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Utilizing Writing Boards in Interactive Mathematics Classes

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Abstract: Most schools in the Philippines settle with utilizing traditional approach of teaching which is starting to become ineffective as evidenced in students' poor academic performance and low engagement in classes, specifically in Mathematics. Due to the high cost of equipment and devices, technology integration as a way to ameliorate the traditional approach could be a limitation in some public schools. Hence, the use of writing boards in an interactive approach of teaching was introduced. The study utilized an exploratory sequential mixed method with experimental within groups design. Forty-one students coming from two heterogeneous classes consented to participate in the study and underwent all three modes of instruction – traditional, interactive approach without writing boards and interactive approach with writing boards. Students' engagement in the class and Mathematics performance were measured using the adopted Student Engagement in Mathematics Scale (SEMS) and researcher-made long quizzes, respectively. Analysis of variance (ANOVA) and post-hoc reveal students' engagement levels in cognitive, social and affective dimensions in the interactive approach with writing boards are significantly higher than either in the traditional and interactive approach without writing boards. Although students' mathematical performance do not differ in the two interactive approaches, these are both significantly higher than their mathematical performance in the traditional approach. Interviews with teachers and students show that the learning environment in the interactive approaches were non-threatening as students were given more opportunities to express their ideas. With the use of writing boards, students had friendly competition and were more challenged to do better as they were given immediate feedback from the teacher and peers to correct their mistakes.

Key Words: Writing boards; students' engagement; academic performance in Mathematics; Interactive teaching and learning;

1. INTRODUCTION

The use of traditional methods of teaching in most schools both private and public often leads to loss of students' interest in the subject matter as evidenced in their poor academic performance. Specifically, in Mathematics, there is also an increasing population of passive learners as can be observed during class discussions. Classroom recitations cater to either simple recall or rote memory learning. These call for a need to divert from the traditional approach. Teachers should integrate different teaching methods and strategies to improve students' learning process and make it more meaningful and fun. One such approach includes combination of strategies that are teacher-centered and student-centered (Ganyaupfu, 2013) – the interactive approach. Teachers should also use variety of instructional tools such as chalkboard, videos, computers, and projector to complement learning, keep students motivated and respond to varying needs of diverse learners (Corpuz & Salandanan, 2013, p.141). However, due to the high cost of equipment and devices and the limitations of public schools, they cannot cope with the advanced technology that private schools have. Hence, the study proposes the use of instructional tool, writing boards in interactive Mathematics classes to enhance student engagement and academic performance.

1.1 Research Questions

This study sought to find out if the interactive approach with the use of writing boards can improve student engagement as well as academic performance in Mathematics by comparing it with the traditional approach and interactive approach without the use of writing boards. Specifically, it aims to answer the following questions:

1. What is the level of engagement of the students in the Math class in the three methods of instruction in terms of:
   a. cognitive b. affective c. social
2. Is there a significant difference in students' engagement between the three methods of instruction?
3. Is there a significant difference in students' academic performance between the three methods of instruction?

1.2 Review of Related Literature

In an interactive teaching approach, learners are given opportunities to interact not only with their teacher but with their peers as well (Corpuz & Salandanan, 2013, p.91). In this approach, students are not spoon fed by the teacher, rather they are involved with their own search for knowledge (Reys, Lindquist, Lambdin, Smith, Rogers, Falle, Frid & Bennett, 2012; Ganyaupfu, 2013). Under this approach, there are several teaching methods that can be used which are referred to as "interactive-engagement" (IE) methods (Hake, 1998; Meltzer & Manivannan, 2002) such as demonstrations, interactive-lectures, inquiry, response systems, etc. IE methods are designed to deepen the comprehension of learners through interactive engagement in "heads-on (always) and hands-on (usually) activities" (Hake, 1998) which result to exchange of feedback with the teacher and other learners during class discussions. Aside from students' cognition, this approach also aims to positively affect their attitudes (Georgiou & Sharma, 2015). Moreover, Meltzer and Manivannan (2002) mentioned that in an interactive class, teachers use "think-pair-share method", promote interaction through inquiry, go around the classroom to monitor students' work and encourage students to share their insights.

