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MEDIATING EFFECT OF ACADEMIC SELF-EFFICACY ON THE RELATIONSHIP BETWEEN SELF-DIRECTED LEARNINGAND PROBLEM-SOLVING SKILLS OF STUDENTS IN MATHEMATICS

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ABSTRACT

This study determined the mediating effect of academic self-efficacy on the relationship between self-directed learning and problem-solving skills of students in Mathematics. A descriptive-correlational research design was employed. There were 264 Grade 9 respondents in four (4) public secondary schools in the Division of Davao de Oro who were chosen in a stratified random sampling. This study used two standardized and one researcher-made questionnaire. Mean, Pearson r, and mediation analysis using sobel test were used as statistical tools. The extent of self-directed learning of students in terms of learning motivation, planning and implementing, self-monitoring, and interpersonal communication is very highly extensive. The level of problem-solving skills of students in terms of understand the problem, devise a plan, carry out the plan, and look back is high. The level of academic self-efficacy of students in terms of self-regulated learning, persistence, competence, and perceived control is very high. The results revealed that there is a significant relationship between self-directed learning and problem–solving skills of students, academic self-efficacy and problem–solving skills of students, and self-directed learning and academic self-efficacy. The academic self-efficacy significantly mediate the relationship between self-directed learning and problem – solving skills of students with partial mediation. Students need technical assistance from their teachers, parents, and other people around them. The results implied that students who are self-directed and academically self-efficient do well in their problem solving skills.

KEYWORDS: *Self-Directed Learning, Academic Self – Efficacy, Mathematical Problem – Solving Skills, Descriptive-Correlational Research Design, Mediation Analysis, Sobel Test, Davao De Oro, Philippines*

INTRODUCTION

Problem-solving skills are crucial for helping students confidently face mathematical and real-life challenges. Phonapichat et al. (2014) emphasized that effective learning should develop students' ability to identify and solve problems, yet Herawatty et al. (2018) found students consistently struggle in this area. The 2018 PISA results revealed low math performance in countries like the Dominican Republic, Panama, and Malaysia, which researchers such as Zahara et al. (2016), Liu (2016), and Heong (2017) attributed to poor conceptual understanding, limited reasoning, and weak problem-solving strategies.

Similar trends are observed in the Philippines. Dela Cruz and Lapinid (2019) reported that 40% of students had difficulty translating math problems due to comprehension issues. In PISA 2018, Filipino students scored an average of 353 in math—below the OECD average of 489—with only 19.7% reaching minimum proficiency. In Davao de Oro, nearly half of Grade 9 students scored 75–78% in math problem-solving tasks during the 2019–2020 school year. These findings led to remediation programs, pointing to gaps in self-directed learning and academic self-efficacy.

Although previous studies (Zhanga et al., 2018; Wang, 2010; Evensen et al., 2001; Saeid, 2017) explored the relationship between self-directed learning, academic self-efficacy, and problem-solving, few investigated the mediating role of academic self-efficacy. This study addresses that gap by focusing on Grade 9 students in Davao de Oro. As Marlborough (2020) noted, regular practice in problem-solving fosters resilience and awareness—skills vital for success in today's modular and online learning environments. The study aims to help educators enhance students' problem-solving abilities in response to the demands of modern education.

STATEMENT OF THE PROBLEM

The purpose of this study was to determine whether academic self-efficacy significantly mediates the relationship between self-directed learning and problem-solving skills of students in mathematics.

Specifically, this sought answers to the following questions:

1. What is the extent of self-directed learning of students in terms of:
   1.1. learning motivation;
   1.2. planning and implementing;
   1.3. self-monitoring; and
   1.4. interpersonal communication?

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2. What is the level of problem-solving skills of students in terms of:
   2.1. understand the problem;
   2.2. devise a plan;
   2.3. carry out the plan; and
   2.4. look back?
3. What is the level of academic self-efficacy of students in terms of:
   3.1. perceived control;
   3.2. competence;
   3.3. persistence; and
   3.4. self-regulated learning?
4. Is there a significant relationship between:
   4.1. self-directed learning and problem – solving skills of students?
   4.2. academic self-efficacy and problem – solving skills of students?
   4.3. self-directed learning and academic self-efficacy?
5. Does academic self-efficacy significantly mediate the relationship between self-directed learning and problem – solving skills of students?

METHODOLOGY

This chapter depicted the various methods of the study including research design, research respondents, research instruments, data collection procedures, and statistical tools.

