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A Study on Self-efficacy and Reasoning Ability among the Secondary School Students

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ABSTRACT The study focuses on the two most important constructs of self-efficacy and reasoning ability, which have a positive impact on the achievement of the students. The study intends to find out the relationship between the two variables with respect to gender. Survey method was employed to conduct the study. The sample group of the study included the secondary school students (n=102) of Kolkata, West Bengal. Purposive sampling technique was used to collect the data. The data collected were statistically analysed and results revealed a positive and significant correlation between the two variables. Gender difference was noticed in the case of both the variables. Girls displayed higher self-efficacy levels compared to the boys, whereas boys outperformed girls in reasoning ability.

INTRODUCTION

Students' performance is known to be governed by their individual differences. The National Council of Teachers of Mathematics (NCTM) 2000 reveals that individual factors, to a great extent, determine the achievement level of the students (Yurt and Sunbul 2014). Studies foreground two such factors that are thoroughly explored and have a considerable effect on the achievement of the students. Researches focus upon a wide variety of factors, cognitive and affective which impact the achievement of the students. These factors play a significant role in helping the individual to either sustain or refrain from performing adequately. The two most researched factors are self-efficacy and the reasoning ability, which are considered to be highly correlated with students' achievement.

Students' ability to reason marks their quality of performance. Reasoning is a cognitive process that helps a person to think logically, tackle a problem efficiently and overcome the barriers that hinder their goal. A person possessing high reasoning ability tends to demonstrate high ability in problem solving, in making decisions and think critically leading to high performance in academics (Bhat 2016). Reasoning further helps a person to implement the previously acquired knowledge and experience in a novel situation (Bhat 2016).

This study highlights the basic six kinds of reasoning, namely, inductive reasoning, deductive reasoning, linear reasoning, conditional reasoning, cause-and-effect reasoning and analogical reasoning. The most basic thinking process, as pointed out by Klauer and Phye (2008) is inductive reasoning. Inductive reasoning, as stated by Polya (1945) refers to the process of deducing a general rule based on the perusal of a particular fact (Haverty et al. 2000). It proceeds from specific to general, known to unknown, concrete to abstract. On the other hand, the process of drawing inferences from given or known facts is deductive reasoning. The conclusions are obtained from the facts provided and hence are not justified by the experiment (Ayalon and Evan 2010). As Atta points out, deductive reasoning proceeds from the general to specific, unknown to known, complex to simple. Linear reasoning comprises of simple, uncomplicated correlation between different facts and events (Bhat 2016). When conclusions are derived regarding the happening of a particular incident, on the basis of the happening or absence of another incident, reasoning is conditional (Attridge and Inglis 2014). In cause and effect relationship, the effect is initiated by the cause (Bhat 2016). The capability to understand and associate the common factor between two different situations or events and draw a conclusion on the basis of the similarities is referred to as the reasoning by analogy (Gentner and Smith 2013).

The ability to reason elevates the achievement level of the students (Rani 2018). Research-

es claim that students' academic achievement can be highly predicted by their ability to reason (Bhat 2016; Rani 2018). Students with high reasoning ability are able to establish a significant relationship between the known and unknown, concrete and abstract and effectively use the previously learnt material in new situations (English 2013; Bhat 2016). Sternberg (2004) claimed that reasoning ability has a significant role in problem solving (cited in Yurt and Sunbul 2014).