Hake (1998) compared interactive approach with traditional approach which he said focuses heavily on lectures wherein students are just passive listeners. He concluded in his study that IE methods were far more effective than traditional methods. Likewise, Ganyaupfu (2013) who compared three teaching methods namely teacher-centered, student-centered and teacher-student interactive method, found out that the latter was the most effective.

Aside from using various teaching methods, it is significant for teachers to utilize instructional tools in class. Several educators suggested the use of digital tools in teaching and learning Mathematics such as calculators, online databases, applications, software, e-textbooks and online help-sites (Van De Walle, Karp and Bay-Williams, 2013). Similarly, Sivasubramaniam and Muniandy (2012) found out that the use of Interactive White Board with *Easitech* software is helpful as pupils solve problems. The four ten-year-old Malaysian students who had difficulties in Mathematics learned to understand word problems effectively.

However, digital instructional tools are expensive and not always available. In an interactive Physics lecture, Meltzer and Manivannan (2002) used flashcards which they said are as effective as electronic response systems to acquire "instantaneous responses from all of the students simultaneously". Further, Candler (n.d.) suggested the use of low-technology boards which students can write on with non-permanent markers. She mentioned that it engages each student in the classroom, it helps teachers find out who is getting the lesson and who is not, and it can be used in different ways may it be individual or group work. In addition, in Education World (2017), it is mentioned that several teachers suggest the use of whiteboards for "it actively involve students in the learning process". Poh and Sam (2012) stated that writing as a teaching tool helps students visualize, model and keep track as they solve in Mathematics.

Engaging the students means fully involving them with their own acquisition of knowledge (Reys et al., 2012). According to Jerome Bruner's Cognitive Learning Theory, "learning is an active process in which learners construct new ideas or concepts based upon their current and past knowledge" (Vega & Prieto, 2012, p.12). In addition, John Dewey (1997 as cited in Sheppard, 2011), a proponent of experiential learning commonly known as "learning by doing", mentioned that teachers have the role to provide students with several learning experiences that will

promote student engagement and interest. This is indeed necessary because Lounsbourry (2000 as cited in Vega & Prieto, 2012, p.99) said that one of the intellectual characteristics of adolescents is that they want to take responsibility for their learning so they choose to be involved in various activities. Student engagement will help students realize the significance of their learning thus will lead to better comprehension (Reys et al., 2012). Hence, engagement is significant to be incorporated in planning and implementing classroom activities to achieve academic success (Lim, Tan & Lin, 2012).

Engagement is actually multifaceted for it can be seen in different but interrelated perspectives. According to Catherine Attard (2012), engagement in mathematical perspective is evident when students are having fun learning and participating in discussions of Mathematical concepts. In a behavioral context, engagement is when students accomplish academic tasks, pay attention and exemplify proper behavior (Attard, 2012; Rimm-Kaufman, Baroody, Larsen, Curby & Abry, 2014). Engagement can also be determined cognitively because students are engaged when they reason out, justify their claims, and exert effort in making meaning out of what they have learned. Moreover, as students engage in their learning, they experience challenges which influence their affective domain. Mathematics engagement affects one's attitude, beliefs and motivation (Hannula et al, 2016). Despite differences of the domains mentioned, all these can be integrated. Appropriate tools to measure engagement must be utilized like in the study conducted by Rimm-Kaufman, et al. (2014) where they measured student-reported engagement with the use of a questionnaire called *Student Engagement in Mathematics Scale (SEMS)*. They also used observers' and teacher-reported engagement. Results show that students have higher engagement in the aforementioned aspects when they are provided with emotional support and when they belong in a class which has high organization.

A study done by Ing, Webb, Franke, Turrou, Wong, Shin, and Fernandez (2015) in elementary school mathematics, explored on the different teaching practices that encourage student participation. Actual footage recording show students expounded their thoughts, conferred with their classmates and how teachers promoted interaction. They found out that student achievement relies on both teaching strategies and student engagement.

