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Gauging metacognitive awareness and performance of grade 8 mathematics learners using a theory-based alternative assessment

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ABSTRACT

The pandemic necessitated the remote implementation of instruction, challenging even the best existing instructional strategies to respond to the demand for self-directed learning. Literature suggests that metacognitive strategies may provide a potential answer to this growing need. In this study, we designed a theory-based alternative assessment for a group of grade 8 learners (n=23). The primary aim is to determine the effect of the alternative assessment on the learners' metacognitive awareness, and its relationship to their performance scores in the subsequent summative assessment. Results show that the alternative assessment improved the metacognitive awareness level of the learners as a whole (p=.011) and particularly, their regulation of cognition (p=.006). Pearson correlation also revealed a significant moderate correlation between learners' alternative assessment and subsequent summative assessment scores – as a whole (r=.47) and when considering higher-order thinking skills items (r=.44). Overall, the alternative assessment model a viable prototype for future metacognitive instructional materials.

Keywords: metacognition, alternative assessment, mathematics

INTRODUCTION

The COVID-19 pandemic has brought about several changes in society, including the educational system. Anthonysamy (2021) indicated that the "global pandemic outbreak has resulted in major interruptions in students' learning and education at all levels of education" (p. 2). In the Philippine context, classes either have migrated online in the form of virtual classrooms or have turned to modular learning, in response to the pandemic situation. These new modes of learning are not without their problems. Pokhrel and Chhetri (2021) have stressed the following issues: "the weakness of online teaching infrastructure, the limited exposure of teachers to online teaching, the information gap, non-conducive environment for learning at home, and the equity and academic excellence in terms of higher education" (p. 134). Furthermore, they maintained that there are concerns with the accessibility and affordability of the Internet connection (especially in developing countries), the need for effective online teaching and learning strategies, and the need for authentic assessments, among many others (Pokhrel & Chhetri, 2021).

Concerning the demand for effective online teaching and learning strategies at this time of the pandemic, learners are compelled to maintain focus, self-regulation, and a sense of organization in the absence of teachers (Anthonysamy, 2021). Such a requirement entails the use of metacognitive strategies as a possible solution to the need. Metacognition allows learners to take charge of their own process of learning such as thoughts regulation, assessment of their own ability, and evaluating personal strategies in delivering the tasks successfully over a given period of time (Anthonysamy, 2021). It has been associated with academic success, personal development, and even career and professional advancement (Terlecki & McMahon, 2018).

In fact, Papaleontiou-Louca (2008) held that the metacognitive strategies enable learners to control their independent learning (see also Alzahrani, 2017; Amin & Mariani, 2017; Schraw & Dennison, 1994), and decisions about what to learn and how to learn for life. Hence, developing metacognitive strategies that would cater to the needs of independent and self-directed learning during this time of pandemic can be a potential means of attaining successful learning performance. In this work, the design and implementation of a theory-based alternative assessment initiate a further study on the specific application of metacognition in improving learners' metacognitive awareness and learning in mathematics.

Preliminary versions of this paper were presented in the following conferences/conventions: (i) Philippine Council of Mathematics Teacher Educators, Inc.'s (MATHTED) 13th Biennial and 1st Virtual International Conference on Mathematics Education, (ii) Philippine Science High School National Teachers' Convention, (iii) Mathematics Teachers Association of the Philippines, Inc. – Iloilo City (MTAP-IC) Research Conference 2022, and (iv) International Network for Outcome-Based Education (IN4OBE) Virtual Summit 2022.

THEORETICAL UNDERPINNINGS AND CONCEPTUAL FRAMEWORK

On Alternative Assessments

The *assessment* encompasses the activities that educators and learners perform in order to obtain data useful in improving the teaching and learning (Amua-Sekyi, 2016). It is the "process for documenting, in measurable terms, the knowledge, skills, attitudes, and beliefs of the learner" (Capraro et al., 2012, p. 1).

Bloom's taxonomy provides an avenue for the alignment of assessment with the objectives and instruction (Anderson et al., 2001). In practice, assessment items are categorized into lower-order thinking skills (LOTS), which include the remembering, understanding, and applying taxonomy levels, and higher-order thinking skills (HOTS), which include the analyzing, evaluating, and creating taxonomy levels.