Another key trait for academic success is self-efficacy, the most researched construct, which significantly contributes towards the quality of performance of the students. First introduced by Bandura, and supported by renowned researches, like Schunk (1991), Pajares and Miller (1997), Usher (2009), Zimmerman (2000) etc., self-efficacy is proved to be highly correlated with the achievement of the students. Bandura viewed that the self-efficacy belief originates, primarily from four different sources, mastery experiences, vicarious experiences, verbal (social) persuasion and psychological states. Mastery experience refers to the outcome of students' personal accomplishment. Bandura advocated that the students tend to develop strong self-efficacy when they encounter continuous success. But their self-efficacy goes down with repeated unsuccessful experiences. Researches consider mastery experience to be the strongest source that significantly affects students' achievement (Bandura 1977; Lent et al. 1986; Usher and Pajares 2006, 2009; Kiamanesh et al. 2004; Arslan 2012; Loo and Choy 2013). Self-efficacy also develops through vicarious experiences. An individual observes how others perform in a particular situation or tackle a definite problem and develops the confidence to endeavour the similar task. Studies conducted by Zeldin and Pajares (2000), Usher and Pajares (2009), Loo and Choy (2013) and Prabawanto (2018) pointed out that vicarious experience too exerts a strong influence upon the efficacy level of the students. The third source of self-efficacy is verbal or social persuasion. A person's self-efficacy increases with positive feedback from others regarding their ability to accomplish a task. Constant motivation from peers, parents, teachers enhance their self-efficacy level whereas lack of it leads to the development of low self-efficacy level (Usher and Pajares 2009). People often demonstrate different psychological traits, like nausea, fear, worry, tension as a result of which their heartbeat increases, palm sweats and they feel sick. These are termed as the physiological state or emotional arousal by Bandura. He suggested that in order to foster students' self-efficacy level, such conditions should be discarded (Bandura 1977).

Self-efficacy belief is found to be the most determinant factor that leads to high achievement (Pajares and Miller 1997; Pajares and Kranzler 1995; Zarch and Kadiver 2006; Liu and Koirala 2009; Sartawi et al. 2012; Ramdhani et al. 2017). Students whose self-efficacy level is high are more dedicated towards their work. They not only select the most arduous path but also persist longer when faced with a difficult problem. They are more interested in solving the problem rather than avoiding it. Students with low self-efficacy level demonstrate fear and anxiety when faced with a difficult problem (Wolters and Rosenthal 2001).

Objectives

The objectives of the present study are:

1. To study the nature of the self-efficacy level of the students.
2. To study the nature of the logical reasoning ability of the students.
3. To study the relationship between the logical reasoning ability and the self-efficacy level of the students.

Significance of the Study

Studies related to reasoning ability and self-efficacy, claim that both the variables are strong predictors of students' achievement. Very few studies have actually studied the two variables together. The researcher thereby attempts to take into consideration both the variables in an attempt to find out the relationship between them and establish their importance with regard to the achievement of the students. The information gathered would help the stakeholders in education to have a better understanding of how reasoning ability and self-efficacy can actually enhance students' performance more appropriately.

Review of Literature

Self-efficacy

Predictive and mediating role of self-efficacy upon students' achievement was noticed in many

studies (Pajares and Miller 1997; Pajares and Kranzler 1995; Zarch and Kadiver 2006; Liu and Koirala 2009; Sartawi et al. 2012; Ramdhani et al. 2017). Among the four sources, mastery experience was considered to be the main predictor for mathematics achievement (Lent et al. 1986; Usher and Pajares 2006, 2009; Kiamanesh et al. 2004; Arslan 2012; Loo and Choy 2013), followed by vicarious experience (Zeldin and Pajares 2000; Usher and Pajares 2009; Loo and Choy 2013; Prabawanto 2018). Self-efficacy was also affected by social persuasion (cited in Gao 2019). Zeldin and Pajares (2000) found that social persuasion and vicarious experience play a significant role in developing self-efficacy among girls. Findings by Usher (2009) also indicated the same in case of girls, while mastery experience remained to be the main source of mathematics self-efficacy among males. Studies by Britner and Pajares (2006), Ozyurek (2005) and Arslan (2012) found insignificant correlation between psychological states and the self-efficacy belief of students.