Several studies (Reys et al., 2012; Attard, 2012; Lim et al., 2012; Ing et al., 2015) have shown that students learn best when they are engaged and this leads to improved academic performance.

1.3 Conceptual Framework

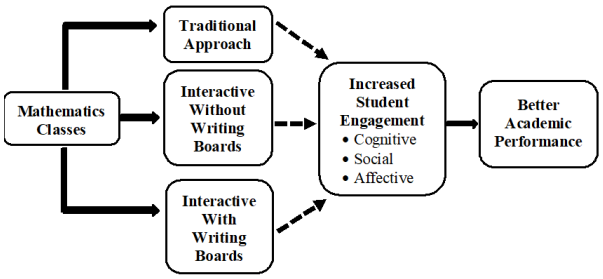

Figure 1. The Conceptual Framework of the Study

The three methods of instruction utilized in Math classes were compared to find out which may best result to an increased student engagement to achieve better academic performance of students.

Students get a full grasp of the lessons when they are involved. One way is to divert from the traditional and utilize an interactive approach of teaching coupled with the use of instructional tool. However, integrating technology is not always made possible in most public schools because of their budget limitations. That is why the writing board as an instructional tool was employed. Student engagement was evaluated in three dimensions namely cognitive, social and affective. These factors were chosen to provide the study with various perspectives under the premise that when the learners are truly engaged in the discussions and they are evaluated accordingly, they are more likely to achieve better academic performance in the subject which is the main goal of every educational institution.

2. METHODOLOGY

The study utilized an explanatory sequential mixed method with an experimental within groups design as all participants underwent all three modes of instruction in Mathematics.

Forty-one Grade 7 students from 2 heterogeneous classes in a public school in Makati consented to be part of the study. Their parents' written consent was also sought and secured before the conduct of the study.

The Student Engagement in Mathematics Scale (SEMS) was developed by Rimm-Kaufman (2010). It consists of 13 closed-ended items where responses are indicated in a 4-point Likert scale from 1-not at all true to 4-very true. It covers the three dimensions: cognitive, affective and social. Items 1, 9, 10 and 13 are on cognitive engagement, items 2, 3, 4, and 5 on social engagement and 6, 7, 8, 11 and 12 for affective engagement which yielded internal reliabilities of 0.89, 0.98, and 0.91, respectively.

Lesson plans and long quizzes with table of specifications on algebraic expressions were validated by teacher experts to ensure alignment of learning objectives, instructional activities and assessment. Actual implementation of lessons was observed using checklists for traditional and interactive approach to teaching.

Interviews were semi-structured and each individual interview lasted 10-15 minutes. One teacher observer and 6 selected student participants were interviewed.

For a week, the students were observed for baseline data gathering while they receive traditional method from their Mathematics teacher. The second and third phases of the study were implemented for one week each: a week for the interactive approach without the use of writing boards; and another week with the use of writing boards. The lessons discussed in those three weeks are different. The SEMS was administered after every class to determine their level of engagement under the three modes of instruction. A long quiz was given at the end of each mode of instruction to determine their academic performance. Interviews were conducted after all three modes of instruction.

To compare student engagement between the three methods of instruction, the single factor Analysis of Variance was used and Tukey-Kramer procedure was done for post hoc analysis. The same statistical treatments were used to compare students' performance in long quizzes in the 3 modes of instruction.

3. RESULTS AND DISCUSSION

Table 1 shows the percentage of students under indicated levels of engagement (BA-below average, A-average, and AA-above average) in cognitive, social and affective dimensions.

