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## **Learning Skills, Strategies, and Students' Mathematics Performance in Distance Education: A Structural Equation Modeling Analysis**

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### **ABSTRACT**

This paper aims to investigate how some predetermined learning skills in distance education directly and indirectly affect the mathematics performance of the students in distance learning modality. These learning skills include metacognitive strategies, motivational strategies, problem solving appraisals, and self-regulated learning skills.

The Partial Least Square – Structural Equation Modeling (PLS-SEM) was employed to measure the effects of the predetermined Learning Skills towards mathematics performance and explored the variables to develop theories. The participants of this study are the 272 students chosen randomly from five (5) districts in the division of Zamboanga del Sur.

The results revealed that motivational strategies along with metacognitive strategies and problem-solving appraisals positively affect self-regulated learning skill in distance education. Meanwhile, problem solving appraisals and metacognitive strategies also positively affects mathematics performance. However, motivational strategies and self-regulated learning skills does not positively affect mathematics performance in distance education. While, self-regulated learning skill does not mediate motivational strategies, metacognitive strategies, and problem solving appraisals towards mathematics performance.

However, this paper has little problem regarding the validity since most of the scales in convergent and divergent validity does not meet the set threshold, however, its reliabilities are all met in accordance with composite reliability threshold. Other researchers may opt to expand the research locale or choose another observable constructs. Since this study conducts the PLS-SEM, CB-SEM is recommended to test the presented theories. The findings of this study could be beneficial to the curriculum planners, head of schools, teachers in the field, and students.

**KEYWORDS:** *Partial Least Square – Structural Equation Modeling, motivational strategies, metacognitive strategies, problem-solving appraisals, self-regulated learning skills, mathematics performance, distance education*

### **INTRODUCTION**

As the world is experiencing an unprecedented event that affects our daily normal life, no other option left but to cope with the changes that it brings. The threat of COVID-19 alters the way we conduct our schooling – even as for the mean time. This resulted to the temporary

termination of face-to-face classes in schools (Viner et al, 2020). With that, adaptation of different sorts of Distance Education such as Distance Learning, online learning, blended education, and home-schooling were the options left to continue the culture of learning in most of the countries such as Colombia, Italy, Japan, Poland, including the Philippines (Alea et al., 2020).

During the prime years on the rise of pandemic, it becomes a big question in the Philippines as to how students prepared for this kind of extraordinary schooling for them to cope up. The new modality speaks mostly of online learning but out 47,177 public schools in the country, only 22, 645 or 48% have internet connection where 8,478 schools alone are in areas with Internet Service Providers (ISP) nearby. In addition, out of 687, 911 surveyed 50.9% or 350, 834 also responded that they have no internet connection at home (DepEd, 2020). Thus, there is a need to realign the traditional paradigm of the educational system. As the COVID – 19 rises, challenges to the teachers and the learning delivery are also contested. Capacity-building activities/teacher training/wellness program, partnership engagements, and fiscal management are the interventions that was catered by the department to address these issues. Altogether, these resulted to adapt another alternative way of schooling. Aside from online education, some schools also conduct modular distance education. Fortunately, these comes with a progress. As according to the Basic Education – Learning Continuity Plan plus of the Department of Education for school year 2021-2022, an increase of 2.53% for the Junior High School and 6.90% for Senior High School is expected (BE-LCP, S.Y. 2021-2022).

The challenge is how to offer, deliver and provide quality education even up to the extreme scenario (Tria, 2020). With this unprecedented education, students must utilize learning skills that are essential in distance education especially on the subject they find it hard which is mathematics. One study was able to construct a learning innovation in relation to problem on performance of students by developing instructional materials to develop independent and self-regulated learning skills (Luzano, 2020).

Some of the predetermined learning skills in distance education are metacognitive, motivational strategies, and self-regulation, which are important for the students to blend in with distance education (Cunha, 2014; Ozkan, 2013; Shapiro & Neiderhauser, 2004). The study is supported by Zimmerman's Self-regulation theory, since it ought to display an individual's belief on their own capability, which provides appropriate actions, feelings, thoughts, and behaviors. In addition, there is also a need to assess problem-solving skills of the students in distance education (Saeid, 2019) which is attributed to problem solving appraisals. It was also emphasized in a study that self-regulated learning skills is significant in conveying or transporting skills, knowledge, and abilities from one domain to another and helps in attaining lifelong learning (Bautista, 2015).

Distance Education (DE) enables learner to practice learning on their own speed at their convenient time and place (Ebru & Yusuf, 2018) on which enhances their self-regulated learning skill. Accordingly, both teachers and learners should have a clear perspective about self-regulated learning skill (SRLS) in distance education for them to enhance their learning process and become self-directed (Norman, 1999). In addition, another important practical skill in distance education is their learning strategy skills. It has been suggested that learners in distance education should adopt appropriate learning strategies that can compensate their cognitive load (Bruggen et al., 2002; Gerjets & Scheiter, 2003; Shapiro & Niederhauser, 2004). This is a way of taking an initiative as part of learning process of the learner away from

their teacher. This learning strategy includes motivational strategies and metacognitive strategies (Cunha & Duarte & Cruz, 2015).

Motivational strategies sustain and activate the interest of the learners in distance education when it comes to learning on their own (Firat & Kilinc & Yuzer, 2017). Thus, it is important in distance education since it influences what, how, and when students learn (Barak, Watted, & Haick, 2016; Deimann & Bastiaens, 2010). Meanwhile, metacognitive strategies are also important in distance education. This refers to regularization and organization of cognitive processes (Ribeiro, 2003) which also determines the success and failure of problem solving in mathematics (Silver, 1985). The success of the learners in distance education does not only need an academic skill. It also needs a problem-solving skill in order to have a suitable performance that will face several problems (Saeid, 2019). However, there are only less studies that investigates problem-solving appraisals in distance education especially in mathematics performance. Thus, this study also involves an appraisal of problem-solving skills related to distance education and mathematics performance.

In general, almost if not all the results presented are the product of various studies under traditional learning environments. Only less articles that relates self-regulation to distance education while rare articles also are being published that relates motivational strategies, metacognitive strategies, and problem-solving appraisals to distance education.

In addition, there may be various articles published that relates these latent constructs to mathematics performance, however, most of them are also done in traditional learning environment specifically in the Philippines. Thus, this study is done differently since its focus is the distance education, which is considered as the practical-knowledge conflict gap of traditional learning environment. In addition, as these latent constructs or the learning strategies are deemed relevant to distance education, a need to investigate each of its relationship is beneficial to the educational system as well.

Hence, this study investigates how these learning skills affected mathematics performance and how they are correlated with each other. It conceptualized a new structural model using the determined variables, which was conducted in distance education setup.

In this study, data are analyzed using regression and factor analysis combined with advanced statistical technique called Structural Equation Modeling specifically the Partial Least Square. Considering the ever-increasing importance of understanding latent phenomena, it is not surprising that SEM has become one of the most prominent statistical analysis today surpassing the previous and manually dated statistical analysis (Hair, Sarstedt, and Ringle, 201).

This study is deemed relevant to the education sector since it can be used as a basis and a guiding research on the assessment and enhancement of the distance modality that most of the schools are adapting during pandemic.

## **FRAMEWORK**

This study is anchored on Zimmerman's (1986) "Self-regulation Theory" which refers to an individual's belief on their own capability in order to provide appropriate actions, feelings, thoughts, and behaviors in order to pursue academic goals with value, while monitoring and reflecting its own progress in completing a certain goal. This theory supports the study since

there is a need to adapt Learning Skills needed in distance education such as self-regulation skill, motivational strategy, and metacognitive strategy. Accordingly, it occurs when an individual can adapt the behaviors needed utilizing own internal sources to guide behavior. This is where an individual was able to adapt and adjust the context of situation (DiBenedetto, 2011). This theory is believed to be directly related to the study since the educational platform offers modular way of learning where no face-to-face interaction is being held. Self-regulated learning skill is unarguably needed in improving mathematics performance in distance education, as the learners must rely mostly on its own skill in order to cope with the modality.

