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The mediating effect of study habits between parental involvement and algebraic problem-solving achievement

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ABSTRACT

Algebra is the major branch of mathematics that deals with numbers, and symbols are mostly used in problem-solving. Students often struggle to learn mathematics due to the difficulties of solving algebraic problems at the secondary level. Several factors affect student problem-solving achievement (PSA). The present study aims to examine the mediating effect of study habits (SH) in the relationship between parental involvement (PI) and algebraic PSA. For this purpose, a study habits scale and a parental involvement scale are used, and a problem-solving test is done for algebraic problem-solving. In this correlational study, Baron and Kenny's series of regression models is used to test the mediating effect of SH. The findings revealed that that PI, SH and algebraic PSA are positively correlated. Also, it is confirmed that SH mediates the relationship between PI and algebraic PSA because there is no longer any significant effect of PI on PSA after SH is included in the model. It is recommended that students' problem-solving skills be developed through their better study habits. Increasing parental support may promote students better SH, which in turn better achievement in problem-solving. Parents and teachers should monitor and encourage students' study habits for better performance in problem-solving and mathematics as a whole.

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1. INTRODUCTION

Mathematics serves as the backbone in the advancement of modern science and technology. It is a basic subject taught globally in primary and secondary school education. In Indian educational system, mathematics is taught as a compulsory subject from primary to secondary schools (up to 10th standard). It is common perception that mathematics is more difficult subject in school education [1]. Teachers, parents, school authorities, and the educational system are often worried about the students' performance in mathematic. The importance of mathematics is comparatively higher than the other subjects in the educational system [2]. The secondary school level mathematics curriculum includes arithmetic, algebra, geometry, statistics, trigonometry, mensuration and probability; all are interconnected to each other. Algebra is the basic field of mathematics, which is regarded as the language of mathematics that uses letters, symbols, and numbers in problem-solving [3]. As a language, learning algebra helps us to understand mathematics [4]. Learning algebra develops students' problem-solving skills, reasoning, and critical thinking abilities. However, due to the abstract nature of algebra, students face difficulties in mathematics learning. The difficulty in learning mathematics is due to the encountering of algebraic problem solving [5]. Problem-

solving is one of the prominent aspects of the mathematics teaching and learning process [6], [7]. Problem-solving ability in algebra is closely related to mathematical achievement [8]. Research has demonstrated that a number of factors are associated with problem-solving achievement [9]. The associating factors of achievement are affecting or cognitive as well as environmental and pedagogical ones [10]. Though problem-solving achievement (PSA) is a cognitive process, the associating factors cannot be ignored, so understanding the connection between the associating factors and PSA is a prominent area of study.

In educational research, students' study habits and parental involvement are the most relevant and influential factors in problem-solving achievement [11]. Research has demonstrated that study habits and parental involvement are the most significant affective factors associated with academic achievement [12]–[14]. For instance, it was found that Ethiopian sixth-grade students' study habits, self-concept, and parental involvement are the most influential factors of academic achievement and have a significant relationship with their academic achievement [13]. Moreover, the relationship between study habits and parental involvement was studied among the ninth-grade secondary school students in the Ganjam district of Odisha in India and found to have a significant relationship with their achievement [14].

In today's educational environment, students' study habits (SH) are the most important aspect of achievement [15], [16]. SH are behaviors and dispositions that can increase motivation and make studying an extremely fruitful endeavor that leads to higher learning skills [17]. These behaviors and skills can also improve a student's learning, problem-solving ability and academic achievement [18]. Research has identified that better SH have a significant role in mathematics achievement [19]. Students' better SH promotes a deeper understanding of mathematical concepts, enabling students to approach problem-solving tasks with confidence. Several recent studies have explored the fact that study habits are one of the most significant predictors of mathematical problem-solving [15], [16], [18]. Also, Reyes *et al.* [15] mentioned that SH is the mediator between the cognitive or affective factors and academic achievement. In a structural study, Hsieh *et al.* [12] established that SH mediated the relationship between parental involvement and academic achievement. Thus, it is one of the most influential factors in mathematical achievements [20], [21].

