdened cognitively is there is no time lag between administration of a test and teacher's provision of feedback. This aligns with the observation of Nakata and Suzuki (2019) [10] that massed instruction imposes more cognitive burden on learners than spaced instruction and is therefore less ideal. Delayed feedback can be more easily noticed, processed, and internalized than immediate feedback because students will have time to possess more knowledge about the items presented to them and will therefore be developmentally more ready to take advantage of feedback. Lending credence to the afore-mentioned, Hattie (2014) [7] proposed that delayed feedback expedites a transfer of skills after the feedback had been processed. In other words, delayed feedback give time for what has been learnt to be transferred after it has been processed by the student. Thus, students are bound to pay more attention to further instruction after they encounter difficulty in the tasks they perform (Quinn and Nakata, 2017) [11]. This, will, in turn, improve their academic achievement. The findings of the current study are in agreement with those of Masadeh and Elfeky (2017) [8] that delayed feedback was more effective in promoting respondents' skills in lesson plan implementation than immediate feedback. The findings of the current study are however contradicted by those of Fyfe and Rittle-Johnson (2017) [6] that immediate feedback and delayed feedback yielded similar results. This contradiction may not be unconnected to differences in sample characteristics.

Effect of Timing Dimension of Feedback on Secondary School Students' Mathematics Self-Efficacy

The findings of the study indicated that mean self-efficacy score of secondary school students exposed to immediate feedback is higher than the mean self-efficacy score of those exposed to immediate feedback in Mathematics. This is rather surprising given that those exposed to delayed feedback are supposed to have higher self-efficacy given that their academic achievement is higher than those exposed to immediate feedback. However, the higher self-efficacy of those exposed to delayed feedback may not be unconnected to the fact that they are less test-anxious than their counterparts that were exposed to immediate feedback. Thus, the less test-anxious a student is, the greater the tendency to employ test-taking skills and the logical consequence is improved performance.

Conclusion

In view of the findings of the study, it was concluded that timing dimension of feedback positively and significantly affected secondary school students' academic achievement and self-efficacy in Mathematics.

Recommendations

In line with the findings of the study, the following recommendations were made. These include

1. Principals should organize seminars and workshop for teachers on the need to utilize delayed feedback so as to enhance secondary school students' academic achievement and self-efficacy in Mathematics.
2. Secondary school students should continually take assessment feedback seriously so as to enhance their academic achievement and self-efficacy in Mathematics.

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