There are also various theories of distance education, which are deemed relevant to this study. It includes the Autonomy and Independence Theory of Wedemeyer (1977) and Moore (1993) which reflects the essential component of the independence of learner. Wedemeyer (1977) identifies vital foundations of independent learning as greater students' responsibility, widely available instruction, effective mix of media and methods, adaptation to individual differences, and a wide variety of start, stop, and learn at times. Independent learners need to adapt skills such as self-regulation in order to be responsible to their own learning. However, these two theories can be covered in the blanket of Self-Determination Theory of Deci and Ryan (2000) which concerns to how individual interacts with depending on the social environment. Primarily, it is based on the humanistic assumption that individuals are naturally engaging themselves actively towards growth and self-organization. It is reflected on many mini-theories, which also focuses on autonomy or the need to be free and self-directed). It evolves on a mini-theory under cognitive evaluation theory that focuses on factors that focuses on intrinsic motivation by affecting autonomy and competence. It also reflects the essential component of the independence of learner. It is related to the study since students also needs internal and external motivation to move and obtain balance in distance learning. Apart from that, they also need to be autonomous in order to enhance their self-regulated learning skills. Independent learners need to adapt skills such as self-regulation in order to be responsible to their own learning. This theory is deemed relevant to the study since for the distance education learners to be successful in the field, they should also practice independent learning.

Another relevant theory of this study is the "Locus of Control Theory" (Altman & Arambasich, 1982). It states that when students think that their academic success is a result of their own personal accomplishments, it creates an internal locus of control and are more likely to persevere in their education. Conversely, if the student had external locus of control, they tend to feel that their success, or lack of it, is due largely to events such as luck or fate outside their control that can result to dropouts. This theory supports the study since there is a need to study the motivational strategy and problem-solving skills of the students in distance education since it can affect both their performance in mathematics and personality.

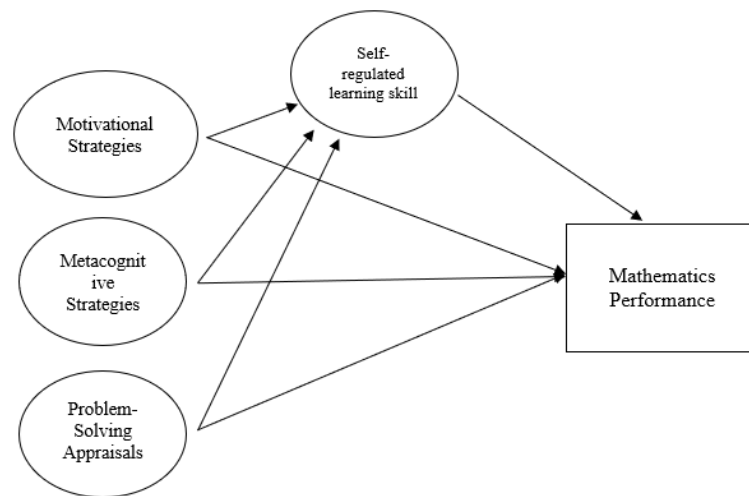


Figure 1: *The Hypothesized Model of Learning Skills in Distance Education and Mathematics Performance*

The schema of the study is shown in Figure 1. It is theorized that the latent variables (as illustrated in circular shapes) correlate with the observed variable (as illustrated in a rectangular shape) in distance education while self-regulated learning skills mediates the relationships of metacognitive strategies, motivational strategies, and problem-solving skills towards mathematics performance.

Self-regulated learning skill in this study refers to the students' skill that enable them to convey or transport skills, knowledge, and abilities from one domain to another that helps them in attaining lifelong learning (Bautista, 2015). It is also a complement to independent learning in this study which is an important learning skill in distance education since it enable learners to enhance their knowledge and performance for themselves by taking resourcefulness with or without the help of others (Herlo, 2017). Its subdomains are environmental structuring, Time management, Help-seeking, self-evaluation, and Goal setting. This study investigates if it has a positive effect to mathematical performance of the students in distance education and if it mediates motivational strategies, metacognitive strategies, and problem-solving strategies towards mathematics performance.

Meanwhile, motivational strategies in this study refers to a learning strategy that sustain and activates the interest of the learners in distance education when it comes to learning on their own (Firat & Kilinc & Yuzer, 2018). Its subdomains are Implication, Positive association, Applicability, self-reinforcing, and gradual approach. In this study, it is investigated if it has a positive effect on self-regulated learning skill and mathematics performance.

Metacognitive strategies, on the other hand, refers to a learning strategy of the students under distance education that enable them to understand how they think, reflect on what they think and controlling their acquired learning (Schraw & Dennison, 1994). Its subdomains are planning and revision. In this study, it is investigated if it has a positive effect on self-regulated learning skill and mathematics performance.

In addition, problem-solving appraisals in this study refers to problem solving skills of the students in distance education that assess them as to how they respond to a task that demands to function adaptively where immediate help or available person that could help is not



around. The subdomains of this variable are problem solving confidence, approach-avoidance style, and personal control. In this study, it is investigated if it has a positive effect to self-regulated learning skill and mathematics performance.

Lastly, mathematics performance in this study is the only observable construct. It refers to the grades of the students during the conduct of distance education. In this study, it is investigated if it is positively affected by self-regulated learning skills, motivational strategies, metacognitive strategies, and problem-solving appraisals. On the other hand, it is also investigated in this study if self-regulated learning skill mediates the other latent constructs towards mathematics performance.

### **Statement of the Problem**

This study aimed to investigate the relationship of Learning Skills that are deemed relevant to distance education and mathematics performance among the students in Quality Learning Circle 4 of the Division of Zamboanga del Sur, Philippines. It ought to investigate the structural effects of self-regulated learning skills in improving the students' mathematics performance along with the effects of metacognitive strategies, motivational strategies, and problem solving skills in distance education by utilizing Partial Least Square – Structural Equation Modeling.

The following specific research questions were investigated:

1. What is the level of the following variables in distance education?
  - a. Metacognitive Strategy practice
  - b. Motivational Strategy practice
  - c. Problem Solving Appraisals
  - d. Self-regulated Learning Skill
  - e. Mathematics Performance
2. What is the extent of the following variables in terms of its validity and reliability in distance education?
  - a. Metacognitive Strategies
  - b. Motivational Strategies
  - c. Problem-Solving Appraisals
  - d. Self-regulated Learning Skill
3. Do the following variables positively affect self-regulated learning skill in distance education?
  - a. Motivational Strategies
  - b. Metacognitive Strategies
  - c. Problem-Solving Appraisals
4. Do the following variables positively affect mathematics performance in distance education?
  - a. Motivational Strategies
  - b. Metacognitive Strategies
  - c. Problem-Solving Appraisals
  - d. Self-regulated Learning Skill
5. Do self-regulated learning skill mediate the relationship between:
  - a. Motivational Strategies and Mathematics Performance;
  - b. Metacognitive Strategies and Mathematics Performance;
  - c. Problem-Solving Appraisals and Mathematics Performance?

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## Hypotheses

- Motivational Strategies, Metacognitive Strategies, and Problem-Solving Appraisals does not positively affect self-regulated learning skill.
- Motivational Strategies, Metacognitive Strategies, Problem-Solving Appraisals and Self-regulated Learning Skill does not positively affect self-regulated learning skill.
- Self-regulated Learning Skill does not mediate the relationship of motivational strategies, metacognitive strategies, and problem-solving appraisals towards mathematics performance.

## Significance of the study

The result of this study is deemed relevant to students, teachers teaching mathematics in distance education, school administrators, parents and stakeholders and other future researchers.

## RESEARCH METHODS AND PROCEDURES

### Methods

The study was a quantitative research design employing descriptive correlational using Structural Equation Modeling. The descriptive methods intend to investigate, examine and summarize information about motivational strategies, metacognitive strategies, problem solving appraisal, self-regulated learning skills and mathematics performance. Correlational and causal research approaches determined the interdependencies, significant relationships and predictions of the antecedents of mathematics performance to mathematics performance itself. It shall utilize Structural Equation Modeling (SEM) since it is a methodology that can quantify and test plausibility of hypothetical assertions about potential interrelationships among constructs as well as their relationship to measures assessing them. (Raykov & Marcoulides, 2006).

### Locale

The study was conducted in Zamboanga del Sur, one of the provinces in the Philippines encompassing the Zamboanga Peninsula region southwestern of Mindanao Island. The Department of Education divided the province into 2 divisions namely the Pagadian City Division and the division of Zamboanga del Sur. Most of the schools in the division of Zamboanga del Sur adapts modular distance learning. It is also divided into 6 Quality Learning Circle (QualCi) wherein the Quality Circle 4 was the environment of the study. QualCi 4 is composed of 5 districts namely Dumalinao, Tigbao, Lakewood, Bayog, and Kumalarang. In addition to the research locale of this study, it includes 1 school in Dumalinao District which obtain an Average Mean Percentage Score in Mathematics of 52.17%. Another research locale of this study are three schools in Tigbao district who have an average MPS in mathematics of 61.07%, 52.07% and 37.17% respectively. In addition, another research locale also of this study is a school in the district of Lakewood who obtained an average MPS of 52.30% and lastly, 2 schools in Kumalarang District who obtained an average MPS of 32.46% and 63.42%. All these data were based on the concluded May, 2022 District Achievement Test (DAT) in the Province of Zamboanga del Sur.