In the present era, parental involvement (PI) has been a new focus of educational research. According to Fuentes *et al.* [22], students' educational developments can be influenced by parental involvement. Their involvement and attitude towards the subject enhance the learning achievement of a student [23]–[25]. Researchers have actively promoted parent involvement in an effort to increase their children's academic success [26], [27]. Parents actively participating in their children's education and attempting to resolve their problems may encourage better SH and can result in better achievements for children [13], [28]. Nowadays, the importance of parental involvement has emerged as one of the significant factors connected to mathematics achievement [29], [30]. Parents' academic support and anticipation throughout their children's education foster a positive attitude toward mathematics, which may enhance their ability to solve mathematical word problems and develop algebraic thinking [31]. Studies have found that PI has a positive relationship with student achievement in mathematics [30], [32]. Thus, PI is one of the environmental factors to be investigated in connection with mathematical achievement.

2. THE PRESENT STUDY

The literature exhibited that study habits and parental involvement are the influential factors of mathematical achievement. However, the relationship between study habits, parental involvement and algebraic problem-solving is rarely studied. Also, the mediating role of study habits between PI and algebraic PSA is relatively new in the field of mathematics education. Therefore, the aim of the study to establish the mediating role of study habits between parental involvement and algebraic problem-solving achievement. Researchers suggest that study habits can be considered as one of the most influential predictors of problem-solving achievement [18], [19], [21]. Also, several studies [12], [15] highlighted the mediating relationship between PI and achievement.

On the other hand, parental involvement has been identified is one of the important factors in mathematical domain [22], [31]. The relationship between PI and mathematical achievement has signified by several studies [30], [32]. Considering all the fact that, it is hypothesized that study habits mediate the relationship between parental involvement and algebraic problem-solving achievement. The hypothesized model is presented in the Figure 1.

3. METHOD

A correlational research design is used to carry out the study. It is an essential tool to determine the effect of two or more independent variables on one dependent variable [33]. In this study, this design is used to investigate the effect of independent variables SH and PI on the dependent variable algebraic PSA.

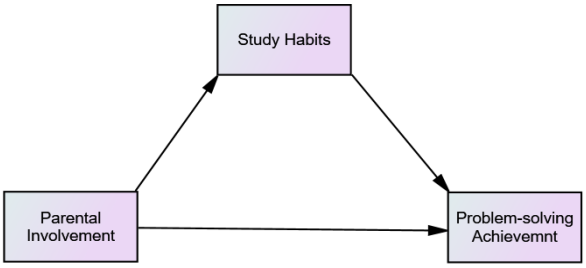

Figure 1. Hypothesized model

3.1. Sample

In a study, the sample is the portion of the population that is chosen to represent the total population. In our study area, the total population is 12,227. However, according to Cochran's formula for finite population [34], the required sample (which can represent the total population) is 374 or more for 12,227 students. Hence, we have considered 400 class IX secondary school students in the Morigaon district of Assam, India. The sample for the study is randomly selected for the study purpose.

3.2. Instruments

In survey research, questionnaires are a common approach to statistical analysis. The use of questionnaires is considered appropriate in this research in order to get sufficient responses from the respondents [35]. The researchers developed self-administered questionnaires that are used for students' SH, PI and a problem-solving test in this study. All items of the questionnaires are validated by the expert educators.

The study habits scale consists of 10 items of the Likert five-point type. For each item, numerical scores are considered "5-strongly agree", "4-agree", "3-neutral", "2-disagree", and "1-strongly disagree". One example of the item is "I study the textbook several times to understand mathematical problems." The Cronbach alpha reliability of the scale is 0.91. Also, the parental involvement scale consists of 10 items of the Likert five-point type. For each item, numerical scores are considered "5-strongly agree" to "1-strongly disagree". An example of an item is "My parents help me when I face difficulty in mathematics." Also, the Cronbach alpha reliability of the scale is 0.82.