Reasoning Ability

Reasoning ability also had a significant and positive impact upon the achievement of students as students with sound reasoning skills tended to solve critical problems successfully (Flegas and Charalampos 2013; Agah and Lamido 2015; Kanimozhi and Ganesan 2017; Maiti 2017). Analogical reasoning was found to be effective with solving algebraic problems (Laliya et al. 2018) whereas in the case of geometry, inductive reasoning was found to be beneficial (Acharya 2016). Studies further claimed reasoning ability to be a significant predictor in achievement in chemistry (Abdu 1998), in science (Kuhn and Holling 2009), in biology (Lawson et al. 2007) and in mathematics (Haverty et al. 2000; Agah and Lamido 2015; Ongcoy 2016; Kanimozi and Ganeshan 2017; Maiti 2017).

Self-efficacy, Reasoning Ability and Achievement

Very limited work has been carried out on the relationship between the two above mentioned variables. Lawson et al. (2007) compared the relationship between self-efficacy and reasoning ability to the achievement of college students in biology. Results revealed a positive and significant relationship among the two variables, stating that both self-efficacy and reasoning ability are required to perform biological tasks successfully. Highly self-efficacious students solved mathematical reasoning problems more efficiently compared to those whose self-efficacy level was low (Yurt and Sunbul 2014; Jumiarsih et al. 2019). The present study thereby intends to add a new dimension to the self-efficacy and reasoning ability of the secondary school students.

Hypotheses

- $H_0 1$. There exists no significant difference between the self-efficacy level of male and female secondary school students.
- $H_0 2$. There exists no significant difference between the logical reasoning ability of the male and female secondary school students.
- $H_0 3$. There exists no significant relationship between the self-efficacy level and the logical reasoning ability of the students.
- $H_0 3.1$. There exists no significant relationship between the self-efficacy level and the logical reasoning ability of the male secondary school students.
- $H_0 3.2$. There exists no significant relationship between the self-efficacy level and the logical reasoning ability of female secondary school students.

METHODOLOGY

Sample

The population of the present study includes the students of CBSE Board of classes 9 and 10 of Kolkata, West Bengal. The sample consisted of a total number of 102 students. Purposive sampling technique was applied for collecting the data. Total sample has been categorised on the basis of gender.

Research Design

Survey method was used to conduct the study. Correlational design has been employed.

Tools

The following tools were used in the study:

1. Students' self-efficacy was assessed with the help of a scale, namely, "Self-efficacy Scale" developed by A. K. Singh and S. Narain (2014). The scale consists of 20 items and it resembles the Likert scale comprising five response options, ranging from strongly agree, agree, neutral, disagree and strongly disagree. The scale is classified into four dimensions, namely, self-confidence, effective expectation, positive attitude and outcome expectancy.
2. Students' logical reasoning ability was assessed with the help of a scale, namely, "Reasoning Ability Test" developed by M. A. Bhat and P. Govil (2016). This scale consists of 35 items classified into six dimensions, namely, analogical reasoning, linear reasoning, conditional reasoning, deductive reasoning, inductive reasoning and cause and effect reasoning.

RESULTS

Based upon the objectives of the study, analysis has been done on the two variables, self-efficacy and logical reasoning of male and female secondary school students.

Self-efficacy

Descriptive Statistics

From Table 1, it can be stated that the mean scores of male and female secondary school students are found to be 78.79 and 77.38, respectively. This predicts that the male students' self-efficacy level is found to be slightly greater than that of the female students. The value of skewness in males and females are -.698 and -.574 respectively, which states that the data is slightly negatively skewed. Kurtosis values of males and females are .558 and -.383 respectively which falls within the range of $\pm 1.96\sigma$, and hence reflects normal distribution.

