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Problem Solving Ability and Attitude towards Mathematics as Predictors of Mathematical Achievement

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Abstract:

The study was intended to predict Mathematical Achievement of Secondary School Students on the basis of their Problem Solving ability and Attitude towards Mathematics. The sample of the study consisted of 200 students of 10th class from Government Schools of Ludhiana city. Mathematics Achievement Test (2012) by Imam and Khatoon, Problem Solving Ability (2011) by Dubey, and Mathematics Attitude Scale (2012) by Imam and Khatoon were used to collect the data. The results of the study showed significant positive relation between Problem Solving Ability and Mathematical Achievement, also between Attitude towards Mathematics and Mathematical Achievement. The prediction of Mathematical Achievement on the basis of Problem solving ability and Attitude towards Mathematics was significant.

Keywords: Problem Solving Ability, Attitude towards Mathematics, Mathematical Achievement

1. Introduction

Mathematics is a backbone of the students to achieve and developed the skill in reasoning and the thinking level. In elementary stage, the base on the Mathematics should be imposed to develop for mental observation and creativity of innovations. Due to lack of proper knowledge on Mathematics, the student suffers in all spheres of life. So, from the grass root level the teaching of Mathematics should be effective and scientific. In their stepping stone and the process of learning the students should involved in the respected area with more interestingly. The new generation must be trained as a lover of Mathematics and science from the very beginning of the stage when they come in contact in the number-world-the very root of the world of Mathematical Science.

2. Mathematics

Mathematics is defined as the science of quantity measurement and spatial relations. It is a systematized organized and exact branch of science. It deals with quantitative facts, relationships as well as with problems involving space and forms. It is a logical study of shape, arrangement and quantity. Mathematics is defined in different ways by different authors. Let us examine a few of them.

Russell (1901) defined Mathematics as “The subject in which we never know what we are talking about, or whether what we are saying is true”, is fundamentally significant

3. Features of Mathematics

- Logical Sequence
- Integer Sequence
- Structure
- Abstraction
- Symbolism

4. Mathematical Achievement

Mathematical achievement refers not only to obtaining excellent marks in the greater level final examination but it also refers to the attainment of the mathematical ability and skills. Mathematical ability is the thought as the power of solving with speed and accuracy the difficult and complex problems in terms of objectives of teaching Mathematics which requires knowledge and the application of the mathematical concepts and skills which the students have learnt during the whole period of schooling.

Mathematical achievement of the pupil refers to the knowledge attained and skill developed through school subjects which are assessed by school authorities with the help of the achievement tests. By mathematical achievement of an individual we mean the achievement in regarding writing, thinking, reasoning and arithmetic as contrasted with the skill development.

According to Kulkarni, Lal. and Naidu (1970) Mathematical achievement refers to the understanding of mathematical concepts, application to knowledge to new situations and logical reasoning as involved in the interpretation of data, identification of missing links, etc. Gronlund (1971) defined Achievement in Mathematics as “a systematic procedure for determining the amount a student has learnt through instruction”. Good (1959) defined Achievement in Mathematics as “knowledge attained or skills developed in the school subjects. Usually test scores or by marks assigned by teachers”.

According to Imam and Khatoun (2012) achievement implies the net result of an individuals’ effort over a period of time. It shows the level of proficiency attained in scholastics or academic work. Achievement is an enduring personality characteristic in which the individual is predisposed towards success and relatively concerned with failure. The scores on the Mathematics Achievement Teas (MAT-IAKT) by Imam and Khatoun (2012) were taken as mathematical achievement in the present study.

5. Problem Solving Ability

According to Piaget (1956) defined problem solving as “Formal reasoning of complex nature.” According to Guilford (1967) problem solving process is based on the “Structure of Intellect”. He presented the elaborate information processing model based on constellation of human abilities organized into holistic problem solving approach. This model relies heavily on several input functions and the symbol system of memory to produce and evaluate alternative problem solution. According to Pribram (1971) problem solving ability has been conceptualized as an information processing model. It is based on the cybernetic mechanism called TOTE (Test-Operate-Test-Exit). The information processing system is a serial representation of the problem solves as a computer where situation, or condition are checked (Test) manipulated (operate), rechecked (Test) and satisfied (Exit) when the original situation has been adequately dealt with. According to Gagne (1985) defined problem solving ability as “Synthesis of other rules and concepts into higher order rules which can be applied to a constrained situation.” According to Smith and Ragan (1999) problem solving ability is ‘The ability to combine previously learned principles procedure, declarative knowledge, and cognitive strategies in a unique way within a domain of content to solve previously unencountered problems.’

Problem solving is the frame work or pattern within which creative thinking and reasoning takes place. It is the ability to think and reason on given levels of complexity. It emphasizes originality of thought and reasoning rather than a mere reproduction of rules and formulae from memory. The scores on the Problem Solving Ability (PSAT) by Dubey (2011) were taken as problem solving Ability in the present study.