To know students' algebraic PSA a test is done based on algebra. The test consists of 20 items based on 9th grade secondary education board of assam (SEBA) text book. The items of the test are of multiple-choice question having four alternative options for each question. Out of those four options, only one option is correct. For the correct option 1 mark is given, and for the wrong option, 0 marks are given. The test items are validated with the help of expert mathematics teacher and educators with more than 10 years of experience. The reliability Cronbach alpha is 0.88 acceptable.

3.3. Data analysis

The statistical product and service solution (SPSS) version 26.0 is used to analysis the collected data. The descriptive statistics are used and the normality tests are also done. The correlation between SH, PI, and algebraic PSA is determined by using Pearson correlation. Baron and Kenny [36] steps are used to establish the mediating effect of SH. At first, algebraic PSA is regressed on PI and in the second step, SH is regressed on PI. In the third step, PSA is regressed on both the independent variable PI and the mediating variable SH. According to Baron and Kenny [36], the following requirements should be satisfied for the mediation effect. In the first step, PI must have an effect on PSA in the regression analysis. In the second step, PI must have an effect on algebraic SH. In the third step, SH should have an effect on algebraic PSA. Finally, the third regression analysis should show a smaller effect of PI on algebraic PSA than the second.

4. RESULTS AND DISCUSSION

In Table 1, the descriptive statistics of SH, PI, and PSA are shown. Skewness and kurtosis values ranging from -1 to 1 indicate that the variables have a normal distribution. Also, the variables (SH, PI, and PSA) are significantly correlated to each other at 0.01. The correlation is moderate as $r>0.3$ and large as $r>0.5$ [37]. PSA is found a large positive correlation with SH ($r=0.809$, $p<0.01$) and PI ($r=0.513$, $p<0.01$). Also, SH is a large positive correlation with PI ($r=0.619$, $p<0.01$).

In this study, a series of regression analyses was used to test the mediating effect of mathematics SH on the influence of PI on algebraic PSA, which was suggested by Baron and Kenny [36]. The results of regression analyses are shown in Table 2. In the first step, algebraic PSA is regressed on PI and the result

found a statistically significant relationship (B=5, t=11.919, P<0.001). The predictor variable PI explains the 26.3% variance of algebraic PSA. In the second step, SH is regressed on PI and found a significant positive relationship (B=0.739, t=15.74, P<0.001). The predictor variable PI explains the 38.4% of variance of SH. Also in the third step, algebraic PSA is regressed on PI and SH. It is found that SH have a significant effect on algebraic PSA (B=6.513, t=21.249, P<0.001). In this regression model, the predictor variable SH explains the 65.5% variance of algebraic PSA. On the other hand, PI have no significant effect on algebraic PSA (B=0.183, t=0.501, P=0.617). But PI was found significant effect on algebraic PSA in second regression analysis. This indicates that the effect of PI on algebraic PSA is no longer exist when SH is simultaneously considered, which satisfies the suggested Baron and Kenny [36] condition of mediation. Hence the hypothesis is accepted. The mediating effect of SH in the relationship between PI and algebraic PSA.