## Participants

After doing the clustering sampling technique, the selected schools are scheduled to be given at least 100 sets of questionnaires randomly distributed among Junior High School and Senior High School students. However, due to the challenges brought about by the lock downs and restrictions of travel due to the increasing COVID-19 cases, some targeted schools are replaced, and some were not covered. Thus, out of 600 set of questionnaires released, only 272 or 45% have returned with complete response. However, earlier studies that systematically assessed the performance of PLS-SEM using small sample sizes gives a conclusion that it can still perform well (Chin & Newsted, 1999; Hui and Wold, 1982). Moreover, another simulation study also indicated that PLS-SEM is a good option when the size of the sample is small (Reinartz et al., 2009).

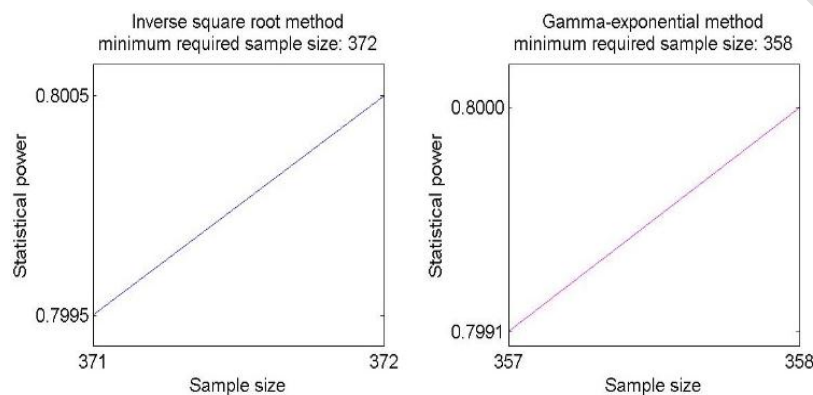


Figure 2: *Sample size estimates using the Monte Carlo Method*

Inverse square root and gamma-exponential method were used to identify the sufficiency of the sample size which is a simulation of the Monte Carlo method (Kock and Hadaya, 2018). Inverse square root method uses the inverse square root of the sample size in estimating the standard error. Meanwhile, the gamma-exponential method uses exponential and gamma smoothing function corrections in estimating standard error. With a minimum absolute value of 0.029, significance level of 0.05 and power level of 0.8, the result of inverse square root sample size estimation is 372 while 358 for gamma-exponential method.

## Data Gathering Procedure

Following the proper research ethics standards, the necessary permission and endorsement documents was secured. Request letters and endorsement forms for the conduct of the study was also processed.

The cross-sectional data gathering approach was employed for this study wherein the targeted participants of student population will answer all four (4) questionnaires in one setting that will measure their motivational strategies, metacognitive appraisal, problem solving appraisal, and self-regulation skills in distance education. Distribution of informed consent for the participants and other necessary research ethics procedures were all observed. In addition, the participants were also asked to indicate their grades in mathematics for the 1<sup>st</sup> Quarter as reflected in their report cards.



The mode of data collection was done through modular-liked distribution process wherein the questionnaires were given together with their modules and were retrieved on the retrieval day of the module constituting one (1) week time span of answering the questionnaire so that it cannot be regarded as additional burden to the part of students. The researcher also ensured the proper administration of questionnaires to gain higher return rates and minimizing rating errors of the item scales.

### **Statistical Treatment**

The preliminary statistical tool that this study is using is the descriptive analysis using the measurement of central tendency and variability, which are the mean and the standard deviation concurrent with the qualitative description based on the given level of interval. For the reliability of the questionnaires of this study, the researcher utilizes Cronbach's Alpha and Composite Reliability based on the set threshold of Fornell and Larcker Criterion. According to Roldan and Franco (2012), there is a need to assess or evaluate the reliability of the constructs to determine the consistency of the item in terms of what it tries to measure. To expand, there are two measures of reliability (Kock, 2017), they are Cronbach's Alpha and the other one is the Composite Reliability. However, when comparing the two measures, Dillon and Goldstein (1984) which are supported also by Peterson and Kim (2013) states that composite reliability is more acceptable. To determine whether the construct and the item are said to be reliable, the Cronbach's Alpha value must be greater than or equal to 0.7 while a composite reliability of greater than or equal to 0.6 (Fornell and Larcker, 1981).

Meanwhile, to test the validity of the constructs, convergent and discriminant validity were also measured. Accordingly, the measurement of the quantity of variance of each variable and its item in relation to the amount due to the error of measurement is an assessment of convergent validity (Chin, 1998; Amora et al., 2016). In this case, Average Variance Extracted (AVE) was being utilized. Fornell and Larcker (1981) set the threshold for the acceptable value of AVE of the construct to be convergently valid should be greater than or equal to 0.5. On the other hand, discriminant validity of the construct is also being assessed. Discriminant validity measures if the statements in each latent variable does not confuse the participants in relation to the statement of one variable to another (Kock, 2017). To test this, the square root of AVE is being extracted. According to Fornell-Larcker criterion, there is a discriminant validity of the questionnaire if the correlation of the latent variable does not exceed to the correlation of each reflective variable (in this case the diagonal value). In addition, to test whether there is a correlation between the construct and the item, item loading was measured. An item loading value of greater than or equal to 0.5 indicates that the construct and the item is statistically significant (Amora et al., 2016; Kock, 2017).

For the relationships of the latent variables and observable variables of this study, it utilizes the Partial Least Squares – Structural Equation Modelling (PLS-SEM) approach in order to examine the interrelationships of four latent constructs (motivational strategies, self-regulated learning skills, metacognitive strategies, and problem-solving skills) and one observable construct (mathematics performance).

## RESULTS AND DISCUSSION

### Level of Metacognitive Strategies in Distance Education

Table 1 shows the descriptive levels of student's metacognitive strategies in the Quality Learning Circle 4 of the Division of Zamboanga del Sur. With 272 recorded number of participants, the over-all qualitative description is shown to be high level among the students of Distance Learning with a mean of 3.92 higher than that of motivational strategies with a standard deviation of 0.63 which is more spread than metacognitive strategies standard deviation average.

On the account of metacognitive strategies' subdomain, both planning ( $M=3.98$ ,  $SD=0.73$ ) and revision ( $M=3.85$ ,  $SD=0.73$ ) garnered high level of qualitative descriptive. In addition, it is also good to notice that a question regarding the organization of task under the subdomain of planning garnered the highest mean while a question regarding reviewing of work or task garnered the highest mean in the subdomain of planning. Meanwhile, the question regarding the consolidation and memorization of points that the student is weaker at garnered the highest standard deviation of this study while both planning and revision have the same level of variability.

Table 1: *Descriptive levels of students' Metacognitive Strategies (n=272)*

Metacognitive Strategies	M	SD	QD
	3.92	0.63	High
<i>Planning</i>	3.98	0.73	High
1. Before I start studying, I often consider what I have to study, what activities I have to do or how much work or time study will consume.	3.97	1.00	High
2. I usually divide the task, work or study into parts, to make it easier for myself.	3.97	1.04	High
3. When I study, I usually order the different activities that have to do, telling myself, "First I have to do this and then that..."	4.11	0.96	High
4. I tend to be look ahead, calculating the time I have available to distribute it realistically.	3.86	0.99	High
<i>Revision</i>	3.85	0.73	High
1. When I study, I usually continually review what review what 2. I'm weaker at or where I fail in order to memorize it properly.	3.86	0.96	High
3. When I finish studying, I have the habit of reviewing everything to see if I am missing anything.	3.95	0.99	High
4. When I finish studying, I try to memorize and consolidate the points I consider I'm weaker at.	3.71	1.07	High

Note: M = mean, SD = Standard deviation, QD = Qualitative description: 1.00 – 1.79 = Very Low (VL), 1.80 – 2.59 = Low (L), 2.60 – 3.39 = Moderately High (M), 3.40 – 4.19 = High (H), 4.20 – 5.00 = Very High (VH)

This implies that students in modular distance learning are highly trying to use metacognitive strategies to cope with the challenges they encountered in the modality. This is also true in a study revealed by Yilmaz (2014) which is supported by the papers finished by Zion, Adler and Mevarech (2015) on his 127 students that independent learning increased the learners' metacognitive awareness.

