

Enhancing Conceptual Understanding of Grade Five Mathematics Learners through Formative Assessment Strategies

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Abstract—This study examined the effectiveness of formative assessment strategies in enhancing the conceptual understanding of Grade V learners in Mathematics. Conceptual understanding is considered a fundamental component of mathematical proficiency and one of the five interwoven strands essential for meaningful learning. The study sought to determine whether learners exposed to differentiated formative assessment strategies (DFAS) demonstrate higher levels of conceptual understanding compared to those exposed to non-differentiated formative assessment strategies (Non-DFAS). The study employed a quasi-experimental pretest-posttest design conducted in a public elementary school in the Division of Digos City, Region XI, Mindanao Philippines during School Year 2019–2020. Sixty Grade V learners participated in the study, with 30 learners assigned to the DFAS group and 30 learners assigned to the Non-DFAS group. Data were gathered using a validated 4-point, 2-tiered conceptual understanding test with a reliability coefficient of 0.748. Statistical analyses included the *t*-test and One-Way Analysis of Covariance (ANCOVA) at the 0.05 level of significance. Findings revealed that learners exposed to DFAS demonstrated a substantial increment in conceptual understanding, progressing from the “No Understanding” level in the pretest ($M = 10.00$) to the “Partially Correct Understanding” level in the posttest ($M = 48.00$), reflecting a two-level increase in understanding. In contrast, learners exposed to Non-DFAS improved from the “No Understanding” level ($M = 12.33$) to the “Incomplete Understanding” level ($M = 32.47$), representing only a one-level increase. Moreover, results indicated a statistically significant difference in the conceptual understanding of learners in favor of the DFAS group ($p = 0.000$). The findings suggest that differentiated formative assessment strategies significantly enhance learners’ conceptual understanding in Mathematics and may contribute to improving the quality of mathematics education.

Keywords— Conceptual understanding, differentiated formative assessment strategies, non-differentiated formative assessment strategies, quasi-experimental design, mathematics education.

I. INTRODUCTION

Conceptual understanding is the ability of learners to grasp the concept, go beyond the basic idea, explore related concepts, and apply these concepts to solve an existing situation. The learners who possess conceptual understanding can represent situations using multiple strategies, with knowledge of how these representations are helpful for different purposes. This attribute is vital in achieving the twin goals of K to 12 Mathematics, specifically, problem-solving and critical thinking (Department of Education [DepEd], 2016).

The results of the mathematics assessments show that Filipino learners have shown a significant deficit in achieving mathematical proficiency. The country's average score in Mathematical Literacy on the Program for International Student Assessment (PISA) of the Organization for Economic Co-operation and Development (OECD) was 353 in 2018. This result indicated below Level 1 Proficiency. At Level 1, learners can answer questions involving a familiar context where all relevant information is present, and the questions are clearly defined. The Trends in International Mathematics and Science Study (TIMSS) also showed that only 1% of Filipino students can apply conceptual understanding to solve problems. Eighty-one percent (81%) of Filipino students did not meet the low benchmark, indicating they lacked basic mathematical knowledge (IEA TIMSS & PIRLS, 2019). Moreover, for the School Year 2017 – 2018, the National Achievement Test Result of Digos City Division for Grade Six has a Mean Percentage Score of 36.72, with Mathematics at 36.54.

These results show that the learners across the country have yet to perform Mathematics with the inclusion of problem-solving, reasoning and proof, representation, communication, and connections. The learners need to develop conceptual understanding to address this gap. They should be able to demonstrate knowledge of concepts in multiple ways by making multiple connections among different models and representations, using various modes of communication to convey their solutions, and explaining what the solutions mean in context. Thus, teachers need to use multiple representations when appropriate to elicit and scaffold students' thinking.

This study investigated the enhancement in learners' conceptual understanding when assessed using formative assessment strategies.

II. FRAMEWORK OF THE STUDY

This study is also anchored in the idea that varied assessment strategies affect learners' performance in mathematics (Kulm, 1994). These strategies are carefully planned and organized by the teacher to help learners learn and for accurate assessment, and they require constant valuing, tracking, and recording of individual factors such as growth, improvement, effort, reflection, risk-taking, and

change. A teacher must have a rich repertoire of assessment strategies (Cole, Ryan, and Kick, 1995)

This study hypothesized that formative differentiated evaluations could improve students' conceptual understanding of mathematics based on Tomlinson's Theory of Differentiated Instruction (1999). This theory posits that, to foster practical learning culturally and academically among the diverse population, the educational provider will use personalized instruction rather than the conventional standardized instruction. Thus, teachers must be responsive to each learner's race, gender, culture, readiness, experience, interests, and learning preferences to increase learner motivation and achievement. Added to this, the increasingly complex society, like the classroom, needs personalized instruction so that each learner becomes a critical thinker and problem-solver, which is the twin goal of mathematics in the country's new educational system. In this flexible learning in differentiation, learners will be producers of knowledge rather than consumers and receivers. The instruction considered personalized will address the learning needs and interests of every learner in a diverse classroom.