Table 1: Self-efficacy scores of secondary school students along with the relevant sample size (n)

	Male	*Female*	*Total*
Mean	78.79	77.38	78.23
Median	79.00	79.50	79.00
Standard deviation	8.277	7.866	8.066
Range	36	30	36
Interquartile range	11	12	11
Skewness	-.698	-.574	-.626
Kurtosis	.558	-.383	.171
N	61	41	102

Source: Field study, January 2021- August 2021

Table 2 depicts the difference in the scores of central tendency and scores of variability among the different dimensions of self-efficacy. The mean scores of male students in self-confidence, effective expectation, positive attitude and outcome expectancy are 18.82, 19.69., 18.67 and 21.59, respectively. Again, the mean scores of female students in self-confidence, effective expectation, positive attitude and outcome expectancy are

Table 2: Scores of the different dimensions of self-efficacy of the students

	SC	*EE*	*PA*	*OC*
Male	Mean=18.82	Mean=19.69	Mean=18.67	Mean=21.59
	Median=19.00	Median=20.00	Median=19.00	Median=22.00
	Mode=19	Mode=20	Mode=18	Mode=22
	SD=2.867	SD=2.896	SD=2.688	SD=2.710
	n=61	n=61	n=61	n=61
Female	Mean=18.29	Mean=19.02	Mean=19.39	Mean=20.56
	Median=18.00	Median=20.00	Median-20.00	Median=21.00
	Mode=18	Mode=20	Mode=21	Mode=21
	SD=2.804	SD=3.711	SD=3.122	SD=2.712
	n=41	n=41	n=41	n=41
Total	Mean=18.61	Mean=19.42	Mean=18.96	Mean=21.18
	Median=19.00	Median=20.00	Median=19.00	Median=22.00
	Mode=18	Mode=20	Mode=20	Mode=21
	SD=2.839	SD=3.247	SD=2.877	SD=2.745
	n=102	n=102	n=102	n=102

Source: Field study, January 2021- August 2021

18.29, 19.02, 19.39 and 20.56, respectively. This indicates that both the males and females secondary school students' average performance is better in outcome expectancy (OC) followed by effective expectation (EE) and positive attitude (PA). The mean scores of the total students in self-confidence, effective expectation, positive attitude and outcome expectancy are 18.61, 19.42, 18.96 and 21.18, respectively.

According to the Shapiro-Wilk test, this p value denotes that the data are normally distributed. As per Table 3, the p value of the scores students' self-efficacy belief is .002, which is less than 0.05. The data is not normally distributed. The p value of males and females are found to be .010 and .098, respectively. In case of females the data is found to be normally distributed, but not in case of male.

Inferential Statistics

This sub-section deals with testing the hypothesis and analysis of the results related to the variables, self-efficacy of both male and the female students. It depicts the statistical comparison of the scores of self-efficacy of both males and females. To examine the difference between performances of male and female secondary school students' independent samples *t* tests were conducted. The results are summarised in Table 4.

From Table 4, it can be stated that the difference between the pair of mean scores of self-efficacy of male and female secondary school students is not significant at one percent and even at five percent levels (that is, the hypothesis $H_0 1$ is not rejected at 1% as well as 5% levels). Therefore, the result establishes the fact that there exists no significant difference between the self-efficacy level of male and female secondary school students.

Reasoning Ability

Descriptive Statistics

From Table 5, it can be stated that the mean scores of male and female secondary school students are found to be 29.36 and 29.33, respectively. This predicts that there hardly exists any difference in their ability to reason. The score of skewness is .165 (females) and -.037 (male) and kurtosis .108 (male) and -.731(female), which are within the range ±1.96ó. The distribution in case of the male, is slightly skewed but kurtosis is found to be normal.

Table 3: Test of normality for self-efficacy scores

	Kilmogorov-Smimov			*Shapiro-Wilk*		
	Statistics	*df*	*Sig.*	*Statistics*	*df*	*Sig.*
Male	.101	61	.190	.947	61	.010
Female	.132	41	.078	.953	41	.098
Total	.116	102	.002	.958	102	.002

Source: Field study, January 2021- August 2021

Table 4: Statistical comparison of the scores of self-efficacy of both male and female secondary school students

	Sample size of male students	*Sample size of female students*	*Mean score of male students*	*Mean score of female students*	*p-value of Levene's Test for Equality of Variances*	*t Test used*	*t*	*df*	*p-value of appro-priate t Test*
SE	61	41	78.79	77.39	.973	Equal variance	.856	100	.394