One important type of assessment is the alternative assessment. This type gauges the knowledge and skills of learners via the use of non-conventional methods (Bulus Kirikkaya & Vurkaya, 2011). Herman et al. (1992, as cited in O'Neil & Abedi, 1996) have identified six characteristics common to all alternative assessments:

1. ask students to perform, create, produce, or do something,
2. tap higher level thinking and problem-solving skills,
3. use tasks that represent meaningful instructional activities,
4. invoke real-world applications,
5. people, not machines, do the scoring, using human judgment, and
6. require new instructional and assessment roles for teachers (p. 6).

O'Neil and Abedi (1996) assert that "metacognition can be directly and explicitly measured in the context of alternative assessments" (p. 243); hence, they serve as important tools in metacognitive investigations–thus the choice of the use of an alternative assessment in this work.

Metacognition, Learning, and Performance in Mathematics

Metacognition is cognition about cognition or thinking about thinking (Papaleontiou-Louca, 2008; Zulkiply, 2006). It refers to the ability to reflect, understand, and control one's own learning or thinking (Alzahrani, 2017; Amin & Mariani, 2017; Divinagracia, 2018; Schraw & Dennison, 1994).

Metacognition has two major aspects–knowledge about cognition and regulation of cognition (Alzahrani, 2017; Schraw & Dennison, 1994). Knowledge about cognition is concerned with knowledge about one's own thinking processes while regulation of cognition is concerned with how these thinking processes are regulated and monitored (Alzahrani, 2017). Schraw and Dennison (1994) have indicated that metacognitively aware learners are more academically performant than their metacognitively unaware counterparts. The underlying reason for the better performance is related to their use of metacognitive strategies (Schraw & Dennison, 1994). These researchers have also developed an instrument to measure metacognitive awareness, a set of 52 questions that compose the metacognitive awareness inventory (MAI), classified according to knowledge about and regulation of cognition (Schraw & Dennison, 1994).

Zulkiply (2006) has ascertained that there is a correlation between metacognition and academic performance. Metacognitive regulation is highly related to learners' performance when compared to metacognitive knowledge (Zulkiply, 2006). Similarly, Terlecki and McMahon (2018) also discussed the influence of metacognitive education on the improved metacognitive awareness of the learners at the college level regardless of their initial level. Their study found that metacognitive strategies can be taught or learned (Terlecki & McMahon, 2018). Moreover, Jaleel and Premachandran (2016) has shown that there was no significant difference in the metacognitive awareness of secondary learners when classified according to their locale, gender, or school management.

In the context of mathematics education, metacognition has been widely studied. For instance, Alzahrani (2017) highlighted the following findings:

1. The traditional (direct) way of teaching mathematics may hinder the metacognitive learning of mathematical concepts,
2. "Although metacognitive mathematics instruction should be planned, the strategy that is introduced should be directly targeted at improving the monitoring and regulation of students' thought when dealing with mathematics problems" (p. 534); and
3. Metacognition should be prioritized.

Altogether, this emphasizes the importance of an intentional metacognitive approach to mathematics.

On the other hand, Tian et al. (2018) were able to determine that *in their model*, metacognitive knowledge could not affect the mathematics performance of learners directly. At first glance, this is in stark disagreement with the findings of some studies–for instance, Schneider and Artelt (2010) held that metacognitive knowledge predicts the mathematical performance of primary and secondary learners even after accounting for differences in their intellectual abilities–unless self-efficacy and intrinsic motivation are considered. In relation to this, Liu (1998) as cited in Tian et al. (2018) also explains that prior research "showed that promoting metacognitive and strategic knowledge would enhance the learners' self-efficacy" (p. 7). This infers a demand for a larger integrated view of understanding metacognitive thinking that covers not only metacognitive knowledge and attitudinal

dimensions processes but, as well as its interrelatedness to strategical knowledge and thinking. The inference implies further support for having a deliberate metacognitive instruction.

Divinagracia's Theory and its Implications for Mathematics Instruction

Recently, Divinagracia (2018) was able to suffice such a need of having an integrated or holistic view in understanding the metacognitive thinking conditions. Her study presented seven emerging themes of metacognitive processes. Their interrelationship synthesizes the complete metacognitive thinking in solving mathematical problems. The themes manifest learners' metacognitive thinking qualities, which emerge to be present in successful mathematical problem solving (Divinagracia, 2018). The learners demonstrate abilities that include their:

1. metacognitive knowledge of the typology of mathematical problems,
2. metacognitive knowledge of the nature of mathematical problems,
3. metacognitive awareness of mathematical knowledge and thinking,
4. metacognitive knowledge of personal strengths,
5. metacognitive knowledge of problem-solving emotions and attitude,
6. metacognitive knowledge of thinking associated with bodily motion experiences, and
7. metacognitive solution qualities (Divinagracia, 2018, p. 4).