Research Design

This quantitative study used a descriptive-correlational design with mediation analysis to examine academic self-efficacy's role between self-directed learning and problem-solving. Data were collected through validated questionnaires and analyzed using appropriate statistical tools.

Research Respondents

The respondents of this study were the Grade 9 junior high school students of four public schools in the Division of Davao de Oro enrolled during the S.Y. 2020-2021. On the other hand, the map of the Division of Davao de Oro was shown in Figure 1 highlighting the schools where the study was conducted.



Figure 1. Local Map of Davao de Oro highlighting the Division of Davao de Oro

Research Instrument

The study used two standardized tools and a validated, researcher-made questionnaire. The SDLI (Cheng et al., 2010) and ASES-FJHS (Dullas, 2018) measured self-directed learning and academic self-efficacy, while a pilot-tested questionnaire assessed problem-solving skills. Reliability was acceptable to good (SDLI $\alpha = 0.843$; ASES-FJHS $\alpha = 0.759$; problem-solving $r = 0.752$).

Statistical Treatment of Data

The study used statistical tools such as the mean to assess levels of self-directed learning, academic self-efficacy, and problem-solving skills. Pearson's r examined their relationships, while the Sobel Test determined if academic self-efficacy mediated the link between self-directed learning and problem-solving.

RESULTS AND DISCUSSION

In this chapter, the researcher discussed the findings and results from the data gathered. The researcher also tested the null hypotheses formulated in the study.

Extent of Self-Directed Learning of Students in terms of Learning Motivation

Table 1 shows that students rated themselves very highly in learning motivation, with the highest mean on "I know what I need to learn" (M = 4.65). The lowest, though still very high, was "I still like learning regardless of results" (M = 4.58). The overall mean was 4.61, indicating strong motivation.

Extent of Self-Directed Learning of Students in terms of Planning and Implementing

Table 2 reveals a very high extent of planning and implementing, with the highest rating for "I know how to find

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resources for my learning" (M = 4.67). The overall mean was 4.60, showing students consistently manage their learning strategies.

Extent of Self-Directed Learning of Students in terms of Self-Monitoring
Table 3 indicates very high self-monitoring skills, with the top item being "I can monitor my learning progress" (M = 4.69). The lowest, though still high, was "I understand the strengths and weaknesses of my learning" (M = 4.54). Overall mean: 4.61.

Extent of Self-Directed Learning of Students in terms of Interpersonal Communication
Table 4 shows very high interpersonal communication, with two top-rated items at M = 4.64. The lowest-rated was "I express messages effectively in oral presentations" (M = 4.54). Overall mean: 4.61.

Summary on the Extent of Self-Directed Learning of Students
Table 5 summarizes all areas of self-directed learning with consistently very high ratings. The overall mean of 4.61 indicates strong self-directed learning habits across all indicators.

Level of Mathematical Problem-Solving Skills of Students
Table 6 presents a high level of problem-solving skills, with "Understanding the problem" rated highest (M = 81.59) and "Looking back" the lowest (M = 78.11). The overall mean of 79.31 shows strong performance in math problem-solving.

Level of Academic Self-Efficacy of Students in terms of Perceived Control
Table 7 shows very high perceived control, with top-rated items at M = 4.70 and a category mean of 4.66. Students feel confident in managing academic outcomes.

Level of Academic Self-Efficacy of Students in terms of Competence
Table 8 indicates very high competence, with the highest rating at M = 4.76 and overall mean of 4.68. Students believe they perform better academically than peers.

Level of Academic Self-Efficacy of Students in terms of Persistence
Table 9 shows strong persistence, with "Even if there are many obstacles, I can learn it" rated highest (M = 4.78). Overall mean: 4.71, reflecting resilience in academic efforts.

Level of Academic Self-Efficacy of Students in terms of Self-Regulated Learning
Table 10 reveals strong self-regulated learning, with top-rated items at M = 4.78. Overall mean: 4.74, showing consistent motivation and planning among students.

Summary on the Level of Academic Self-Efficacy of Students
Table 11 shows all four areas of academic self-efficacy rated very high. The highest was competence (M = 4.78), and the overall mean was 4.72, showing strong belief in academic abilities.

Relationship Between Variables
Table 12 presents strong positive correlations among self-directed learning, academic self-efficacy, and problem-solving skills, with r-values above 0.87 ($p < 0.000$), confirming all are significantly related.