Table 1. *Percentage of students in each level of engagement in Cognitive, Social and Affective Dimensions of Engagement*

Mode of Instruction	Cognitive			Social			Affective		
	BA	A	AA	BA	A	AA	BA	A	AA
Traditional	0	49	51	22	68	10	0	34	66
Interactive w/o WB	0	37	63	7	54	39	0	32	68
Interactive w/ WB	0	15	85	2	27	71	0	10	90

None of the students were below average level in terms of cognitive and affective engagement in all three modes of instruction. In the traditional teaching, 22% of the respondents admitted they had low social engagement. In all three dimensions of engagement, there are more students with above average level of engagement in the interactive approach with writing boards use compared to both the traditional and interactive approach without writing boards. This implies that some students with average level of engagement in the traditional teaching had increased their level of engagement during interactive approaches. This increase in levels of engagement are significant (see Table 2) as indicated in the single factor Analysis of Variance test results (p-value < 0.05).

Table 2. *Single Factor ANOVA p-values*

	Student Engagement			Academic
	Cognitive	Social	Affective	Performance
p-value	2.93E-06	1.38E-10	0.000375	1.429E-05

After performing Tukey-Kramer post hoc analysis, cognitive engagement and affective engagement means were different in comparing traditional and interactive with writing boards, and interactive with and without writing boards. The means were not different in comparing traditional and interactive without writing boards. Hence, the students engaged with their mental processes in almost the same way in first and second phases. But they cognitively engaged more when they used the writing boards. Similarly, the combination of interactive approach and the use of writing boards boosted students' affective engagement. Nonetheless, students' social engagement significantly differ in all 3 pairwise comparisons.

Post hoc analysis of students' scores in long quizzes show that there is significant difference when mathematical performance under traditional method was compared to either of the interactive approaches. Students' mathematical performance in

the two interactive approaches do not differ significantly.

The interactive approach was useful in fostering student engagement. In this phase, students were given opportunities to work with their classmates. Majority of them enjoyed cooperating with their peers. A respondent supported this when she said "We can share our ideas with each other and bond at the same time". Two of the interviewees also mentioned that they ask help from their classmates when they did not get the lessons. The cooperating teacher mentioned that "*Mas nagiging* light *yung* discussion… feeling *nila naglalaro lang sila*" (the discussion becomes lighter… students feel like they are just playing).

Furthermore, the interactive method with the use of writing boards yielded the best results based on the comparisons. There was an increase in all domains. The cooperating teacher supported this as she said "Yes, *mas nagiging* okay *ang* participation of the students in using the writing boards especially in recall and drill part." (participation of students is better with the use of writing boards especially in recall and drill part). One student mentioned that "*Kapag* with boards, *yung bilis ko ng pag-iisip nachachallenge*" (when using writing boards, my thinking speed is challenged). Another learner also added that the use of boards makes Math more interesting. Students were indeed holistically engaged when writing boards were utilized in interactive Mathematics classes for they did a lot of thinking, they felt motivated to do the tasks in Math and they worked well with their peers by either helping each other out or by engaging in friendly competition.

4. CONCLUSIONS

Considering all the results and analyses presented, it can be concluded that the respondents, on the average, were engaged even if they were receiving direct instruction from their Mathematics teacher. This is in contrast to Hake (1998) who mentioned in his study that students are passive listeners when utilizing lecture method. However, it can be seen that most of the learners were not that engaged socially. That is because they were not given time to interact with their peers when traditional method is being used. Thus, it can be improved by making the Mathematics classes interactive. Also, the utilization of writing boards enhanced student engagement as well as academic performance in Mathematics. The writing boards made the class student-centered for they were asked to apply their knowledge about past lessons or their newly acquired content right after the discussions. The transfer of learning can easily be manifested because the writing board as a tool was appropriate for the students since the topics were more on solving. The tool served as an aid to the teacher in eliciting responses simultaneously and instantly. Hence, the teacher can easily pinpoint those who understood the lessons and those who did not. It also provides room for exchange of ideas and exchange of immediate feedback.

Moreover, there are a lot of factors that may affect students' learning. This was supported by Mokhtar, Yusof and Misiran (2012) who mentioned that attitude, role of teacher, peers and interest were the most common factors. Almost the same results were drawn from the personal interviews conducted by the researcher which yielded the factors such as complexity of the topic, interaction with peers and teacher and interest in Mathematics.

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