In addition, the similarity on the standard deviation of the two subdomain implies that both have the same level variability which means that students responses in this area are almost the same in terms of concentration. Meanwhile, the 4<sup>th</sup> question under the subdomain of

revision garnered the highest standard deviation which implies that the responses of the participants have different opinions regarding the matter.

To add, the acquisition of a qualitative description of high among both subdomains in the metacognitive strategies is apparent since students learn to accurately evaluate themselves by recalling so that they can select strategies suitable in addressing their learning challenges during planning phase (Bautista, 2015).

Practically, metacognition is practice by the students distance education especially that some of the topics in the modules are connected with their previous grading level wherein they need to rethink their thinking in order to dive into their previous knowledge and connect it to the current assessments they're facing.

### **Level of Motivational Strategies in Distance Education**

Table 2 shows the descriptive levels of student's motivational strategies in the Quality Learning Circle 4 of the Division of Zamboanga del Sur. With 272 recorded number of participants, the over-all qualitative description is shown to be high among the students of Distance Learning with a mean of 3.88 having a standard deviation of 0.55.

*Table 2: Descriptive Levels of students' Motivational Strategies (n=272)*

Motivational Strategies	M	SD	QD
	3.88	0.55	High
<i>Implication</i>	3.90	0.64	High
1. I often relate what I will study with things I already know, or experiences related to the topic that I have had.		0.89	High
2. I often relate the topics I'm going to study with my interests.	3.83	0.95	High
3. Before I start studying, I try to consider the importance, interest or applicability of what I'm going to study.	3.93	0.96	High
4. I often consider the usefulness of what I'm going to study: why is it important? What will it do for me? How useful is it?	3.93	1.03	High
<i>Positive Association</i>	3.92	0.73	High
1. I try to set goals for myself before studying to motivate myself for instance, "I was able to learn this within half an hour" "Today I will get up to page x".	3.69	1.14	High
2. I often encourage myself with positive things when I can achieve what I has set for myself.	4.02	1.09	High
3. I seek to feel satisfaction when I manage to learn what I have studied.	3.98	1.02	High
4. I often value success and what I've learned after studying.	4.00	1.03	High
<i>Applicability</i>	3.86	0.81	High
1. When I start studying, I usually concentrate intensely in study	3.94	1.10	High
2. When I'm studying, I'm focused on what I'm doing; I do not like to be distracted from my goal.	3.95	1.11	High
3. When I'm studying and I'm so interested in what I'm studying, I lose tract of time.	3.70	1.08	High
<i>Self-reinforcing</i>	3.97	0.61	High
1. When lack of will or phobia arises, I try to avoid them by imagining positive things.	4.02	1.05	High
2. When I have little desire to study, I often consider pleasant study situations or content to get into it.	3.86	0.95	High

3. When I am very active or excited, I usually use relaxation techniques before I start studying.	3.98	1.01	High
4. When I have concerns or problems that prevent me from studying, I often relate them with pleasant ideas to help me to study.	3.93	1.01	High
5. When I finish the solution of a mathematical problem, I read the problem again and check if I did the operations in the order they should be done.	4.06	1.04	High
<i>Gradual Approach</i>	3.69	0.77	High
1. When I lack the will to study or dislike it, I often take a look at the topic to let it float around my mind for a while to make it motivate me to study.	3.73	1.05	High
2. When I lack the will to study, I usually develop diagrams, ideas or graphs on the subject before looking at it. This keeps me entertained and simulates me to study.	3.48	1.10	High
3. When I lack the will to study or dislike it, I try to focus on the parts that are most enjoyable and simple so as to facilitate the task.	3.84	0.97	High

Note: M = mean, SD = Standard deviation, QD = Qualitative description: 1.00 – 1.79 = Very Low (VL), 1.80 – 2.59 = Low (L), 2.60 – 3.39 = Moderately High (M), 3.40 – 4.19 = High (H), 4.20 – 5.00 = Very High (VH)

With regards to the subdomain of students' motivational strategy, the result of implication among the participants revealed high level ( $M=3.90$ ,  $SD=0.64$ ) specially on question where they relate what they study on things they already know which garners the highest mean and the most compressed standard deviation.

In addition, positive association ( $M=3.92$ ,  $SD=0.73$ ) and applicability ( $M=3.86$ ,  $SD=0.81$ ) is also high. It is interesting to note that the highest level of qualitative description on positive association is on the question where they are asked as to if they encourage themselves to be positive when achieving a goal in Distance Learning. Question regarding focuses on studying also garners the highest mean among the questions regarding applicability.

Next subdomain which is self-reinforcement ( $M=3.97$ ,  $SD=0.61$ ) also shows high result specially on the question as to if students review their mathematical output by double checking their work. The question also that talks about overcoming anxiety or phobia garners high. Lastly, Gradual Approach ( $M=3.69$ ,  $SD=0.77$ ) also shows high result specially on the question where they are asked about the things they would do if they dislike what they are studying.

Table 2 talks about the summary of the response of the selected students in the quality learning circle 4 of the Division of Zamboanga del Sur.

The acquisition of qualitative description "High" of the students in distance education implies that students in distance learning are highly trying to use motivational strategies to cope with the challenges they encountered in the modality. This can be substantiated by the statement of Wang et al (2008) as cited by the study of Logan et al (2017) that some researchers found encouraging or positive feedback on the part of students' motivation when it comes to distance education. This is ascribed to the fact that students must motivate themselves in order to cope with the challenges they're in.

The question that garners the highest mean in the subdomain of implication indicates that students consider the content of what they are about to study to be motivated to engage in. Meanwhile, the highest mean of the positive association and applicability also indicates that part of students' motivational strategy is to encourage themselves to be positive first and

positively immerse themselves on their study. In addition, the question also that talks about overcoming anxiety or phobia garners high mean which means that when a student encountered snags in their learning process during Distance Learning, they tend to reinforce it by either imagining good things or relaxation techniques to motivate themselves.

Practically, motivations are needed by the students in distance education since it is a foundation in order for them to give an interest to the current modality they are facing. As motivation is an integral part of the lesson of the teacher inside a classroom, students are in no doubt have high level of motivational strategies in order for them to continue their endeavor.

### **Level of Problem Solving Appraisals in Distance Education**

Table 3 shows the descriptive levels of students' problem-solving appraisals in the Quality Learning Circle 4 of the Division of Zamboanga del Sur. With 272 recorded number of participants, the over-all qualitative description is shown as moderately high level among the students of Distance Learning with a mean of 3.27 and a standard deviation of 0.26 which is highly compressed. This Learning Skill focuses on students' problem-solving skill and any other endeavor that is related to solving a problem.

Regarding the subdomains of problem solving appraisal, problem solving confidence ( $M=3.56$ ,  $SD=0.45$ ) of the students in Distance Learning achieves high level qualitative description. The question that obtain the highest mean talks about locating or seeking the problem itself. It is also good to notice that there are questions that obtained low level qualitative description. These questions involved negative statements that talks about the uncovering of a complex problem which seems unsolvable. Another question that garners low qualitative description is the question that talks about the unsureness of the students in handling a problem which is also a negative commentary.

*Table 3: Descriptive levels of students' problem solving appraisal (n=272)*

	<b>M</b>	<b>SD</b>	<b>QD</b>
Problem Solving Appraisal	3.27	0.26	Moderately High
<i>Problem Solving Confidence</i>	<i>3.56</i>	<i>0.45</i>	<i>High</i>
1. I am usually able to think up creative and effective alternatives to solve a problem.	3.76	0.95	High
2. I have the ability to solve most problems even though initially no solution is immediately apparent.	3.48	0.98	High
3. I make decisions and I am happy with them later.	3.90	0.98	High
4. After making a decision, the outcome I expected usually matches the actual outcome.	3.52	1.02	High
5. I trust my ability to solve new and difficult problems.	3.75	1.05	High
6. When making a decision, I weight the consequence of each alternative and compare them against each other.	3.78	1.06	High
7. I try to predict the overall result of carrying out a particular course of action.	3.67	0.95	High
8. Many problems I face are too complex for me to solve. <sup>a</sup>	2.38	0.98	Low
9. When I become aware of my problem, one of the first things I do is to try to find out exactly what the problem is.	3.98	0.99	High
10. When I make plans to solve a problem. I am almost certain that I can make them work.	3.75	1.03	High
11. Given enough time and effort, I believe I can solve most	3.94	1.03	High



problems that confront me.