The seventh theme resulted from the interaction of the ten micro-metacognitive process's sub-themes, namely, "diagnostic, scanning, searching and referencing (SSR), direction-steering, rectification, restoration, pattern-seeking, predicting, natural flipping of thought, evaluating and controlling time" (Divinagracia, 2018, p. 7). Further, Divinagracia (2018) also discussed three emerging and overlapping macro-metacognitive stages, namely,

1. the big understanding process,
2. the conceptualization of a mathematical solution strategy, and
3. the execution of procedural or computational processes governing the said problems' solution (p. 11).

Divinagracia (2018) regarded the *metacognitive awareness of mathematical knowledge and thinking* as the "core phenomenon", which is activated by the first two of the seven themes collectively known as the "task-related knowledge". This is operated by themes four to six, together called the "affect and motion experience". The task-related knowledge and affect and motion experiences compose the "nurture factor", which affects the *metacognitive solution qualities* as the "nature factor", and in turn, affects the three macro-metacognitive stages leading to the success in mathematical problem-solving (Divinagracia, 2018).

As such, it is apparent that what educators can tap into, based on this theoretical model, is the nurture factor. This can serve as the basis for designing an intentional metacognitive instruction, which the present work has pursued.

Research Gap

Despite these studies, the utilization of metacognitive strategies among learners is quite low (Hashemyolia et al., 2015 as cited in Anthonysamy, 2021). Likewise, Divinagracia (2018) indicated that there is a "need for the teaching-learning integration of metacognitive thinking skills and strategies" (p. 16). In support of this, Alzahrani (2017) emphasized that "metacognition should be given priority to improve learners' consciousness of the learning processes" (p. 534).

In addition, Anthonysamy (2021) recommended that an "experimental design can be conducted to examine the actual use of metacognitive strategies among learners in online learning" (p. 14). He also held that only a few studies have investigated metacognitive skills in learning, especially in Asia (Anthonysamy et al., 2020 as cited in Anthonysamy, 2021).

Moreover, there are no known studies utilizing the theory of Divinagracia (2018) as a basis for intentional metacognitive instruction despite its merits in understanding the relationship between metacognitive processes and mathematical problem solving, and its potential for application in learning in general.

Conceptual Framework

Figure 1 illustrates the conceptual framework of the study. The framework is rooted in our main assumption that the theory of Divinagracia (2018) helps holistically in improving the metacognitive awareness of learners. Therefore, in this study, the designed alternative assessment utilizes the theory and measures its influence on metacognitive awareness and student performance. Hence, measurement tools are necessary. In our case, we have chosen the metacognitive awareness inventory (MAI) of Schraw and Dennison (1994) for the former and a summative assessment for the latter. We also mapped Divinagracia's (2018) theory with the MAI, to ensure that our action of measuring metacognitive awareness through the MAI tool is valid and reliable.

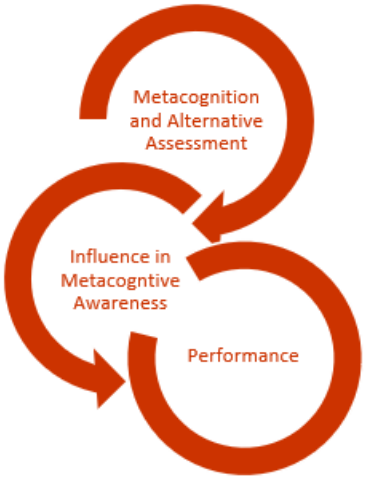

Figure 1. Illustration of the conceptual framework of the study

Aims and Objectives of the Study

This study aims to investigate the effect of the alternative assessment utilizing the theory of Divinagracia (2018) on the metacognitive awareness of grade 8 learners in a secondary school in Western Visayas, Philippines.

Specifically, the objectives of this study are, as follows:

1. To design and implement an alternative assessment using the theory.
2. To determine the metacognitive awareness scores of the learners before (pre-test) and after (post-test) the implementation of the alternative assessment.
3. To compute and compare the mean metacognitive awareness scores of the learners from pre- and post-test groups using a right-tailed paired t-test.
4. To determine the performance scores of the learners in their alternative and summative assessments.
5. To compute and compare the correlation coefficients between the alternative assessment and summative assessment performance scores.