Lev Vygotsky's Social Interaction Theory, which holds that learning is an essential and universal part of the process of creating culturally organized, particularly human psychological function, also supports assessment. Besides, static measures, such as intelligence tests, are significantly limited in their usefulness for understanding a child's capabilities because they depict only the "level of the child's mental development at a particular time" (Vygotsky, 1986). This assessment is a monotonous approach that fails to accommodate learners' diverse learning styles. This theory supports the idea that the evaluation should not be limited to a single strategy, as this can leave some learners behind. Assessments measure learners' intelligence. The learning styles of all diverse learners are addressed accordingly in evaluations. The researcher uses the Social Interaction Theory as the theoretical framework for this study's assessment.

The Theory of Multiple Intelligences supports the learner's learning style. Different types of intelligence exist among people (Gardner, 2011). Since people have a variety of skills and abilities outside of their intellectual capacity, the Intelligence Quotient is not the exclusive measure of intelligence. Verbal-linguistic, logical-mathematical, visual-spatial, rhythmic-musical, bodily-kinesthetic, naturalistic, interpersonal, and personal domains are all areas of intelligence. This intelligence implies that some people excel in one area of learning but struggle in others. To fully realize each student's potential and enhance their learning capacity, the teacher considers each student's intelligence in the teaching, learning, and evaluation processes.

III. OBJECTIVE

This study aimed to investigate the effectiveness of formative assessment strategies among Grade Five Mathematics learners in a public elementary school in the Digos South District, Division of Digos City, during the School Year 2019–2020. Specifically, the study sought to:

1. Determine the level of conceptual understanding of Grade Five Mathematics learners; and
2. Determine whether a significant difference exists in the conceptual understanding of learners assessed using differentiated formative assessment strategies and those assessed using the Non-Differentiated formative assessment strategies.

IV. METHODOLOGY

This study employed a quasi-experimental pretest-posttest research design to determine the effectiveness of Differentiated Formative Assessment Strategies (DFAS) in enhancing the conceptual understanding of Grade V learners in Mathematics. The design involved two intact groups of learners: an experimental group and a control group drawn from the same grade level. Both groups were taught the same mathematical competencies and learning content; however, they differed in the formative assessment approaches employed during instruction. The experimental group was exposed to differentiated formative assessment strategies, while the control group received conventional or non-differentiated formative assessment strategies commonly utilized in the K–12 classroom setting.

During School Year 2019–2020, the study was carried out in a public elementary school located in Digos City, Mindanao, Philippines. The school was selected because it served as the researcher's official teaching station, allowing close monitoring of the intervention and immediate utilization of the findings for instructional improvement. The participants of the study consisted of Grade V Mathematics learners. From the four Grade V sections in the school, two intact classes were selected as participants in the study. The assignment of the classes into experimental and control groups was determined through a coin toss to minimize selection bias. Each group consisted of 30 learners, resulting in a total of 60 participants.

The study utilized a researcher-made conceptual understanding test administered as both pretest and posttest. The instrument was a validated 4-point, 2-tiered test designed to measure learners' conceptual understanding in Mathematics. Prior to implementation, the instrument underwent expert validation to ensure content validity and appropriateness for Grade V learners. Reliability testing yielded a coefficient of 0.748, indicating acceptable internal consistency.

The conduct of the study followed a systematic sequence of procedures. Initially, the researcher developed the lesson plans and assessment tools aligned with the targeted mathematical competencies. These materials were subsequently validated by experts in Mathematics education and assessment. After the selection and assignment of participants, a pretest was administered to both groups to establish baseline data on learners' conceptual understanding. Following the pretest, the experimental group underwent instruction using Differentiated Formative Assessment Strategies (DFAS), while the control group received instruction using conventional formative assessment methods. Upon completion of the intervention period, the same test was

administered as a posttest to both groups to determine changes in learners' conceptual understanding.

The gathered data were analyzed using descriptive and inferential statistical techniques. Mean scores were used to describe the learners' levels of conceptual understanding, while a t-test and One-Way Analysis of Covariance (ANCOVA) were employed to determine whether significant differences existed between the experimental and control groups at the 0.05 level of significance. ANCOVA was specifically utilized to control for differences in pretest scores and to determine the effect of the intervention on posttest performance.

Throughout the research, ethical issues were carefully followed. Participation of the learners was voluntary, and parental consent was secured prior to data collection. The anonymity and confidentiality of participants and their responses were maintained at all stages of the research process, and all gathered data were used solely for academic and research purposes.