Steps in Mediation Analysis
Table 13 confirms that self-directed learning, academic self-efficacy, and problem-solving skills are significantly connected. Academic self-efficacy mediates the effect of self-directed learning on problem-solving ($\beta = 42.212$, $p < 0.000$).

Type of Mediation Used
Table 14 shows academic self-efficacy partially mediates the relationship between self-directed learning and math problem-solving ($z = 20.81$, $p < 0.000001$). The mediation ratio is 95.1%, with the indirect effect greater than the direct.

RECOMMENDATIONS
Based on the findings, teachers are encouraged to foster self-directed learning and problem-solving through engaging, tech-based activities. Schools and DepEd should enhance math programs and resources. Students should develop strong learning habits and self-efficacy, while future studies may explore other factors to boost math performance.

CONCLUSION
The study concludes that Grade 9 students showed very high self-directed learning and academic self-efficacy, and high problem-solving skills. Academic self-efficacy partially mediated the link between self-directed learning and problem-solving, indicating that confident, self-directed learners perform better in math problem-solving.

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FIGURES AND TABLES

Figure 1. *Local Map of Davao Del Norte*



Table 1. *Extent of Self-directed Learning of Students in terms of Learning Motivation*

Items	SD	Mean	Descriptive Equivalent
1. I know what I need to learn.	0.66	4.65	Very Highly Extensive
2. Regardless of the results or effectiveness of my learning, I still like learning.	0.80	4.58	Very Highly Extensive
3. I strongly hope to constantly improve and excel in my learning.	0.71	4.60	Very Highly Extensive
4. My successes and failures inspire me to continue learning.	0.72	4.60	Very Highly Extensive
5. I enjoy finding answers to questions.	0.60	4.64	Very Highly Extensive
6. I will not give up learning because I face some difficulties.	0.66	4.61	Very Highly Extensive
Category Mean	**0.69**	**4.61**	**Very Highly Extensive**

Table 2. *Extent of Self-directed Learning of Students in terms of Planning and Implementing*

Items	SD	Mean	Descriptive Equivalent
1. I can pro-actively establish my learning goals.	0.73	4.60	Very Highly Extensive
2. I know what learning strategies are appropriate for me in reaching my learning goals.	0.79	4.55	Very Highly Extensive
3. I set the priorities of my learning.	0.64	4.62	Very Highly Extensive
4. Whether in the classroom or on my own, I am able to follow my own plan of learning.	0.82	4.54	Very Highly Extensive
5. I am good at arranging and controlling my learning time.	0.73	4.62	Very Highly Extensive
6. I know how to find resources for my learning.	0.64	4.67	Very Highly Extensive
Category Mean	**0.72**	**4.60**	**Very Highly Extensive**

Table 3. *Extent of Self-directed Learning of Students in terms of Self-monitoring*

Items	SD	Mean	Descriptive Equivalent
1. I can connect new knowledge with my own personal experiences.	0.69	4.58	Very Highly Extensive
2. I understand the strengths and weakness of my learning.	0.85	4.54	Very Highly Extensive
3. I can monitor my learning progress.	0.58	4.69	Very Highly Extensive
4. I can evaluate on my own learning outcomes.	0.69	4.62	Very Highly Extensive
Category Mean	**0.70**	**4.61**	**Very Highly Extensive**

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Table 4. Extent of Self-directed Learning of Students in terms of Interpersonal Communication

Items	SD	Mean	Descriptive Equivalent
1. My interaction with others helps me plan for further learning.	0.69	4.64	Very Highly Extensive
2. I would like to learn the language and culture of those whom I frequently interact with.	0.67	4.64	Very Highly Extensive
3. I am able to express messages effectively in oral presentations.	0.82	4.54	Very Highly Extensive
4. I am able to communicate messages effectively in writing.	0.71	4.61	Very Highly Extensive
Category Mean	**0.72**	**4.61**	**Very Highly Extensive**

Table 5. *Summary on the Extent of Self-directed Learning of Students*

Indicators	SD	Mean	Descriptive Equivalent
Learning Motivation	0.69	4.61	Very Highly Extensive
Planning and Implementing	0.72	4.60	Very Highly Extensive
Self-monitoring	0.70	4.61	Very Highly Extensive
Interpersonal Communication	0.72	4.60	Very Highly Extensive
Overall Mean	**0.71**	**4.61**	**Very Highly Extensive**