Relevance of the Study

The relevance of this study lies in the prime importance of metacognition as a response to the needs of the new learning modalities during the pandemic (e.g., online classes) as indicated by Anthonysamy (2021). The designing and implementation of an alternative assessment based on metacognition theory and the subsequent evaluation of its impact on learners may help in understanding effective metacognitive instructional strategies.

Further, this study is in line with the United Nations' sustainable development goal 4 (SDG 4) on quality education (United Nations, n. d.) as this work seeks to make education more accessible to all types of learners through metacognitive strategies.

MATERIALS AND METHODS

This study utilizes a quantitative research design. In particular, we have two approaches–experimental and correlational. The experimental aspect employed a *one-group pre-test-post-test quasi-experimental design*. The pre-test, intervention (application of the alternative assessment), and post-test were all applied to the same group of learners all throughout. The correlation analysis intends to investigate on the probable relationship that exists between the alternative and summative performances.

Research Site and Study Participants

The research site is a secondary school in the Philippines. It is one of the country's flagship schools specializing in science and mathematics located in the region of Western Visayas, one of the largest regions in the country. The school has a strict and rigorous process of admission with highly competitive requirements. The sampling frame for the participants of this study is the set of all grade 8 learners from three sections in the said school. A set of 23 grade 8 learners opted to participate after obtaining the free and prior informed consent from the school and the parents.

Key Materials

The materials utilized in this study include a validity instrument (Libutaque, n. da; West Visayas State University Director of Instructional Quality and Assurance, 2018), a usability instrument (Libutaque, n.db; Lund, 2001), and a metacognitive awareness inventory (MAI) (Schraw & Dennison, 1994).

The MAI is a 52-item questionnaire consisting of true/false statements answerable by a 100-point bipolar scale (Schraw & Dennison, 1994). Based on its restricted two-factor analyses on knowledge and regulation of cognition, the internal consistency α coefficient attained a value of .91 for items loading on each factor (Schraw & Dennison, 1994). Meanwhile, for the entire instrument,

α attained a value of .95 (Schraw & Dennison, 1994). Zulkiply (2006) also found an overall α of 0.89 for the inventory. As for the validity, MAI has been tested for face validity by Zulkiply (2006) and rated to be "easily understandable". Pintrich (2000, as cited by Terlecki & McMahon, 2018) agreed to the external validity of the instrument.

For the statistical analyses, the R software (R Core Team, 2020) was utilized along with MS Excel.

Design and Implementation of the Alternative Assessment

First, the objectives of the alternative assessment were identified and classified according to their proper domains in Bloom's taxonomy (Anderson et al., 2001; Bloom et al., 1956; Dave, 1970 as cited in Clark, 1999; Krathwohl et al., 1974) with the pertinent metacognitive processes in mind.

Second, a table of specifications (TOS) was produced. The TOS contains the mappings between the school curriculum learning competencies, the alternative assessment objectives, the metacognitive processes (from Divinagracia's [2018] framework) involved, the planned parts of the alternative assessment, and their proper taxonomy level (Anderson et al., 2001; Bloom et al., 1956; Dave, 1970 as cited in Clark, 1999; Krathwohl et al., 1974).

Third, the TOS guided the design of the alternative assessment. The alternative assessment tool has five parts with a total of 22 items, as follows:

1. **Table organizer**: This was adapted from Divinagracia (2020). Mathematical concepts were identified. For each concept, the learners were asked to determine the definition and notation or equation from a given pool of definitions and notations or equations (themes 1, 2, 6, and 7 from the framework of Divinagracia, 2018).
2. **Identifying mathematical procedures**: For each mathematical concept, an example problem was presented with blanks. The learners are asked to fill in the blanks with the correct answer (themes 1, 2, 6, and 7 from the framework of Divinagracia, 2018).
3. **Developing a problem-solving strategy**: From the given example problems, the learners were asked to choose one that they found difficult, challenging, or interesting. Then they were asked to develop their own strategy of solving the given problem (themes 3, 6, and 7 from the framework of Divinagracia, 2018).
4. **Determining the advantages and disadvantages of the problem-solving activity**: The learners were asked to critique their problem-solving strategy by providing one advantage and one disadvantage (themes 4 and 7 from the framework of Divinagracia, 2018).
2. **Reflection**: The learners were asked to answer reflective questions regarding their problem-solving strategy and the overall activity (themes 5 and 7 from the framework of Divinagracia, 2018).

