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Investigating Cognitive Engagement of Eighth Graders' in Mathematics Classrooms

Abstract *The main objective of the study was to analyze the association of mathematics achievement and cognitive engagement at the school level. The research was followed by a quantitative research method following a survey by administering a questionnaire on sampled 300 students for data collection. Half of them were male students and the other half were female students in District Lahore. Data were analyzed using inferential and descriptive statistics. The researcher has used two instruments first one mathematics achievement test and second students' cognitive engagement in mathematic. The sample was selected by convenient sampling technique. The study revealed that students' level of association of engagement and achievement was high. The study also revealed that gender difference exists in students' mathematics achievement and students' cognitive engagement. The study was also found a positive and strong relationship between students' deep level strategies used in mathematics with achievement. This study recommends that the gender difference in mathematics achievement needs attention.*

Key Words: cognitive engagement, eight graders, mathematics classrooms.

Introduction

Previous researches have demonstrated the strong link of students' engagement and achievement in academics. Therefore, researchers need to encourage mathematically engaged society to promote achievement in mathematics examinations. The researches on school engagement are very closely linked with cognitive engagement and thinking logically and thinking strategically is the part that cognitive engagement (Fredricks, Blumenfeld, & Paris, 2004). Connell and also Wellborn (1991), insight cognitive engagement as a person's competence in problem solving, feeling capability to exciting work, and presenting about definite adapting aptitudes. Wong, Lam, and Kong (2003) have find out the relationship between student engagements and learning outcomes in mathematics it was found that performance in non-routine questions such as open-ended problems is closely related to deep level strategy in learning whereas performance in routine problems is closely related to surface learning. Corno and Mandinach (1983) have examined students' cognitive engagement. They defined student engagement when they continued attention to a challenging task, resulting in improved levels of critical thinking.

Students who are cognitively engaged with learning and can identify the higher value of mathematics course have a positive learning experience. Therefore, this study was designed to explore the linkage of students' cognitive engagement with mathematics achievement in eight graders' classroom.

Literature Review

The interest of the present study is to examine students' cognitive engagement in the classroom. According to the literature, measures for cognitive engagement concentrated on investment in learning are missing. The measurement of cognitive engagement is difficult to be measured because it is less

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Observable than behavioral engagement and it can be measured with some indicators (Appleton, Christenson, & Furlong, 2008). Blumenfeld and Meece (1988) have explained that educational activities should be designed to appreciate students so that they can be more engaged cognitively in their study. The literature on cognitive engagement has shown that some researcher has divided cognitive engagement into sub-components like surface-level engagement in which student did not bother to do work in detail and deep level of engagement which include in-depth strategies of understanding students and seek help or avoid struggle while dealing with the task (Annetta, Minogue, Holmes, & Cheng, 2009; Blumenfeld & Meece, 1988; Kong, Wong & Lam, 2003). The majority of educators included metacognitive strategies in cognitive engagement (Devito, 2016). Cognitive engagement comprises more inner indicators, for example, a guideline to self and self-sufficient, the objective direction, and the value of education (Fredricks, Blumenfeld, & Paris, 2004).

Batool, Noureen, and Ayuob (2019) have shown in their study that self-regulation is related to learner empowerment. Some educators focus on planning and regulating behavior to explore cognitive engagement (Hoffman & Nadelson, 2010; Pintrich, Smith, Garcia, & McKeachie, 1991). Therefore, self-regulation and cognitive engagement are closely correlated. Helme and Clarke (2001) have explored in their study that questioning, verbalizing thinking mathematics, and justifying an answer are indicators of cognitive engagement. In an educational context, engagement is an experience of enjoyment and interest (Shernoff & Schmidt, 2008). Engagement compares with fundamental engagement characterized by deep-level processing and intrinsic motivation (Nystrand & Gamoran, 1991). On the other hand, surface-level strategies in learning are associated with memorization in learning and the need to get a passing score (Draper, 2009). Similarly, the use of deep level strategies is mater of higher-level thinking skills such as evaluation level of Bloom taxonomy, it implies that thoroughly learning with personal commitment instead of merely learning for the sake of passing examination (Ramsden, 2003).