Table 6. *Level of Mathematical Problem-solving Skills of Students*

Indicators	SD	Mean	Descriptive Equivalent
Understanding the Problem	22.24	81.59	Very High
Devising a Plan	23.21	78.86	High
Carrying Out the Plan	22.13	78.71	High
Looking Back	24.25	78.11	High
Overall Mean	**22.96**	**79.31**	**High**

Table 7. *Level of Academic Self – efficacy of Students in terms of Perceived Control*

Items	SD	Mean	Descriptive Equivalent
1. I will succeed because I can improved my study habit.	0.68	4.64	Very High
2. I will be able to finish Junior high school because I am smart enough to do so.	0.66	4.70	Very High
3. When I am called in recitations, I give the correct answer because I paid attention.	0.66	4.68	Very High
4. Passing a subject depends on how well I perform.	0.75	4.63	Very High
5. The future depends on what I do now.	0.71	4.62	Very High
6. My teachers give me high marks because I deserve it.	0.71	4.61	Very High
7. Because I develop good study habits, I learn more.	0.69	4.68	Very High
8. I can successfully control the outcome of my performance tasks such as group presentations, oral works, multimedia presentations, and research projects.	0.67	4.69	Very High
9. My teachers see me as a good student.	0.69	4.63	Very High
10. I believe that I can pass English subject because I have the ability to do so.	0.66	4.68	Very High
11. I believe that I can pass Math subject because I have the ability to do so.	0.69	4.65	Very High
12. I can successfully control the outcome written works in my academics such as quizzes, unit, or long test.	0.56	4.70	Very High
Category Mean	**0.68**	**4.66**	**Very High**

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Table 9. ***Level of Academic Self – efficacy of Students in terms of Persistence***

Items	SD	Mean	Descriptive Equivalent
1. Despite discouragement from peers, I still continue to study hard.	0.65	4.72	Very High
2. In spite of pressures in school, I continue to maintain my good grades.	0.67	4.68	Very High
3. I manage to pull through even when others think there is no hope in passing a subject.	0.75	4.67	Very High
4. I know how to help myself and that is persistently working hard.	0.76	4.63	Very High
5. Regardless of obstacles, I keep moving toward my goal.	0.69	4.68	Very High
6. If I will not give up, I can figure out difficult homework.	0.66	4.66	Very High
7. If I try really hard, I can get through even the most difficult subject.	0.65	4.73	Very High
8. I am persistent to pass Araling Panlipunan (Social Studies) subject.	0.70	4.69	Very High
9. I persistently solve problems with regards to my academic subjects.	0.51	4.75	Very High
10. I consistently figure out how to do the most difficult class works.	0.52	4.74	Very High
11. If I don't give up, I can do almost all hard tasks in school.	0.64	4.72	Very High
12. Even if there are many obstacles, I can learn it.	0.61	4.78	Very High
13. When I'm having a hard time understanding the lesson, I never stop trying.	0.63	4.77	Very High
14. I work hard despite of difficulties to get good grades in written works in my academics such as quizzes, unit, or long tests.	0.65	4.69	Very High
15. Despite obstacles, I am able to accomplish my performance tasks in my academics such as group presentation, oral work, multimedia presentations, and research projects.	0.61	4.77	Very High
Category Mean	**0.65**	**4.71**	**Very High**

Table 10. ***Level of Academic Self – efficacy of Students in terms of Self-regulated Learning***

Items	SD	Mean	Descriptive Equivalent
1. I can adjust whenever there are hard activities in class.	0.69	4.73	Very High
2. I can study on my own.	0.66	4.75	Very High
3. Whenever there are suggestions with regards to my negative study habits, I welcome it to change.	0.70	4.70	Very High
4. I can monitor my learning development.	0.64	4.74	Very High
5. I can submit my requirements before the deadlines.	0.60	4.78	Very High
6. I organize my school works.	0.70	4.76	Very High
7. I plan my school activities.	0.66	4.77	Very High
8. I believe I perform at my best in written works in my academics such as quizzes, unit, or long test.	0.68	4.71	Very High
9. I can apply my lessons in textbooks.	0.66	4.76	Very High
10. I can focus to study.	0.68	4.70	Very High
11. I arrange my study room to learn without distractions.	0.63	4.76	Very High
12. I can motivate myself to do school works and assignments.	0.65	4.76	Very High
13. I am motivated to pass Edukasyon sa Pagpapakatao (Values Education) subject.	0.73	4.71	Very High
14. I can motivate myself to learn.	0.67	4.78	Very High
15. When I commit mistakes, I am willing to adjust my behavior.	0.60	4.77	Very High
16. I am motivated to pass MAPEH (Music, Arts, Physical Education and Health) subject.	0.73	4,70	Very High
17. I can remember the presented discussions in class.	0.71	4.66	Very High
18. I am motivated to pass Edukasyong Pantahanan at Pangkabuhayan (Technology and Livelihood Education) subject.	0.73	4.70	Very High
19. I organize and plan proficiently to succeed in my performance tasks in my academics such as group presentations, oral work, multimedia presentations, and research projects.	0.62	4.74	Very High
20. I am motivated to excel in my quarterly assessment in my academics such as periodical exams.	0.67	4.71	Very High
Category Mean	**0.67**	**4.74**	**Very High**