The validity of the alternative assessment was evaluated using an adaptation of the WVSU evaluation tool (West Visayas State University Director of Instructional Quality and Assurance, 2018) by three of the grade 8 math teachers. The usability of the alternative assessment was also evaluated using an adaptation of the USE questionnaire (Lund, 2001) by the same.

The alternative assessment obtained an average validity rating of 3.77 (out of a 4-point scale with 4 the highest) based on three ratings. Additionally, the assessment had an average usability rating of 3.70 (out of a 4-point scale with 4 being the highest) based on three ratings.

The alternative assessment was deployed on a specified date. The submission bin of the assessment was set to open six days after the deployment at 8 AM Philippine time and was set to close nine days after the deployment at 5 PM Philippine time (with a two-hour extension for those with internet connection problems).

Determining the MAI Scores from the Pre- and Post-Test

A pre- and a post-test were held using the metacognitive awareness inventory (MAI) (Schraw & Dennison, 1994) to determine the metacognitive awareness of the 23 grade 8 learners who chose to participate and were able to participate, prior to and after the deployment of the alternative assessment, respectively. The MAI items were mapped to the metacognitive processes identified in the study of Divinagracia (2018) to ensure alignment.

In both instances, the scores were obtained from the responses of the learners to the inventory (as a whole and as categorized into knowledge and regulation of cognition).

Data Analysis of the Pre-Test-Post-Test Data

The means and the standard deviations of the pre- and post-test data were computed (as a whole and as categorized into knowledge and regulation of cognition).

A right-tailed paired t-test was performed given the computed parameters with a significance level of α=.05. The null hypothesis states that there is no significant difference between the pre- and post-test MAI scores in favor of the latter (as a whole and as categorized into knowledge and regulation of cognition). Meanwhile, the alternative hypothesis states that there is a significant difference between the pre- and post-test MAI scores in favor of the latter (as a whole and as categorized into knowledge and regulation of cognition).

Determining the Alternative and Summative Assessment Scores

The 22-item alternative assessment was checked. The scores of the participants were then obtained. It is important to note that the alternative assessment produced a coefficient of internal consistency (Cronbach's alpha) of 69.16% based on the attempts

of the study participants, which may be considered acceptable based on the surveyed articles of Taber (2017). But this relatively low value can be attributed to the small number of participants in the study.

A 30-item summative assessment, answerable in one hour, was prepared as part of the regular class routine, 50% of which were higher-order thinking skills (HOTS) items, and the remaining, lower-order thinking skills (LOTS) items. This was deployed after the submission of the assessment. The assessment was checked, and the scores were obtained as a whole and categorized into HOTS and LOTS.

To ensure the validity of the summative assessment, items were cross-checked by three grade 8 math teachers as well as two math teachers from other grade levels. After the deployment of the exam, the scores of the participants were obtained. It is also important to note that the exam results produced a coefficient of internal consistency (Cronbach's alpha) of 51.11% based on the attempts of the study participants, which may also be considered acceptable based on the surveyed articles of Taber (2017). But the low value can be attributed to the small number of participants in the study.

Data Analysis of the Alternative and Summative Assessments Data

The correlation coefficients between the alternative and the summative assessments (as a whole and as categorized into HOTS and LOTS) were obtained using Pearson correlation analysis.

The correlation coefficients between the alternative and summative assessment scores (as a whole and as categorized into HOTS and LOTS) were compared. The significance level was set at α=.05.

Ethics

Ethical issues were dealt with accordingly in the study. A letter of permission was sent to the school heads for approval of the conduct of the research study. Permission was granted with the condition that the activity should not be an added burden to the learners. This was dealt with by having the activity checked and reviewed thoroughly by all the grade 8 math teachers.

A letter of permission was sent to both the parent and the learner to ask for their consent for participation in the study. Out of 91 potential participants, 23 learners were given permission by their parents, gave their consent to participate in the study, and actually participated in the study.

Coercion issues were dealt with appropriately. The anonymity of the respondents was ensured. Only the main researcher has access to the raw data. The other members of the research team have access only to anonymized data.

The name of the school, the participants, and all the data obtained are confidential information and have been treated as thus, appropriately. All information that could possibly link this work to the school or the participants has been eliminated. Only the members of the research team have access to this information.