Parents are responsible for creating an environment of comfort to manage their children's' homework behavior to help in their study (Epstein & Van Vooris, 2001; Xu & Corno, 2003). Xu and Corno (1998) established the fact that parents can manage the environment of their child's homework by lessening interruptions, concentrating their children on their homework, and can make homework more interesting for them. Such parents engage their children in homework more successfully. Therefore, homework can be a social and interesting experience with parental involvement. The level of parental involvement is different in students (Batool & Riaz, 2019). Therefore, parental variation in attitude towards their child's homework has a positive influence on their achievement (Else-Quest, Hyde, & Hejmadi,2008; Leone & Richards, 1989).

Research Questions

This study was unfolded under the following research questions:

1. What are the responses of participants about the use of surface strategies?
2. What are the responses of participants about the use of deep strategies?
3. What are the responses of participants about the use of dependence on the teacher?
4. What is the extent of correlation among participants' achievement and cognitive engagement that exists in mathematics?
5. What are the comparisons of the mean scores of participants' achievement and cognitive engagement regarding gender in the subject of mathematics?
6. Is parental help in students' homework have any effect on mathematics achievement?

Methodology

Research design

It was a quantitative research approach followed by a survey research method. Participants' opinion was collected with the help of a questionnaire by surveying different schools in Lahore.

Population and Sampling

The population of the study was all students in public sector schools. Schools were selected from the Lahore district. A convenient sampling technique was used to select schools. In this way, six schools were selected for data collection. In the same way, three hundred students were randomly selected as a sample of the study. The ratio of male and female students was equal in the sample of this study.

Research Instrument

The questionnaire was used as an instrument of this research. It comprised two parts: First part as demographic information and the second part was a statement about cognitive engagement with three components, 1) surface strategies, 2) deep strategies, and 3) dependence on the teacher. The focus of this instrument was to find out the level of student engagement. This questionnaire namely students' cognitive engagement in mathematics classrooms was adapted from Kong Wong and Lam (2003). They have developed "The student engagement in classroom scale". It was pilot tested and for this purpose, data were collected from the 60 students of grade eight. The reliability index Cronbach Alpha of three components of the instrument were calculated and found as alpha value of surface strategies is .751, alpha value of deep strategies is .731, and an alpha value of dependence on the teacher is .812. These values were encouraging for study. On the other hand, mathematics achievement test was used for finding mathematics achievement.

Process of Data Collection and Data Analysis

After explaining the purpose of the study, the questionnaire was distributed to the respondents and the data was collected from eighth-graders. Data were analyzed using inferential and descriptive statistics with computer software SPSS.

Results

After using computer software SPSS results were obtained that were shown in tables.

Table 1. Responses of Participants Related to Surface Level Strategies

Statements	SA n(%)	A n(%)	N n (%)	D n(%)	SD n(%)
I can learn mathematics by memorizing formulas.	206(68)	58(20)	21(7)	5(2)	10(3)
I like to memorize the important formulas somewhat than understanding the philosophies behind them.	91(30)	125(42)	54(18)	15(5)	15(5)
Learning facts and solutions by heart the facts is a better choice than learning topics thoughtfully.	130(43)	88(29)	53(18)	16(5)	13(4)
It is beneficial to memorize the methods for finding solutions to word problems in learning mathematics.	105(35)	89(30)	57(19)	25(8)	24(8)
I choose to memorize different approaches to the solution; this is the actual	110(37)	84(28)	58(19)	25(8)	23(8)

method of learning mathematics.					
Learning mathematics is to learn facts by heart by repetitively doing mathematical problems.	156(52)	75(25)	36(12)	14(5)	19(6)
I consider memorizing mathematics; it is more operative than understanding it.	63(21)	42(14)	60(20)	44(15)	91(30)

Table 1 describes the opinion of students about the use of surface-level strategies related to mathematics learning. Seventy-two percent (72%) students were agreed that memorizing is useful in learning mathematical formulas, (72 %) students were agreed that memorizing is better than understanding mathematics, (65%) students agreed that memorizing methods of solving word problems is useful, (75%) students agreed that memorizing solution method is useful, (77%) students agreed that finest method of learning mathematics is to memorize facts by repeatedly doing mathematics problems, (35%)students agreed that memorizing mathematics is more operative than understanding it.