V. RESULTS AND DISCUSSIONS

Table 1 presents the pretest and posttest levels of conceptual understanding of Grade Five Mathematics learners exposed to Differentiated Formative Assessment Strategies (DFAS) and Non-Differentiated Formative Assessment Strategies (Non-DFAS). Prior to the intervention, both groups exhibited a "No Understanding" level of conceptual understanding, as reflected in the pretest results. The DFAS group obtained a mean score of 10.00 with a standard deviation of 3.06, while the Non-DFAS group recorded a mean score of 12.33 with a standard deviation of 3.24. The findings indicate that learners from both groups initially possessed limited understanding of the mathematical concepts covered in the study, suggesting comparable baseline performance before the implementation of the instructional interventions.

TABLE 1. Level of Conceptual Understanding of Grade V Learners

Level of Conceptual Understanding	Range Of Scores	DFAS				Non-DFAS			
		Pretest		Posttest		Pretest		Posttest	
		f	%	f	%	f	%	f	%
Mathematically Correct Understanding	61-80	0	0	0	0	0	0	1	3
Partially Correct Understanding	41-60	0	0	29	97	0	0	2	7
Incomplete Understanding	21-40	0	0	1	3	0	0	27	90
No Understanding	0-20	30	100	0	0	30	100	0	0
Mean		10.00		48.00		12.33		32.47	
SD		3.06		6.10		3.24		8.07	
Qualitative Description		No Understanding		Partially Correct Understanding		No Understanding		Incomplete Understanding	

The learners demonstrated incomplete understanding and misconceptions in three interconnected concepts in circle geometry: drawing circles with specific radii using a compass, measuring the circumference of a circle using appropriate tools, and deriving the formula for circumference. In drawing circles, learners were already familiar with sketching circular

shapes; however, they struggled to accurately locate the center and construct circles using a compass. Most relied on tracing circular objects and arbitrarily placing the center point. Their lack of prior exposure to the compass further contributed to difficulty in producing precise geometric constructions.

In measuring and deriving circle-related concepts, learners also showed persistent misconceptions. Many lacked a clear understanding of circumference and were unfamiliar with appropriate measurement tools, including how to correctly use and interpret them. Some students used instruments like rulers for curved measurements incorrectly or had never encountered them before, which led to incorrect results. In deriving the formula for circumference, learners tended to rely on memorized procedures without understanding the relationship between radius, diameter, and the constant π . This led to confusion when problems deviated from familiar formats, causing incorrect application or misuse of formulas. Collectively, these misconceptions reveal weak conceptual foundations in geometric relationships, measurement skills, and algebraic reasoning, which significantly affected learners' accuracy and problem-solving performance.

After the implementation of the differentiated formative assessment strategies, the posttest results revealed a substantial improvement in the conceptual understanding of learners in the experimental group. The DFAS group achieved a mean score of 48.00 with a standard deviation of 6.10, which corresponds to the "Partially Correct Understanding" level. Specifically, 29 out of 30 learners (97%) in the DFAS group reached the "Partially Correct Understanding" category, while only one learner (3%) remained at the "Incomplete Understanding" level. Notably, no learner in the group remained in the "No Understanding" category during the posttest. This result demonstrates that differentiated formative assessment strategies effectively enhanced learners' conceptual understanding by addressing learners' varying needs, readiness levels, and learning preferences.

In contrast, the learners exposed to Non-Differentiated Formative Assessment Strategies also manifested improvement, although at a relatively lower level compared to the DFAS group. The Non-DFAS group obtained a posttest mean score of 32.47 with a standard deviation of 8.07, which falls under the "Incomplete Understanding" level. Majority of the learners in this group, or 27 learners (90%), were classified under "Incomplete Understanding," while only two learners (7%) attained the "Partially Correct Understanding" level. Although no learner remained under the "No Understanding" category after the intervention, the improvement observed in the control group was less pronounced than that of the experimental group. This finding suggests that conventional formative assessment strategies may contribute to learning gains, but they may not be as effective in deepening conceptual understanding as differentiated approaches.

Overall, the findings of the study indicate that Differentiated Formative Assessment Strategies (DFAS) were more effective in improving the conceptual understanding of Grade Five Mathematics learners than Non-Differentiated Formative Assessment Strategies. The experimental group demonstrated a two-level increase in conceptual

understanding, progressing from “No Understanding” to “Partially Correct Understanding,” whereas the control group exhibited only a one-level increase, from “No Understanding” to “Incomplete Understanding.” The lower standard deviation observed in the DFAS group during the posttest further suggests more consistent learner performance within the group. These results imply that differentiated formative assessment strategies provide meaningful opportunities for learners to process mathematical concepts more effectively, thereby contributing to improved learning outcomes and supporting quality mathematics instruction.