RESULTS AND DISCUSSION

Results for Determining the MAI Scores from the Pre-Test and Post-Test

The descriptive analysis results show that when taken as a whole, the mean pre-test score is 3456.52±680.62 (n=23) while the mean post-test score is 3671.48±696.51 (n=23) (**Table 1**).

Table 1. Computed mean and standard deviations for the pre-test-post-test data

Categorization	Pre-test		Post-test	
	Mean	Standard deviation	Mean	Standard deviation
As a whole	3,456.52	680.62	3,671.48	696.51
Knowledge of cognition	1,169.52	241.49	1,227.39	230.91
Regulation of cognition	2,287.00	480.79	2,444.09	494.44

When categorized into knowledge and regulation of cognition, the descriptive statistical analysis results showed that the mean pre-test score is 1169.52±241.49 (n=23) and the mean post-test score is 1227.39±230.91 (n=23) for the knowledge of cognition and the mean pre-test score is 2287.00±480.79 (n=23) and the mean post-test score is 2444.09±494.44 (n=23) for the regulation of cognition. In all cases, the mean post-test scores are higher than the mean pre-test scores.

Results for Comparing the MAI Scores from the Pre-Test-Post-Test

The right-tailed paired t-test analysis results show that when the MAI scores are taken as a whole, there is a significant difference (p=.011) between the pre- and post-test groups signaling that the alternative assessment has increased the metacognitive awareness levels of the grade 8 learners (**Table 2**).

Table 2. Results of the t-test for the pre-test-post-test MAI scores

Categorization	p-value	Cohen's d
As a whole	.011	0.31
Knowledge of cognition	.052	0.24
Regulation of cognition	.006	0.32

However, when the MAI items are categorized into knowledge and regulation of cognition and the scores are obtained in each group, we find that for the knowledge of cognition, there is no significant difference (p=.052). As for the regulation of cognition, there is a significant difference (p=.006). This indicates that the alternative assessment has helped improve the learners' regulation

significantly but not their knowledge of cognition. While the results showed the limitations of the alternative assessment with regards to metacognitive instruction, it is worthwhile to note that Alzahrani (2017) stated that planned metacognitive instruction should focus on improving the learners' monitoring and regulation of mathematical thought – which has been achieved by the alternative assessment. Further, Cohen's d has been calculated for each particular case. McLeod (2019) claimed that " Cohen suggested that d=0.2 be considered a 'small' effect size, 0.5 represents a 'medium' effect size and 0.8 a 'large' effect size" (par. 9). In our case, the values fall within the small to medium range. This indicates that the alternative assessment had a statistically significant effect (as a whole and when considering regulation of cognition), and the effect is not negligible (McLeod, 2019). Moreover, for the knowledge of cognition, although there is no significant difference, the effect is not negligible as well.

Results for Determining the Alternative and Summative Assessment Scores

The descriptive analysis results show that for the alternative assessment, 23 learners scored above or at cutoff (50% of total score) while none of the learners scored below cutoff. Meanwhile, for the summative assessment, 14 learners scored above or at cutoff (50% of total score) while nine learners scored below cutoff (**Table 3**).

Table 3. Frequency table of the number of learners who scored above or at, and below cutoff

Assessment type	Number of learners who scored above or at cutoff	Number of learners who scored below cutoff
Alternative	23	0
Summative	14	9

Results of the Data Analysis of the Alternative and Summative Assessments Data

The correlation analysis results show that when the alternative and summative assessment performance scores are considered as a whole, the Pearson r value is .47 suggesting moderate correlation (Schober et al., 2018) (**Table 4**).

Table 4. Correlation coefficients of the alternative-summative assessments data

Categorization	R	p-value
As a whole	.47	.023
HOTS	.44	.035
LOTS	.39	.063

When considering HOTS items only, the correlation coefficient produced is .44 suggesting moderate correlation (Schober et al., 2018) as well. As for the LOTS items, the coefficient produced is .39 suggesting a weak correlation (Schober et al., 2018).

When calculating the p-values, the results show that when taken as a whole and when considering HOTs items only, the correlation is significant (p=.023 and p=.035, respectively). For LOTS items, the correlation is not significant with a p-value of.063.