Table 2. Responses of Participants about Deep Strategies

Statement	SA n(%)	A n(%)	N n(%)	D n(%)	SD n(%)
I was wonder by knowing that mathematics that I have learned is applicable in my daily life.	125(42)	67(22)	60(20)	26(9)	22(7)
During new learning, I think about the things that I have previously well-understand and I attempt to get new thoughtful things that I know.	153(51)	78(26)	35(12)	18(6)	16(5)
I effort to choose those things from my textbook which should be thoroughly understood somewhat than just reading it.	144(48)	80(27)	45(15)	17(6)	14(5)
I effort to link things that I have learned in mathematics with what I meet in other subjects and real life.	144(47)	81(27)	45(15)	16(5)	17(5)
I spend extra time to get an in-depth understanding of the thought-provoking aspects of mathematics.	109(36)	90(30)	58(19)	28(9)	15(5)
I usually try to pose questions to myself during mathematics learning and these questions often help me to understand the basic concepts of mathematics.	59(19)	87(29)	79(26)	36(12)	39(13)

I often spend my spare time in studying the topics that we have discussed in class.	143(48)	68(23)	43(14)	23(8)	23(8)

Table 2 describes the opinion of students about the use of deep strategies related to mathematics learning. Sixty-four percent (64%) of students were agreed that it was wondering they learned mathematics can be applied to real life. Similarly, (77 %) participants agreed that when they learn new things they think about the things they have already learned and they are willing to get new knowledge. (75 %) students were agreed that while reading the textbook they are keen to read it thoroughly instead of just reading the text through. Students agreed (74%) that the effort to connect what they learned in mathematics when they encounter in real life. In the same way, (66%) students were agreed that they spend extra time to get an in-depth understanding of the interesting aspects of mathematics. Forty-eight percent (48%) of students were agreed that in learning mathematics they often try to pose questions to themself and these questions always help them to understand the basics of mathematics. Furthermore, (71%) students agreed that they use their spare time to study those topics that were have discussed in class.

Table 3. Responses of Participants about Dependence on Teacher

Statements	SA n(%)	A n(%)	N n(%)	D n(%)	SD n(%)
Following the teacher's instructions is the best way of mathematics learning.	99(33)	71(24)	73(24)	30(10)	27(9)
Following the teacher's directions is the most functioning technique to learn mathematics.	129(43)	73(24)	69(23)	14(5)	15(5)
I learn that teacher teaches in mathematics.	113(38)	90(30)	56(19)	19(6)	22(7)
I learn in that method in which the teacher instructs me.	134(45)	76(25)	49(17)	27(16)	14(5)
I try to solve mathematical problems in the same method in which the teacher does.	140(47)	74(25)	52(17)	17(6)	17(6)
I always follow the method that teachers do in learning mathematics.	89(30)	88(30)	85(28)	19(6)	18(6)

Table 3 describes the opinion of students about the dependence on teachers related to mathematics learning. Fifty-seven percent (57%) of students were agreed that the finest method of mathematics learning is to follow the teacher's directions. In the same way, (67 %) were agreed upon the method followed by the teacher is the effective method of mathematics learning. Sixty-eight percent (68 %) students were agreed that they like to learn in the same way as the teacher teaches. Similarly, (70%) participants were in the opinion of mathematics learning according to teachers' instruction. Seventy-two percent (72%) students were agreed that they like to solve problems by using the same technique as the teacher does. Similarly, (60%) students were agreed that they follow accordingly as the problem-solving method was used by the teacher.