Table 1. Correlation and descriptive statistics for SH, PI, and PSA

	PI	SH	PSA
PI	1	0.619	0.513
SH		1	0.809
PSA			1
Mean	3.5	3.44	11.6
Standard deviation	0.55	0.66	5.39
Skewness	-0.74	-0.59	-0.02
Kurtosis	-0. 27	-0.72	-0.9

**. Correlation is significant at the 0.01 level (2-tailed)

Table 2. Mediation effect of SH in the relationship between PI and PSA

	Model		F	P	R^2	B	Std. error	β	t	P
1.	Regressed of PSA on PI	Constant	142.064	0.000	0.263	-5.839	1.484		-3.934**	0.000
		PI				5.000	0.419	0.513	11.919**	0.000
2.	Regressed of SH on PI	Constant	247.746	0.000	0.384	0.854	0.166		5.14**	0.000
		PI				0.739	0.047	0.619	15.74**	0.000
3.	Regressed of PSA on	Constant				-11.403	1.05		-10.865**	0.000
	SH and PI	PI	377.210	0.000	0.655	0.183	0.366	0.019	0.501	0.617
		SH				6.513	0.307	0.798	21.249**	0.000

**P<0.001

It is widely accepted that students' problem-solving achievement is affected by many factors [38]. In the present study, SH and PI are the affective factors that have significant relationship with algebraic PSA. In the first regression analysis PI has significant effect on algebraic PSA. The positive correlation indicated that increasing parental involvement promotes their children's PSA. The result is consistent with the study showing that PI is significantly related to mathematical achievement [13], [28]. Research by Tang *et al.* [30] found a positive connection between PI and mathematics achievement at the high school level. In relation to this establishment, other studies also indicate that PI is one of the predictors of mathematical achievement [13], [39]. Thus, parental support has significant contribution to their children' mathematical achievement which leads to their academic success.

In the second regression analysis, it is found that PI has an effect on SH. This indicates that increasing PI is significantly influence their children's SH. This is consistent with earlier studies [13], [14] [31], [32]. When parents encourage mathematical exploration, provide resources, and show interest in learning mathematics, children are likely to develop strong study habits in the subject. These support and interest in their children's education may often lead to better study habits and academic success.

However, the effect of PI on algebraic PSA is no longer exist when SH is considered at the same in the third regression analysis. According Baron and Kenny [36], no significant effect of PI on algebraic PSA after including SH in the model confirm that SH plays a mediating role in the relationship between PI and PSA. This means that the effect of PI on algebraic PSA took place through the mediation of SH. This result aligns with a prior study [15] mentioned that SH is a predictor of achievement and plays a mediating role between the affective variables and achievement at the secondary level. Also, Hsieh *et al.* [12] established the similar result that SH mediated the relationship between PI and achievement in a structural study. Thus, increasing parental support may promote students better SH [40], which in turn better achievement in problem-solving [25]. Moreover, the direct positive effect of SH on algebraic PSA indicates that students with better study habits can achieve more in problem-solving and mathematics as a whole [13], [30], [32]. This positive correlation between SH and mathematical PSA has been established previously [14], [18]. Some other studies have identified that students with better study habits have differing achievement in mathematics from those with poor study habits and their academic achievement [16], [41].

5. CONCLUSION

The study investigates the mediating effect of SH in the relationship between PI and algebraic PSA. The study found a significant positive relationship among the variables (study habits and parental involvement), and algebraic PSA. The finding revealed that SH has a significant positive effect on algebraic PSA and mediates the relationship between PI and algebraic PSA. Based on the findings, students' better study habits for learning may improve their algebraic PSA and mathematics as a whole. Also, parents and teachers should be more concerned about their children's SH from an early age while learning mathematics.

It is recommended that students' problem-solving skills be developed through their better study habits. Parents should create a supportive environment at home for their children to develop better study habits. Parents should frequently communicate with teachers regarding their academic performance, especially in mathematics. Parents and teachers should monitor and encourage students' study habits for better performance in problem-solving and mathematics as a whole.

The mediating role of study habits between parental involvement and algebraic PSA holds significant implications for education. Consistent study routines promote a deeper understanding of mathematical concepts, enabling students to approach problem-solving tasks with confidence. Parents and teachers can encourage effective study habits, such as regular practice and active engagement with the material, to enhance students' analytical skills. This approach not only improves academic achievement but also cultivates a minimum of continuous learning and adaptability, which are very essential skills for success in various fields.

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