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Table 11. ***Summary on the Level of Academic Self – efficacy of Students***

Indicators	SD	Mean	Descriptive Equivalent
Perceived Control	0.68	4.66	Very High
Competence	0.69	4.78	Very High
Persistence	0.65	4.71	Very High
Self-regulated Learning	0.67	4.74	Very High
Overall	**0.67**	**4.72**	**Very High**

Table 12. ***Relationship Between the Variables***

Variables Correlated	r	p-value	Decision on H_o	Decision on Relationship
Self-directed Learning & Mathematical Problem Solving Skills	0.958	0.000	Reject	Significant
Academic Self-efficacy & Mathematical Problem Solving Skills	0.879	0.000	Reject	Significant
Self-directed Learning & Academic Self-efficacy	0.947	0.000	Reject	Significant

Table 13. ***Steps in Mediation Analysis***

Independent Variable (IV)	Self-directed Learning
Dependent Variable (DV)	Mathematical Problem-solving Skills
Mediating Variable (MV)	Academic Self-efficacy
Step 1. Path C (IV and DV)	
Unstandardized Beta (β)	33.260
Standard Error (e)	0.615
p-value	0.000
Step 2. Path B (MV and DV)	
Unstandardized Beta (β)	30.974
Standard Error (e)	1.038
p-value	0.000
Step 3. Path A (IV and MV)	
Unstandardized Beta (β)	0.961
Standard Error (e)	0.020
p-value	0.000
Step 4. Combined Influence of IV and MV on DV	
Academic Self-efficacy	
Standardized Beta	0.272
Part Correlation	0.087
Total R-square	0.925
Self-directed Learning	
Unstandardized Beta (β)	42.212
Standard Error (e)	1.828
Standardized Beta	0.962
Part Correlation	0.391

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Table 14. ***Type of Mediation Used***

Type of Mediation	Significant		
Sobel z-value	20.813166		p = < 0.000001
95% Symmetrical Confidence Interval			
	Lower	0.08123	
	Higher	0.29115	
Unstandardized Indirect Effect			
	a*b	0.84628	
	se	0.32510	
Effective Size Measures			
Standardized Coefficients			R^2 Measures (Variance)
Total:	0.958		0.145
Direct:	0.272		0.001
Indirect:	0.686		0.245
Indirect to Total Ratio:	0.951		0.904

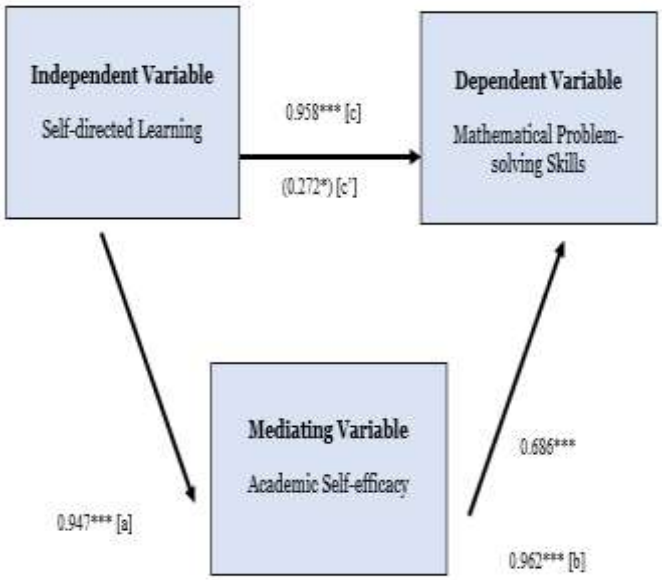


Figure 2. Sobel Test for the Significance of Mediation Effect

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