Table 4. Correlation among Academic Achievement, Cognitive Engagement, Surface Strategies, Deep Strategies and Dependence on Teacher

		1	2	3	4	5
1.	Academic Achievement	1				
2.	Cognitive Engagement	.075	1			
3.	Surface Strategies	.009	.844**	1		
4.	Deep Strategies	.166*	.876**	.166*	1	
5.	Dependence on Teacher	.025	.787**	.461**	.520**	1

*p < .05. **p < .01

Table 4 shows the correlation between mathematics achievement, cognitive engagement, surface strategies, deep strategies, and dependence on the teacher. There was no noteworthy association between cognitive engagement and mathematics achievement (r = .075, $p > .05$). The mathematics achievement was connected with deep strategies used in mathematics (r = .166, $p < .01$). If the involvement of the usage of deep strategies by students was increased then the mathematics achievement of students was also increased. Relationship exist between the cognitive engagement and surface strategies used in mathematics (r = .844, $p < .01$). If the involvement of usage of surface strategies by students was increased then the cognitive engagement of students was also increased. Association between cognitive engagement and deep strategies was (r = .876, $p < .01$) significantly exists. If the involvement of usage of deep strategies by students was increased then the cognitive engagement of students was also increased. Surface strategies and deep strategies (r = .166, $p < .01$) also correlated with each other. Dependence on teacher and cognitive engagement is also correlated (r = .787, $p < .01$). Dependence on teacher and surface strategies (r = .461, $p < .01$) are associated with each other. Dependence on the teacher has an association with deep strategies (r = .520, $p < .01$) used by the teachers.

Table 5. Comparison of the mean scores of Academic Achievement, Cognitive Engagement, Surface Strategies, Deep Strategies and Dependence on Teacher regarding Gender.

	Male Students		Female Students		Independent samples *t*-test		
	Mean	St.D	Mean	St.D	*t*-value	df	*P*
Mathematics Achievement	61.21	12.67	69.85	10.28	-6.37	298	.000
Cognitive Engagement	47.11	13.16	43.78	12.39	2.216	297	.035
Surface Strategies	15.22	5.77	15.11	4.22	.183	298	.885
Deep Strategies	15.94	5.68	13.77	4.86	3.458	298	.000
Dependence on teacher	15.13	5.11	15.99	5.15	1.469	297	.143

An independent samples *t*-test was applied to link the scores of mathematics achievement, cognitive engagement, surface strategies, deep strategies and dependence on teacher for male and female students. Results have displayed that a notable difference in mean scores of Mathematics Achievement for male students (M = 61.21, SD = 12.67) and female students (M = 69.85, SD = 10.28), t = -6.37 and p < .000 exists. Furthermore, results have exposed that mean scores are notably different with mean scores of engagement for male students (M = 47.11, SD = 13.16) and female students (M = 43.78, SD = 12.39), t = 2.216 and p < .035. A notable difference in mean scores were not found in results of data analysis in surface strategies used by male students (M = 15.22, SD = 5.77) and female students (M = 15.11, SD = 4.22), t = .183 and p < .885. In the same way, results have shown that a remarkable difference in mean scores of male students' deep strategies used (M = 15.94, SD = 5.68) and female students (M = 13.77, SD = 4.86), t = 3.458 and p < .000. A remarkable difference in mean

scores of dependence on teacher for male students (M = 15.99, SD = 5.04) and female students (M = 15.13, SD = 5.15), t = 1.469 and p < .143 also exists.

Table 6. Comparison of the mean scores of Mathematics Achievement, Cognitive Engagement, Surface Level Strategies, Deep Strategies and Dependence on Teacher for students of three groups, G,(parents involved in homework), G, (parents medium involved in homework) and G,(parents not involved in homework) by using ANOVA