Source: Field study, January 2021- August 2021

Table 5: Reasoning ability scores of secondary school students along with the relevant sample size (n)

	Male	*Female*	*Total*
Mean	29.36	29.33	29.29
Media	30.00	29.00	29.00
Standard deviation	2.483	2.777	2.631
Range	12	10	12
Interquartile range	3	4	4
Skewness	.165	-.037	.039
Kurtosis	.108	-.731	-.334
n	61	41	102

Source: Field study, January 2021- August 2021

Table 6 depicts the difference in the scores of central tendency and scores of variability among the different dimensions of reasoning ability. The mean scores of male students in linear reasoning (LR), conditional reasoning (CR), deductive reasoning (DR), inductive reasoning (IR) and cause and effect reasoning (CER) are 4.43, 4.11, 4.59, 5.49 and 5.13, respectively. Again, the mean scores of female students in linear reasoning, conditional reasoning, deductive reasoning, inductive reasoning and cause and effect reasoning are 4.44, 3.93, 4.63, 5.39 and 5.07, respectively. This indicates that both the male and female secondary school students' average performance is better in inductive reasoning (IR) followed by cause and effect reasoning (CER) and deductive reasoning (DR). Overall mean scores of the students in linear reasoning, conditional reasoning, deductive reasoning, inductive reasoning and cause and effect reasoning are 4.43, 4.04, 4.61, 5.45 and 5.11, respectively.

In Table 7, the p value of the scores students' reasoning ability is .119, which is greater than 0.05. According to the Shapiro-Wilk test, this p value denotes that the data are normally distributed. The p value of males and females are found to be .356 and .093, respectively. Both the values are greater than p- value of 0.05, which also signifies the data are normally distributed.

Table 6: Scores of the different dimensions of reasoning ability of students

	LR	*CR*	*DR*	*IR*	*CER*
Male	Mean=4.43 Median=5.00 Mode=5 SD=.718 n=61	Mean=4.11 Median=4.00 Mode=5 SD=.877 n=61	Mean=4.59 Median=5.00 Mode=5 SD=.616 n=61	Mean=5.49 Median=5.00 Mode=5 SD=.994 n=61	Mean=5.13 Median=5.00 Mode=6 SD=1.072 n=61
Female	Mean=4.44 Median=5.00 Mode=5 SD=1.026 n=41	Mean=3.93 Median=4.00 Mode=4 SD=.877 n=41	Mean=4.63 Median=5.00 Mode=5 SD=.488 n=41	Mean=5.39 Median=5.00 Mode=5 SD=.919 n=41	Mean=5.07 Median=5.00 Mode=5 SD=.985 n=61
Total	Mean=4.43 Median=5.00 Mode=5 SD=.850 n=102	Mean=4.04 Median=4.00 Mode=4 SD=.878 n=102	Mean=4.61 Median=5.00 Mode=5 SD=.566 n=102	Mean=5.45 Median=5.00 Mode=5 SD=.961 n=102	Mean=5.11 Median=5.00 Mode=6 SD=1.033 n=102

Source: Field study, January 2021- August 2021

Table 7: Test of normality for reasoning ability scores

	Kilmogorov-Smimov			*Shapiro-Wilk*		
	Statistics	*df*	*Sig.*	*Statistics*	*df*	*Sig.*
Male	.115	61	.043	.978	61	.356
Female	.121	41	.143	.953	41	.093
Total	.093	102	.031	.980	102	.119

Source: Field study, January 2021- August 2021

Inferential Statistics

This subsection deals with testing the hypothesis and analysis of the results related to the reasoning ability of both male and the female students. It depicts the statistical comparison of the scores of reasoning ability of both males and females. To examine the difference between performances of male and female secondary school students' independent samples t tests were conducted. The results are summarised in Table 8.

Table 8 represents that the difference between the pair of mean scores of reasoning ability of male and female secondary school students is not significant at one percent and even at five percent levels (that is, the hypothesis $H_0$2 is not rejected at 1% as well as 5% levels). Therefore, the result establishes the fact that there exists no significant difference between the reasoning ability of male and female secondary school students.