12. When I face with a new situation, I have confidence that I can handle problems that may arise.	3.75	1.01	High
13. When confronted with a problem, I am unsure of whether I can handle the situation. <sup>a</sup>	2.44	1.07	Low
14. When confronted with a problem. I consistently examine my feelings to find out what is going on in a problem situation.	3.78	0.95	High
<i>Approach-Avoidance Style</i>	<i>3.01</i>	<i>0.42</i>	<i>Moderately High</i>
1. After I have tried to solve a problem with a certain course of action, I take time and compare the actual outcome to what I thought should have happened.	3.79	1.00	High
2. When I am confronted with a complex problem, I do not bother to develop a strategy to collect information so I can define exactly what the problem is.	3.63	0.95	High
3. When I am confused by a problem, one of the first things I do is survey the situation and consider all the relevant pieces of information.	3.80	1.03	High
4. When I have a problem, I think up as many possible ways to handle it as I can until I can't come up with any more ideas. <sup>a</sup>	2.25	1.06	Low
5. When deciding on an idea or possible solution to a problem. I do not take time to consider the chances of each alternative being successful. <sup>a</sup>	2.65	1.09	Moderately High
6. When confronted with a problem. I do not usually examine what sort of external things my environment may be contributing to my problem. <sup>a</sup>	2.52	1.07	Low
7. Even though I work on a problem, sometimes I feel like I am grouping or wandering and am not getting down on real issues. <sup>a</sup>	2.45	1.08	Low
<i>Personal Control</i>	<i>2.85</i>	<i>0.44</i>	<i>Moderately High</i>
1. I have systematic method for comparing alternatives and making decisions.	3.83	0.95	High
2. When my first efforts to solve a problem fail, I become uneasy about my ability to handle the situation. <sup>a</sup>	2.22	1.02	Low
3. Sometimes I do not stop and take time to deal with my problems, but just kind of muddle ahead. <sup>a</sup>	2.35	1.05	Low
4. I make snap judgements and later regret them. <sup>a</sup>	2.52	1.15	Low
5. When confronted with a problem, I stop and think about it before deciding on a next step.	3.88	1.01	High
6. Sometimes I get so charged up emotionally that I am unable to consider many ways of dealing with my problems. <sup>a</sup>	2.28	1.10	Low

Note: M = mean, SD = Standard deviation, QD = Qualitative description: 1.00 – 1.79 = Very Low (VL), 1.80 – 2.59 = Low (L), 2.60 – 3.39 = Moderately High (M), 3.40 – 4.19 = High (H), 4.20 – 5.00 = Very High (VH)

<sup>a</sup> means the item is reversed

On the other hand, regarding approach-avoidance style (M=3.01, SD=0.42), the result shows moderately high. This subdomain refers as to how the student approach their endeavor in the learning modality and as to how they avoid problems that may arise. The question that talks about how the student approach a certain problem garners the highest mean. However, it is also good to note that there are plenty of questions that results to low level of qualitative description. This is because such questions are negative in nature.

In addition, on the account of students' personal control as part of their problem solving appraisal, the mean is significantly low which is 2.85 but can still be interpreted as moderately high. Just like the previous subdomain, the questions of this subdomain have also plenty of negated questions. On the other hand, the question that obtain the highest mean in this subdomain talks about controlling oneself in facing another problem when a certain problem is still on the run. Table 3 talks about the summary of the response of the selected students in the quality learning circle 4 of the Division of Zamboanga del Sur.

The results imply that students in Distance Learning have high level compliance in solving a problem that may arouse in their learning process. It is because, problem solving in the real sense is defined as a coping strategy where a person tries to attempt in identifying an effective response to a certain level of problem (D'Zurilla & Nezu, 1999).

On the other hand, the presence of plenty of negative questions while obtaining low mean is an indication that the students are doing the otherwise. It is good to note also that the acquisition of low marks on negative questions implies that the participants are answering the instruments with honesty. Taking as example the subdomain of personal control which has a significantly low mean but can still be interpreted as moderately high, 67% or more than half of the questions are negative. Thus, the low mean result is a positive response.

Lastly, it is practical also to note that loads of problems arise in the process of the conduct of distance education since independent learning is very new to the students. Thus, for them to continue and hold onto their schooling, students' problem solving appraisal level is increasing.

### **Level of Self-regulated learning skill in Distance Education**

Table 4 shows the descriptive levels of students' self-regulated learning skill in the Quality Learning Circle 4 of the Division of Zamboanga del Sur. With 272 recorded number of participants, the over-all qualitative description is interpreted as high level among the students of Distance Learning with a mean of 3.86 and a standard deviation of 0.59.

Environmental structuring (M=4.04, SD=0.81) as the subdomain of SRLS is also high where the question that talks about comfort of study garners the highest mean. Time management (M=3.84, SD=0.71) also obtained a high response in the conducted survey where time organization obtained the highest mean. Help seeking (M=3.76, SD=0.79) on the other hand is also high where reaching out to the most knowledgeable garners the highest mean.

Meanwhile, self-evaluation (M=3.78, SD=0.66) also obtained a high response where evaluating themselves as to the level of their learning garners the highest mean. And lastly, Goal Setting (M=3.86, SD=0.67) again obtained a high response where students achieve their set goals obtained the highest mean. In addition, self-evaluation has the lowest standard deviation while environmental structuring has the highest in this learning skill.

Table 4 talks about the summary of the response of the selected students in the quality learning circle 4 of the Division of Zamboanga del Sur.

*Table 4: Descriptive levels of students' self-regulated learning skills (n=272)*

Self-regulated learning Skill	M	SD	QD
	3.86	0.59	High
<i>Environment Structuring</i>	<i>4.04</i>	<i>0.81</i>	<i>High</i>
1. I choose the location where I study to avoid too much distraction.	4.11	1.09	High

2. I find a comfortable place to study.	4.18	1.09	High
3. I know where I can study most efficiently for modular classes.	3.98	1.09	High
4. I choose a time with few distractions for studying for my modular class.	3.92	1.06	High
<i>Time Management</i>	<i>3.84</i>	<i>0.71</i>	<i>High</i>
1. I allocate extra studying time for my modular classes because I know if it is time demanding.	3.91	0.99	High
2. I try to schedule the same time every day or every week to study for my modular classes, and I observe the schedule.	3.87	0.99	High
3. Although we don't have to attend daily classes, I still try to distribute my studying evenly across days.	3.65	1.07	High
4. I organize my time to complete the requirements in a timely manner.	3.94	1.08	High
<i>Help-seeking</i>	<i>3.76</i>	<i>0.79</i>	<i>High</i>
1. I find someone who is knowledgeable in the topic content so that I can consult with him/her when I need help.	3.92	1.12	High
2. I share my problems with my classmates so that we know what we are struggling with and how to solve our problems.	3.78	1.07	High
3. I am persistent in getting help from my teacher through text/chat.	3.58	1.12	High
<i>Self-evaluation</i>	<i>3.78</i>	<i>0.66</i>	<i>High</i>
1. I summarize my learning in modular classes to examine my understanding of what I have learned.	3.91	1.02	High
2. I ask myself a lot of questions about the course material when studying for a modular class.	3.80	0.98	High
3. I communicate with my classmates to find out how I am doing in my modular classes.	3.76	1.02	High
4. I communicate with my classmates to find out what I am learning that is different from what they are learning	3.67	1.02	High
<i>Goal Setting</i>	<i>3.86</i>	<i>0.67</i>	<i>High</i>
1. I set standards for my assignments in modular classes.	3.94	0.92	High
2. I set short-term (daily or weekly) goals as well as long-term goals (monthly)	3.74	0.96	High
3. I keep a high standard for my learning in my modular classes.	3.66	0.99	High
4. I set goals to help me manage study time for my modular classes.	3.95	0.98	High
5. I achieve goals I set for myself.	4.02	1.05	High

Note: M = mean, SD = Standard deviation, QD = Qualitative description: 1.00 – 1.79 = Very Low (VL), 1.80 – 2.59 = Low (L), 2.60 – 3.39 = Moderately High (M), 3.40 – 4.19 = High (H), 4.20 – 5.00 = Very High (VH)

The level of self-regulated learning skill of the students in Distance Learning is high. The results imply that self-regulated learning skill of the students is working and greatly impact how the student is doing in the conduct of modular distance learning. Students tend to consider their environment, their time allotment for the modules, how to reach out people who can help them, assessing their level of thinking and also and interestingly, students are also achieving the goals they set for themselves in the conduct of Distance Learning.

Meanwhile, the result of their responses in environmental structuring implies that students really do consider the place they are in where distraction is low as they engage the modality of their education in distance. Thus, it is a big factor. However, this subdomain also obtained the highest standard deviation which mean that the participants opinion regarding this is a bit different from one another. A bit in the sense that it is not that significantly high. In addition, self-evaluation as a subdomain of self-regulated learning skill obtained the lowest standard

deviation which means that participants' response to this domain is homogenous than the rest or that they agree with one another.