		Sum of Squares	df	Mean Square	F	Sig.
Mathematics achievement	Between Groups	1117.043	2	558.521	3.324	.037
	Within Groups	49908.637	297	168.043		
	Total	51025.680	299			
Cognitive Engagement	Between Groups	5352.745	4	1340.689	8.738	.000
	Within Groups	44110.302	294	143.436		
	Total	50173.057	298			
Surface Strategies	Between Groups	678.788	4	169.697	7.206	.000
	Within Groups	6946.879	295	23.549		
	Total	7625.66	299			
Deep Strategies	Between Groups	689.556	4	172.389	6.357	.000
	Within Groups	7999.281	295	27.116		
	Total	8688.837	299			
Dependence on Teacher	Between Groups	464.659	4	116.165	4.675	.001
	Within Groups	7304.946	295	24.847		
	Total	7769.605	299			

Data analyzed on Table 6 has shown a comparison of the mean scores of mathematics achievement, dependence on teacher, cognitive engagement, surface-level strategies and deep strategies used by the students of three groups namely G,(parents involved in homework), G, (parents medium involved in homework)and G, (parents not involved in homework) by using analysis of variance on dependent variables. Result in the table have shown that all three groups are different in mathematics achievement (F = 3.324, p = .037). Therefore, parents in group one that is involved in students' homework are significantly different from each other two groups. The post hoc test indicated that the mean score of each group one was not considerably different from the mean score of other groups of students' parental involvement in homework. Similarly, cognitive engagement and its three components are different significantly different in three groups in the table.

Discussion

Findings of this study have been shown that students were in opinion about the use of surface-level strategies related to mathematics learning and they feel memorizing is useful in learning mathematical formulas and better way than understanding problem-solving in mathematics. But, the use of deep strategies related to mathematics learning was also found a popular way in mathematics learning that

Can be applied to real-life and they think about the things they have already learned when they are willing to get new knowledge to encounter in daily life. They often use to pose questions to themself and these questions always help them to understand the basics of mathematics (e.g., Devito, 2016). The finest method of mathematics learning was to follow the teacher's directions and they like to learn in the same way as the teacher teaches.

Findings also have shown a correlation between cognitive engagement and mathematics achievement (Mo & Singh, 2009). The mathematics achievement was connected with deep strategies used in mathematics. A relationship exists between the cognitive engagement and surface strategies used in mathematics. If the involvement of usage of surface strategies by students was increased then the cognitive engagement of students was also increased. Association between cognitive engagement and deep strategies significantly existed. Dependence on the teacher has an association with deep strategies (e.g., Vukovic, Roberts, & Wright, 2013). When mathematics achievement, cognitive engagement, surface strategies, deep strategies, and dependence on teachers for male and female students were compared then a significant difference was found. Mathematics achievement of female students was found better, on the other hand, cognitive engagement of male students was found better. It was an interesting result of the present study.

There were three groups formed in data: the first group of students whose parents were fully involved in their homework and the second group was of students whose parents are medium engaged with their homework and in the third group, parents were not involved in their homework. All three groups were significantly different in mathematics achievement and cognitive achievement in favor of group one. Therefore, parental variation in attitude towards their child's homework has a positive influence on their achievement (Batool & Riaz, 2019; Else-Quest, Hyde, & Hejmadi, 2008; Leone & Richards, 1989). Cognitive engagement and academic achievement are integral parts of a learning experience for mathematics students. Consequently, cognitive engagement is of worth in case of academic achievement.

Conclusion and Recommendations

The study has concluded that parents' attention in students' homework has highly useful in students' engagement and achievement in mathematics and learning abilities supports improved student outcomes. Participants' use of surface strategies is popular and students know the value of the use of deep strategies in mathematics learning. They feel a dependence on the teacher is also very useful for them. They think parental help in students' homework has large effect on mathematics achievement and cognitive engagement that is also evident from previous studies (Batool & Jannat, 2019; Cooper, Lindsay, Nye, & Greathouse, 1998) The above body of research makes clear that mathematics learning by repeatedly doing mathematical problems is effective. Memorizing formula in mathematics is more operative than understanding it. They think the best way of mathematics learning to relate it with common life problems. This study recommends that surface-level strategies are not long life understanding and have no significant relationship with mathematics achievement and gender difference in mathematics achievement needs attention.

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