Relationship between Self-efficacy and Reasoning Ability

Inferential Statistics

According to Table 9 the correlation value is significant at the 0.05 level (2-tailed) for the total sample. The coefficient of correlation value (*r*) is .219, which is moderately high. So, hypothesis $H_0$3 is rejected at a five percent level of significance. This states that both the variables, self-efficacy and reasoning ability are positively and significantly correlated. As per the hypotheses $H_0$3.1 and $H_0$3.2, correlation is based upon the categorical variable, gender. Here, the result reveals that there exists a positive and significant relationship between self-efficacy and reasoning ability in case of the male students but the correlation value is not significant in the case of the female students. The coefficients of correlation value (*r*) are .313 and .087, respectively. The hypothesis $H_0$3.1 is rejected at a five percent level of significance but $H_0$3.2 is not rejected at five percent and one percent levels.

Table 9: Pearson's Correlation between the scores of the variables of both male and female secondary school students

Gender	*Sample size*	*r*	*p*
Male	61	.313	.014
Female	41	.087	.587
Total	102	.219	.027

Source: Field study, January 2021- August 2021

DISCUSSION

From the analysis of data, it was found that there exists no significant difference between the mean achievement scores of male and female secondary school students in their self-efficacy level, which is similar to other findings of Pajaras and Kranzler 1995; Nicolaidou and Philippou 2002; Chen 2003; Chen and Zimmerman 2007. The male students' self-efficacy level is found to be slightly higher than that of the females. Studies by Matsui et al. 1990; Kundu A 2019 supported the fact that self-efficacy levels of the boys demonstrate high self-efficacy levels compared to the girls. However, this finding does not support the theoretical explanations and studies conducted in the relevant fields on self-efficacy (Kiamanesh et al. 2004), which stated that girls outperformed the boys. The reasoning ability of the students also does not depict gender sensitivity.

Table 8: Statistical comparison of the scores of reasoning ability of both male and female secondary school students

Sample	*Sample size of male students*	*Mean size of female students*	*Mean score of male students*	*p-value score of female students*	*t Test of Levene's Test for Equality of Variances*	*t used*	*df*	*p-value*	*of appropriate t Test*
LRA	61	41	29.36	29.20	.215	Equal variance	.310	100	.757

Source: Field study, January 2021- August 2021

However, the study shows that gender difference is very nominal in this case. This result supports the findings of the previous research, which state that performance of both boys and girls is uniform (Ongcoy 2016; Kanimozhi and Ganesan 2017; Maiti 2017) whereas, Yenilmez et al. (2005), Rani (2017), Zaman et al. (2017) found that male students scored higher in reasoning ability compared to their female counterparts. The findings further revealed a positive correlation between the two variables, self-efficacy and reasoning ability, which is in line with the previous research carried out by Lawson et al. (2007), Karunika et al. (2019). This states that both self-efficacy and reasoning ability are positively and significantly correlated, as an increase in one variable leads to an increase in the other variable.

CONCLUSION

The present study reveals that the students of Kolkata exhibit a high level of self-efficacy and moderate level of reasoning ability. There exists no significant difference between boys and girls in terms of their self-efficacy level and also their ability to reason. The study further claims a strong and positive relationship between the two variables, namely, self-efficacy and reasoning ability.

RECOMMENDATIONS

Both self-efficacy and reasoning ability are essential variables that ensure productivity and success. Hence, students should always be encouraged to develop both the abilities. It is the responsibility of the teachers and the school to guide the students, to answer their queries as well as provide constant encouragement and support to strive better. Varied techniques and strategies should be adopted to enhance the reasoning ability of the students. Sources of self-efficacy, like mastery experience, modelling and social persuasion should be employed so that the students' self-efficacy level increases. The study is of specific importance to the teachers who should be aware of the students' anxiety regarding their achievement and thereby adopt techniques to motivate them and make learning more meaningful.

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