Practically, the acquisition of a qualitative description "High" in self-regulated learning skill of the students in distance education is totally not surprising since students tend to regulate their own thinking or mind-setting for them to cope with the challenges they are having.

### **Level of Mathematics Performance in Distance Education**

Table 5 shows the descriptive levels of the participants' Mathematics performance in distance learning randomly selected from Grade 9 to Grade 11 in the Quality Learning Circle 4 of the Division of Zamboanga del Sur, Philippines. The percentage range and the qualitative descriptors are taken from the DepEd Memo. No. 8 series of 2015.

**Table 5: Descriptive levels of students' mathematics performance (n=272)**

Percentage Range	<i>f</i>	%	Qualitative Descriptors
90% – 100%	18	6.62	Outstanding
85% – 89%	121	44.49	Very Satisfactory
80% – 84%	119	43.75	Satisfactory
75% – 79%	14	5.15	Fairly Satisfactory
Below 75%	0	0.00	Did Not Meet Expectations
M	84.76		Satisfactory
SD	3.11		

*Note:* M = mean, SD = standard deviation, *f* = frequency, % = percentage, Scale is based from DepEd Memo. No. 08 series 2015

The table shows that most of the participants' mathematical performance in the Distance Learning are concentrated between 80% - 89% which constitutes to 88.24% of the total number of participants.

In general, the average level of mathematical performance of the students in the conduct of Distance Learning is satisfactory with a percentage mean of 84.76%, and standard deviation of 3.11. The previous table shows the descriptive summary of the participants' mathematical performance in the conduct of Distance Learning. Upon checking the normality of data using Pearson's index of skewness, the result shows  $PC = -0.23$ . Since the index of skewness is not equal or greater than +1 and equal or less than -1, then the data is said to be approximately normally distributed. This implies that the data is suitable for a statistical tool that requires the data to be normally distributed.

### **Evaluation of Measurement Model**

The evaluation of the measurement model is necessary to ensure the criteria's quality of the constructs, the item or the questions, and the variables before going to structural model assessment. Its purpose is to provide an overview on how the instruments used are being evaluated during analysis.

For the items' multicollinearity to not exist, Kock and Lyn (2012) set the threshold for Variance Inflation Factor (VIF) to be equal to or lower than 3.3. Meanwhile, convergent validity measures the constructs if they correspond with the other constructs who have the same goal to measure. It is important in using PLS-SEM as part of examining the reflective measurement models using the average variance extracted (AVE). Accordingly, the set threshold for the value of AVE to be convergently valid is 0.5 using Fornell- Larcker criterion. Thus, for a construct to be convergently valid, it must have an AVE of greater than 0.5.

In addition, to test the strength of the reliability of the constructs, the Cronbach's Alpha (CA) and Composite Reliability (CR) are also presented.

Table 6: *Indicator loadings, AVE, reliability measures the variables*

Construct/Item	Item Loading	VIF	AVE	CR	CA
Motivational Strategies			0.393	0.852	0.805
SE3	0.694	1.565			
SE4	0.562	1.351			
IMP1	0.621	1.342			
IMP3	0.598	1.376			
PA2	0.733	1.678			
PA4	0.634	1.429			
APP1	0.529	1.315			
APP2	0.626	1.438			
GA1	0.622	1.34			
Metacognitive Strategies			0.442	0.825	0.745
PL1	0.781	1.645			
PL2	0.681	1.397			
PL3	0.659	1.332			
PL4	0.611	1.291			
RV1	0.591	1.238			
RV2	0.649	1.352			
Problem-Solving Appraisal			0.336	0.655	0.541
PC1	0.607	1.547			
PC3	0.547	1.485			
PC5	0.621	1.622			
PC7	0.513	1.366			
PC9	0.573	1.418			
PC10	0.586	1.442			
PC11	0.593	1.459			
PC12	0.681	1.76			
PC13	-0.514	1.274			
PC14	0.623	1.568			



AA3	0.575	1.419			
AA4	-0.585	1.437			
AA5	-0.518	1.358			
PCn3	-0.543	1.413			
PCn5	0.585	1.461			
Self-Regulated Learning Skills			0.363	0.894	0.873
ES1	0.661	1.89			
ES2	0.712	1.914			
ES3	0.673	1.781			
TM1	0.569	1.457			
TM2	0.59	1.463			
TM4	0.63	1.552			
HS1	0.552	1.393			
HS2	0.513	1.31			
HS3	0.546	1.418			
SEv1	0.601	1.499			
GS1	0.644	1.578			
GS2	0.517	1.405			
GS3	0.517	1.314			
GS4	0.635	1.625			
GS5	0.632	1.619			
Mathematics Performance			0.789	0.882	0.733
MP1	0.888	1.503			
MP2	0.888	1.503			

*Notes: All item indicators are significant at 0.001 ( $p < 0.001$ ). AVE = average variance extracted; VIF = variance inflation factor; CR = composite reliability; CA = Cronbach's alpha*

Accordingly, for the construct and an item to be reliable, the CA value should greater than or equal to 0.7 and the CR value should be greater than or equal to 0.6 (Fornell and Larcker, 1981). But since Cronbach's Alpha is sensitive to the number of items in a construct that generally tends to underestimate the internal consistency reliability, a more appropriate measure is the composite reliability.

Table 7: Square root of AVE and correlation coefficients of motivational strategies

	MathPerf	MoS	MeS	PSA	SRL	<i>Notes:</i> Diagonal elements are the square root of AVE of construct s, while the off-
MathPerf	<b>0.888</b>					
MoS	0.303	<b>0.627</b>				
MeS	0.329	0.6	<b>0.665</b>			
PSA	0.323	0.634	0.646	<b>0.579</b>		
SRL	0.291	0.705	0.689	0.731	<b>0.602</b>	

diagonal elements are the correlation between constructs

Another important part of a PLS-SEM is the assessment of discriminant validity of the items in the construct. Discriminant validity tells the uniqueness of the items to the extent that the item in the construct is distinct from the other construct or that it does not confuse the participants considering the items of the other constructs. In this paper, it was assessed using the square root of AVE which is shown in the diagonal path of Table 7.

### **Validity and Reliability of Metacognitive Strategies, Motivational Strategies, Problem-Solving appraisals, and Self-regulated learning skills in Distance Education**

All the values of the item loading under motivational strategies are on acceptable range which means that there is a correlation between the construct and the item. In addition, Cronbach's Alpha value of 0.805 and Composite Reliability value of 0.852 are also both on acceptable range which means that the constructs are reliable and are consistent in terms of what it tries to measure. However, there is a minimal problem regarding the convergent validity of the construct since the value is not enough on the acceptable range which is also true for discriminant validity since there are other latent constructs who are greater than the construct being measured (See table 6 and 7).

In addition, all the values of the item loading under motivational strategies are on acceptable range which means that there is a correlation between the construct and the item. In addition, Cronbach's Alpha value of 0.805 and Composite Reliability value of 0.852 are also both on acceptable range which means that the constructs are reliable and are consistent in terms of what it tries to measure. However, there is a minimal problem regarding the convergent validity of the construct since the value is not enough on the acceptable range which is also true for discriminant validity since there are other latent constructs who are greater than the construct being measured (See table 6 and 7).

Subsequently, all the values of the item loading under Problem-Solving Appraisal are on acceptable range which means that there is a correlation between the construct and the item. In addition, Cronbach's Alpha value of 0.541 is not enough to be accepted as reliable, however, a Composite Reliability value of 0.655 is on acceptable range based on Fornell-David threshold. However, there is a minimal problem regarding the convergent validity of the construct since the value is not enough on the acceptable range which is also true for discriminant validity since there are other latent constructs who are greater than the construct being measured.

Lastly, all the values of the item loading under self-regulated learning skills are on acceptable range which means that there is a correlation between the construct and the item. In addition, Cronbach's Alpha value of 0.873 and Composite Reliability value of 0.894 are also both on acceptable range which means that the constructs are reliable and are consistent in terms of what it tries to measure. However, there is a minimal problem regarding the convergent validity of the construct since the value is not enough on the acceptable range which is also true for discriminant validity since there are other latent constructs who are greater than the construct being measured.

### **Evaluations of Structural Model**

After the evaluation of the measurement model that checks the quality of the criteria – of the constructs, items, and other variables – an evaluation of structural model is taking place. It is

to assess collinearity issues, assess the significance and relevance of the structural model relationships, and model comparison (Hair, Hult, Ringle, & Sarstedt, 2017).