These results indicate that there is an association between the alternative assessment scores and the summative assessment scores in the same direction (i.e., those who do well in the alternative assessment tend to do well in the summative assessment as well). However, this correlation is more pronounced when considering the items as a whole and when considering HOTs items only (wherein the correlations are found to be moderate). It is also for these two cases that the correlations are found to be significant. This, coupled with our result that the alternative assessment improved the overall metacognitive awareness of the grade 8 learners, points toward the idea that learners who had a better transfer of metacognitive learning from the alternative assessment (as reflected in their scores) may have translated these skills into the summative assessment, especially HOTS items. Although further investigations are needed to establish this, studies such as Schneider and Artelt (2010) have shown how metacognitive instruction can impact mathematical performance.

Interpreting the Findings

From these results, we can say that the alternative assessment developed based on the theory of Divinagracia (2018) may be a viable tool for metacognitive instruction in the classroom setting. It has increased the metacognitive awareness of the grade 8 learners sampled. And those who do well in it tend to do well in the corresponding summative assessment.

The effect of alternative assessment on a learner's knowledge of cognition and summative assessment scores, in this study, manifests areas to strengthen particularly in the domain of mathematical knowledge utilized in the regulation of cognition. Divinagracia (2018) theorizes the demand for the development of mathematical knowledge and thinking as one integrated metacognitive function. The theory assumes the strengthening role of the regulation of cognition in the knowledge of cognition. However, the total success in gaining knowledge of cognition depends on the quality and accuracy of the mathematical knowledge learned. The regulation of cognition, therefore, calls for defining a more appropriate set of regulative thinking strategies at varying levels functional to the achievement of mathematical knowledge, and consequently, the development of the knowledge of cognition.

The authors acknowledge, therefore, that the alternative assessment still needs improvement in providing components effective in improving the knowledge of cognition of the learners. This is something that needs to be investigated further, as the study finding of Divinagracia (2018) observes that accuracy in mathematical knowledge suggests stronger knowledge of cognition. But the current work may serve as a prototype for other future theory-based metacognitive instructional materials.

CONCLUSIONS

In this work, we have designed and implemented an alternative assessment based on the metacognition theory of Divinagracia (2018) for a group of grade 8 learners. The impact of the alternative assessment on the metacognitive awareness of the learners was investigated. Results showed a statistically significant effect on the overall metacognitive awareness of the learners with p=.011 and Cohen's d=0.31 between the pre-test and post-test groups. Further, when categorized into knowledge and regulation of cognition, results showed that the improvement (pre-test-post-test) for regulation was statistically significant while for knowledge of cognition, it was not.

Our findings have also highlighted the moderate, positive correlation between the alternative and summative assessment scores of the learners (r=.47). In particular, there was a moderate correlation for HOTS items and a weak correlation for LOTS items.

Taken together, these results show that the alternative assessment is a possible tool for metacognitive instruction. While it does have its limitations, it may serve as a prototype for future investigations or developments on metacognitive instruction.

One of the main limitations of this study is due to the utilization of the one-group pre-test-post-test research design. The one-group pre-test-post-test research design was implemented in favor of other possible designs due to ethical considerations and the constraints imposed by the pandemic.

Knapp (2016) identified five threats to internal validity and external validity of the said design: history, maturation, testing, instrumentation, and statistical regression (to the mean). In this work, maturation may not be too much of an issue because the pre-test and the post-test were done within a span of three weeks, which can be regarded as a relatively short amount of time. Nevertheless, the length of time has something to explain also on the effect of alternative assessment on the knowledge of cognition and scores in summative assessment. Also, instrumentation may not be too much of an issue since most of the conditions of the pre-test were replicated during the post-test, except for a few exceptions. The most viable threats then are the history, testing, and statistical tool utilization. These must be kept in mind when understanding the findings.

It is also important to point out that metacognitive skills are developed over time. The time frame of three weeks, though circumventing the issue of maturation, may have been relatively short for the students to develop transferable metacognitive skills even though there has been a statistically significant increase in their metacognitive awareness. That is, the metacognitive skills gained over the course of answering the alternative assessment may not readily translate into their performance in the summative assessment due to this time factor–although, the results do show a moderate correlation suggesting some translation.

For future studies, it is recommended to pursue other research designs that have fewer threats to its internal or external validity. Also, a longer time frame for the study is suggested to allow the learners to develop stronger and more apparent metacognitive skills. Interviews with the learners may also be pursued to offer a more qualitative account of the effects of metacognitive instruction. Lastly, studies may also be conducted on a more general profile of learners than what was considered in this study.

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