Table 2 presents the One-Way Analysis of Covariance (ANCOVA) results used to determine whether a significant difference exists in the conceptual understanding of Grade Five Mathematics learners exposed to Differentiated Formative Assessment Strategies (DFAS) and those exposed to the conventional Non formative assessment strategies (Non-DFAS). ANCOVA was employed to control the possible influence of learners’ pretest scores on their posttest performance, thereby providing a more accurate estimate of the effect of the intervention.

TABLE 2. Comparison of the Conceptual Understanding of Non-DFAS and DFAS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	4386.900 ^a	2	2193.450	56.835	.000
Intercept	3211.710	1	3211.710	83.219	.000
Pretest	767.633	1	767.633	19.890	.000
Group	4364.415	1	4364.415	113.087	.000
Error	2199.834	57	38.594		
Total	103710.000	60			
Corrected Total	6586.733	59			

Legend: a. R Squared = .666 (Adjusted R Squared = .654)

The results reveal that the overall model was statistically significant, as indicated by an F-value of 56.835 and a significance value of $p = .000$. This implies that the variables included in the model significantly explained the variation in the learners’ posttest scores in conceptual understanding. Furthermore, the adjusted R-squared value of .654 indicates that approximately 65.4% of the variance in the learners’ conceptual understanding can be explained by the combined effect of the pretest scores and the type of assessment strategy used. This suggests that the model has a strong explanatory power and that the intervention contributed substantially to the improvement of learners’ conceptual understanding.

The table further shows that the pretest scores significantly influenced the posttest results, as reflected by an F-value of 19.890 with a significance level of $p = .000$. This finding indicates that learners’ initial level of conceptual understanding had a significant relationship with their post-intervention performance. However, after controlling for the effect of the pretest, the group variable remained highly significant, with an F-value of 113.087 and a p-value of .000. This demonstrates that the type of formative assessment

strategy employed significantly affected the conceptual understanding of the learners.

Specifically, the findings indicate that learners exposed to Differentiated Formative Assessment Strategies performed significantly better in conceptual understanding compared to learners exposed to the conventional K to 12 formative assessment strategies. Since the computed significance value for the group variable was less than the 0.05 level of significance, the null hypothesis stating that there is no significant difference between the two groups was rejected. The results therefore confirm that differentiated formative assessment strategies were more effective in enhancing learners’ conceptual understanding in Mathematics than the conventional formative assessment approach.

The findings support the view that differentiated formative assessment strategies provide more responsive and learner-centered opportunities that address individual learning needs, readiness, and learning styles. Consequently, these strategies contribute to deeper conceptual learning and improved mathematical understanding among Grade Five learners.

VI. CONCLUSIONS

Based on the findings, the following conclusions have been drawn:

1. The results of the pretest revealed that learners in both the Non-DFAS and DFAS groups demonstrated weak conceptual understanding, as they were generally unable to provide both correct answers and valid justifications for the test items. However, in the post-test, a divergence in learning outcomes was observed. Learners in the Non-DFAS group were able to arrive at correct answers but often provided incorrect or unsupported reasoning, indicating procedural knowledge without conceptual grounding. In contrast, learners in the DFAS group tended to provide correct reasoning but arrived at incorrect answers, suggesting emerging conceptual understanding that had not yet fully translated into procedural accuracy.
2. The findings indicate that differentiated formative assessment strategies were effective in enhancing the conceptual understanding of Grade Five Mathematics learners. The strategy facilitated deeper engagement with mathematical concepts, enabling learners to develop more meaningful explanations and improved conceptual reasoning compared to traditional assessment approaches.

VII. RECOMMENDATIONS

Based on the summary, findings, and conclusions, the researcher recommends the following:

1. Teachers may use differentiated formative assessment strategies to assess learners' learning, as research shows this enhances learners' conceptual understanding. Identifying their learners’ learning styles and designing differentiated formative assessment strategies appropriate to their learners’ context may help improve delivery of quality instruction.
2. Learners may expose themselves to various differentiated formative assessment strategies to further develop their conceptual understanding in mathematics and in other

subject areas. They may study the various types of assessment in order to drill themselves to think critically and creatively thereby improving their study habits and academic performance.

3. School administrators may encourage teachers to use differentiated formative assessment strategies to assess learners' learning.
4. Parents and stakeholders may provide support to the school regarding learners' learning styles and inform school personnel of their learners' learning behaviors. They are encouraged to assist the school with activities that enhance learners' conceptual understanding, academic contests and competitions, and other activities that require learners' participation.
5. Division personnel may facilitate relevant, high-quality training, seminars, and workshops on these strategies to empower teachers and are encouraged to lead instructional developers in creating supplementary instructional materials and assessment strategies tailored to learners' different learning styles.
6. Future researchers may use this study as a reference in their future research. They are encouraged to explore differentiated assessment strategies, additional variables to consider, and approaches to enhance learners' conceptual understanding.

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