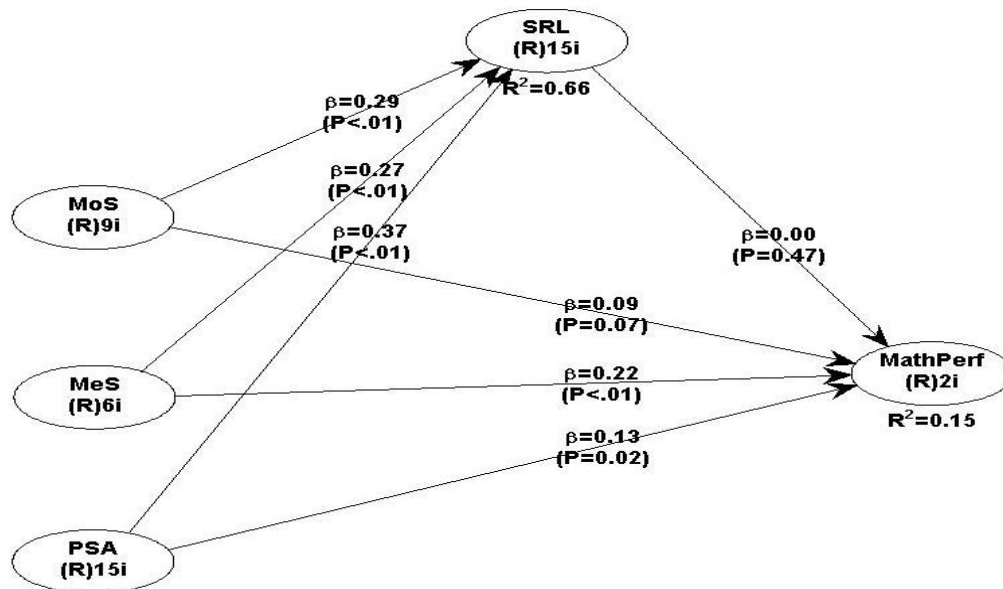


Figure 3: The PLS path model with path coefficients

Figure 3 shows the path model or the interrelationships of latent variables towards another latent variable and latent variables towards the observed variable.

In the figure, it shows the direct influence of motivational strategies, metacognitive strategies, and problem solving appraisals towards self-regulated learning skill as indicated by a single-headed arrow. In the path model, it obtained an R-squared value of 0.66 which means that 66% of the variability observed in the targeted variables is explained by the model.

On the other hand, the figure also shows the direct influence of self-regulated learning skills, motivational strategies, metacognitive strategies, and problem-solving appraisals towards mathematics performance and the indirect effects of motivational strategies, metacognitive strategies, and problem solving appraisals towards mathematics performance taking self-regulated learning skill as the mediator. It obtained an R-square value of 0.15 which means that 15% only of the variability observed in the targeted variables is explained by the model.

Table 8 shows the direct and indirect effect of PLS Path Model together with its conforming path coefficients.

Table 8: Direct and Indirect effect of PLS Path Model

				$\beta$	SE	P-value	$f^2$
Direct Effects							
H1	MoS	→	SRL	0.288	0.058	<0.001	0.205
H2	MeS	→	SRL	0.267	0.058	<0.001	0.187

<i>H3</i>	PSA	→	SRL		0.366	0.057	<0.001	0.272
<i>H4</i>	MoS	→	MathPerf		0.088	0.060	0.070	0.029
<i>H5</i>	MeS	→	MathPerf		0.215	0.059	<0.001	0.077
<i>H6</i>	PSA	→	MathPerf		0.129	0.059	0.015	0.042
<i>H7</i>	SRL	→	MathPerf		0.005	0.061	0.468	0.002
Indirect effects								
<i>H8</i>	MoS	→	SRL	→MathPerf	0.001	0.043	0.487	0.000
<i>H9</i>	MeS	→	SRL	→MathPerf	0.001	0.043	0.488	0.000
<i>H10</i>	PSA	→	SRL	→MathPerf	0.002	0.043	0.483	0.001

### **Direct effect of Motivational Strategies to Self-regulated Learning Skill in Distance Education**

The study reveals that Motivational Strategy ( $\beta = 0.288, p < 0.001$ ) positively affects self-regulated learning skill with standard error of 0.058 and Cohen's effect size of 0.205. This implies that motivational strategies of the students under modular distance learning is one of the factors that contributes to the self-regulated learning skills of the students. This supports the idea that motivational strategies are self-regulating activities that are purposely utilize by the learner in managing their level of motivation. It influences what, how, and when students learn in distance education (Barak, Watted, & Haick, 2016; Deimann & Bastiaens, 2010). It also supports the statement of Pintrich (2000<sup>b</sup>) that SRL also takes perspective much on inclusive perspective more to include not only on cognitive but also on motivation. On the other hand, the statistical result reveals that motivational strategies and self-regulated learning skill have correlations in modular distance learning set-up thus supporting the earlier claims that motivational strategy is deemed important in self-regulated learning (Boekaerts and Niemivirta, 2000; Corno, 1993; Garcia et al., 1998; Wolters, 1998). And lastly, in a study conducted by Schmidt et al (2007), one positive effect of student achievement is its high level of motivation and self-regulatory ability as presented in the literature review. (See table 8).

Practically, self-regulated learning skill needs motivation to last. As motivational strategies positively affect self-regulated learning skill, it implies that low motivational strategies can give low self-regulation among the students in distance learning and vice versa. Thus, self-regulated learning skill in distance education is affected by students' implication, positive association, applicability, self-reinforcement and gradual approach.

### **Direct effect of Metacognitive Strategies to Self-regulated Learning Skill in Distance Education**

The result also reveals that metacognitive strategies ( $\beta = 0.267, p < 0.001$ ) positively affects self-regulated learning skill having a standard error of 0.058 and Cohen's medium effect size value of 0.187. It presents that student's self-regulated learning skill in distance education is also affected by their metacognitive strategies. This supports the claim that SRL

and metacognition have been significantly impacting student's academic routine and/or performance on to of student's attainment (Hacker, Dunlosky, & Graesser, 2009; Ponitz et al, 2008; Pressley & Harris, 2006) even in the conduct of Distance Learning. Thus, supporting the claim of Efklides (2011) that self-regulated learning skill and metacognition are relatively stable characteristic of an individual learner. However, this result also is a little contradiction to the previous statement of Veenman et al (2004) that SRL and metacognition are likely to develop through interaction since interaction is less in the midst of student's Distance Learning. In addition, an investigation between metacognition and self-regulation also concluded that both are supplementary to each other (Demir et al, 2019) which could support the statistical result of this study. (See table 8)

Practically, it is no doubt that metacognitive strategies positively affect self-regulated learning skill in distance education especially that the subdomain of metacognition in this study involves planning and revision. In order for self-regulation to succeed, planning is a crucial part since it is here where organization of ideas takes place. In addition, revision also can be considered as a foundation of SRL since it can be used as an assessment to the strategy to fit in to the desired output of the students in the conduct of distance education.

#### **Direct effect of Problem-Solving Appraisals to Self-regulated Learning Skill in Distance Education**

Problem-solving appraisals ( $\beta = 0.366, p < 0.001$ ) also positively affects self-regulated learning skills of students in modular distance learning with a standard error of 0.057 and a Cohen's medium effect size of 0.272. It reveals that student's self-regulated learning skill in modular distance education are affected by their problem solving confidence, approach-avoidance style, and personal control. Aydin (2019) stated that self-regulation skills of the individual arise during the process of mathematical problem-solving. This could also be true during the conduct of Distance Learning since there is a positive association between problem-solving and self-regulated learning skill of the students in distance education. This result also supports the study of Kılıç and Tanrıseven (2007), that there is a positive correlation between the level of self-regulation strategy. It was observed that there was a linear correlation between the two. This is also true with the results of the study of Çelik (2012) and Şimşek (2012) that there is a significant relationship between mathematical problem-solving success and metacognitive self-regulation. (See table 8)

Practically, the positive effect of problem solving appraisal to self-regulated learning skill implies that independent learning of the students is also highly affected by how they engage/solve, control, and avoid their problem.

#### **Direct effect of Motivational Strategies to Mathematics Performance in Distance Education**

The result of the study also reveals that motivational strategies ( $\beta = 0.088, p < 0.070$ ) does not positively affect mathematics performance under 95% confidence interval. This goes to show that motivational strategies do not in any way affect the mathematics performance of the students in modular distance learning. Practically, this could imply that mathematics needs to be self-reinforce as a subdomain of this motivational strategy wherein it is hard for students in modular distance learning thus attaining low motivation. It could also imply that it is hard for the students to associate positivity in answering their modules in distance education especially in mathematics. (See table 8).



In addition, this result also indicated that by far motivations cannot move students to learn mathematics in distance education as it is a pure science where answers are based on accuracy.

### **Direct effect of Metacognitive Strategies to Mathematics Performance in Distance Education**

Metacognitive strategies ( $\beta = 0.215, p < 0.001$ ) positively affect the Mathematics performance with a standard error of 0.059 and a Cohen's medium effect size of 0.077. This supports the statements of Wilson and Clarke (2004) that metacognition has a huge role in both learning mathematics and mathematical problem-solving. This means that metacognitive strategies are essential to student's mathematical performance under modular distance learning. (See table 8)

In addition, it is also practical to imply that metacognition is thinking beyond thinking which is a foundation in learning mathematics since it works based on logics and critical thinking.

### **Direct effect of Problem-Solving Appraisals to Mathematics Performance in Distance Education**

Just like metacognitive strategies, problem-solving appraisal ( $\beta = 0.129, p < 0.015$ ) also positively affect mathematics performance in distance education. This supports the statement of Saeid (2009) that success of the learners in distance education also needs problem-solving skills in order to have suitable performance that can face several problems. This study also reveals that mathematics performance of the students are also enhance or are affected by their problem-solving appraisals. (See table 8).

Practically, this result is no surprise at all since mathematics also works on problems that requires flexibility in thinking to solve another problem.

### **Direct effect of Self-regulated Learning Skill to Mathematics Performance in Distance Education**

For the direct effect of the path model shows that self-regulated learning skill ( $\beta = 0.005, p < 0.001$ ) does not positively affect mathematics performance of the students in modular distance learning. It is intriguing and interesting since self-regulated learning skill could be a best asset in mathematics performance. However, this could also imply the reality in our educational system wherein self-regulated learning skill of the students are not widely focus on our country's curriculum. This supports the study of Aydin (2019) that that there is a need to develop or a need for improvement to the self-regulated learning skill of the students which is also parallel to the study of Totan and Kabasakal (2012). Considering that self-regulated learning skill is an important skill in distance education, it does not correlate with mathematics performance in this study. (See table 8)

### **Mediation of Self-regulated Learning Skill in the relationship between Motivational Strategies and Mathematics Performance**

Table 8 shows that self-regulated learning skills does not mediate the relationship between Motivational strategies and Mathematics performance ( $\beta = 0.001, p < 0.487$ ) in distance education. It is interesting since self-regulated learning skill is significant in conveying or transporting skills, knowledge, and abilities from one domain to another and it helps in

attaining lifelong learning (Bautista, 2015) while motivational strategies sustain and activates the interest of the learners in distance education when it comes to learning on their own (Firat & Kilinc & Yuzer, 2018). Hence, even though both play a huge role in the independent learning modality, it does not guarantee the mediation of SRL to Motivational strategies towards Mathematics performance.

However, previous result indicates that self-regulated learning skill does not positively affect mathematics performance. And this relationship creates a domino effect on the role of SRL as mediation to motivational strategies towards mathematics performance.

### **Mediation of Self-regulated Learning Skill in the relationship between Metacognitive Strategies and Mathematics Performance**

Table 8 shows that self-regulated learning skill does not mediate the relationship between Metacognitive Strategies and Mathematics Performance ( $\beta = 0.001, p < 0.488$ ) in distance education. It is apparent since previous articles of Pressley & Ghatala (1990) showed that learners with high metacognitive awareness are not directly correlated with higher scores academically and that self-regulated learning skills does not positively affect mathematics performance in distance education. Thus, the result isn't that surprising taking considerations the literature reviews of this paper.

### **Mediation of Self-regulated Learning Skill in the relationship between Problem Solving Appraisals and Mathematics Performance**

Table 8 shows that self-regulated learning skill does not mediate the relationship between problem solving appraisals and mathematics performance ( $\beta = 0.001, p < 0.488$ ) in distance education. Even though that the success of the learners in distance education does not only need an academic skill but rather a problem-solving skill in order to have a suitable performance that will face several problems (Saeid, 2019) and that problem-solving skill positively affect self-regulated learning skill ( $\beta = 0.366, p < 0.001$ ) in distance education, it does not guarantee that SRL can mediate the relationship of PSA and Mathematics performance.

However, previous result indicates that self-regulated learning skill does not positively affect mathematics performance. And this relationship creates a domino effect on the role of SRL as mediation to problem solving appraisals towards mathematics performance.

### **Limitations of the Findings**

The results of this study have a concern regarding the convergent validity and discriminant validity of the constructs. It is because the average variance extracted which measures the convergent validity of the construct does not met the set threshold based from the Fornell-Larcker Criterion. In addition, discriminant validity also is not met since some of the off-diagonal values are greater than those that of the diagonal values (see table 7).

Fortunately, some other measures are met in this study such as the item loadings, the variance inflation factor for multicollinearity, Cronbach's alpha, and composite reliability.

### **CONCLUSIONS**

As the goal of study is to determine the level of the variables presented towards distance education, the result found out that the level of metacognitive strategies, motivational

strategies, and self-regulated learning skills are high in distance education while problem-solving appraisal is moderately high. On the other hand, it also ought to find if there are positive effects of the latent variables towards self-regulated learning skill and mathematics performance. And this study found out that motivational strategies, metacognitive strategies, and problem-solving appraisals positively affect self-regulated learning skills in distance education. Meanwhile, both metacognitive strategies and problem-solving appraisals positively affect mathematics performance in distance education while motivational strategies and self-regulated learning skills do not. In addition, this study also reveals that self-regulated learning skill does not mediate motivational strategies, metacognitive strategies, and problem-solving appraisals towards mathematics performance.

These results conclude that learning strategies used by the students in distance education are mostly high especially the variables used in this study. It maybe because students need it more in distance education since skills or strategies are not just necessary but also important. On the other hand, the positive effect of motivational strategies, metacognitive strategies, and problem solving appraisals towards self-regulated learning skills concludes that SRL can be affected by many factors which could not just be the variables used inside this research. Meanwhile, the no positive effect of self-regulated learning skill and motivational strategies towards mathematics performance concludes that not every learning strategy can move to increase or decrease the mathematics performance of the students in distance education but only by the few strategies that can compensate its package.

In addition to the result that SRL does not positively affect mathematics performance, it could be due to factors that involves a learning isolation or distance education that greatly affect the students' self-regulation which is done in a normal scenario. This result could also imply that there is a less awareness regarding SRL skill on the part of the teacher since it is not given a big highlight in the country's curriculum. Meanwhile, the result also concludes that SRL as a mediator do not statistically strengthen the relationship between metacognitive strategies, motivational strategies and problem-solving appraisals towards mathematics performance.

In general, if motivational strategies, metacognitive strategies, and problem-solving appraisals are applied by the students in distance education, it could positively affect their self-regulated learning skill to progress. On the other hand, if students will use metacognitive strategies and problem-solving appraisals in distance education, it could also positively affect their mathematics performance.

However, convergent validity and discriminant validity are a concern of this study thus minor adjustments could be done - by removing some items - could improve the result while making sure that reliability is not hindered. In addition, future researchers who opt to exhibit the same kind of study may have it under different latent and observed variables.

## **RECOMMENDATIONS**

The following recommendations are hereby offered based on the findings and conclusions of the researcher.

1. The result of the study shows that metacognitive strategy and problem-solving appraisal are essential in modular distance learning since it positively affect the mathematics performance of the students. Thus, teachers may opt to use the result for the betterment of their students in modular distance learning.
2. Self-regulated learning skill are not that effective when it comes to students' mathematical performance in modular distance education, thus, it is recommended to introduce and practice them first since it can enable the students to adapt quickly on its environment and enable them to improve their performance (Brockett & Hiemstra, 2018).
3. Since PLS-SEM is primary an exploratory approach which is used to develop theories in exploratory research, it is recommended to test the results of this study using CB-SEM to confirm or reject the structured theories.
4. Convergent validity and discriminant validity are not met in this study since it was not on the acceptable range based on the AVE and the square root of AVE of this study. It is recommended to increase the sample size of the study or make minor adjustments to the questions to obtain such concerns validity while making sure that the constructs reliability is not affected.
5. When it comes to gathering of data, maximize also the participants to include all the levels to give a more vivid visual on the result of the study on a larger scale. Always follow the health protocols and always get updates on the whereabouts of the research locale.
6. It is also recommended to introduce, practice, and exercise the self-regulated learning skill of the students in our curriculum so that teacher as a facilitator will be realize. Thus, when another lockdown may arise, students are already equipped with how independent learning will takes place.

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