6. Attitude towards Mathematics

Attitude towards Mathematics is just a positive or negative emotional disposition toward Mathematics (McLeod, 1994). Ma and Kishore (1997) propose a definition they conceive attitude toward Mathematics as ‘aggregated measure of a liking or disliking of Mathematics, a tendency to engage in or avoid mathematical activities, a belief that one is good or bad at Mathematics and a belief that Mathematics is useful’. Research on attitude in Mathematics education has been motivated by the belief that ‘something’ called ‘attitude plays a crucial role in learning Mathematics but the goal of highlighting a connection between positive attitude and Mathematics achievement has not been reached conclusively (Zan & Martino 2007). Eshun (2004) defines an attitude towards Mathematics as ‘a disposition and aspect of individual through his or her beliefs and experiences but which could be changed’. Kulum (1980) suggests that it is probably not possible to offer a definition of attitude toward Mathematics that would be suitable for all situation, and even if one were agreed on, it would probably be too general to be useful.

According to Hannula (2002) attitude can also be seen as an emotional disposition towards Mathematics. This definition has four components.

- The emotions the student experiences during Mathematics related activities.
- The emotions that the student automatically associates with the concept Mathematics.
- Evaluations of situations that the student expects to follow as a consequence of doing Mathematics; and
- The value of Mathematics related in the student’s global goal structure.

The Mathematical attitude has been defined by Imam and Khatoun (2012) as generalized attitude towards the universe of Mathematics content and being measured in terms of its favourableness or unfavourableness estimated from the score obtained by the subject on an attitude scale towards Mathematics comprising of the four categories from the universe of content ‘Mathematical Attitude’: (i) positive intellectual, (ii) negative intellectual, (iii) positive emotional, and (vi) negative emotional attitude. The scores on the Mathematics Attitude Scale by Imam and Khatoun (2012) were taken as attitude towards Mathematics in the present study.

7. Review of the Related Literature

7.1. Mathematical Achievement and Problem Solving Ability

Most researchers working on problem solving agree that a problem occurs only when someone is confronted with a difficulty for which an immediate answer is not available. Students are not the same especially when we find out the rate at which facts and principles in sciences are being assimilated.

Patricia and Eugene (1955) studied the technique in problem solving as a predictor of educational achievement. The main results of the study were: (1) techniques used in problem-solving are variables which can serve as differential predictors of school achievement; (2) the table format of the test provides a situation in which the subject is able to select the kinds and amount of information he believes will best enable him to solve the problems; (3) the table method might well be applied to situations where the initial selection and use of a specific series of procedures is an important aspect of the individual’s subsequent training.

Ashmanand and Conway (1993) conducted a study on teaching students to use process-based learning and problem solving strategies in mainstream classes. Teachers who use the programme, called Process-Based Instruction, focus upon developing students' independence in learning and problem solving by providing a structure into which curriculum activities can be placed. Academic achievement and planning data were collected from 147 Grades 4 through 7 students attending regular primary classes in which process-based instruction had been used and from students in comparable classes in which the program had not been introduced. The process-based instruction students outperformed their peers on measures of reading, Mathematics and on one measure of planning ability.

Rodriguez and Olivares (2000) studied the impulsive/careless problem solving style as predictor of subsequent academic achievement. The result of the study indicates that social problem-solving ability significantly predicts academic performance in college students after accounting for their academic aptitude. Furthermore the dimension responsible for this relationship was impulsive/careless problem-solving.

Ali (2010) studied the effect of using problem solving method in trading Mathematics on the achievement of Mathematics students at elementary level. Pro test Post test design was used. Results were analyzed using mean, S.D. & t-test from the findings it was observed that the use of problem solving method enhanced the achievement of students in Mathematics.

Parveen (2010) determined the effect of problem solving approach on academic achievement of students in Mathematics at secondary level. The students of 10th class of Government Pakistan Girls High School, Rawalpindi were selected as a sample of study. Sample size consisted of 48 students who were equally divided into an experiment group and control group on the basis of pre-test. After the treatment post test was used to see the effects of the treatment. A two tailed test was used to analyze the data which revealed that experimental group outscored the control group significantly on the post test. Problem solving approach thus has effect on academic achievement in Mathematics.

Jeotee (2012) examined reasoning skills, problem solving ability and academic achievement from a Cohort of final year university students. The purpose of the study was to investigate the influences of academic ability on reasoning skills and problem solving ability and vice versa. The data has been collected from 333 final year students. The result showed a significant relationship among them.

7.2. *Mathematical Achievement and Attitude towards Mathematics*

Antonnen (1969) conducted a study and reported a strong positive correlation between Mathematics attitude and mathematical achievement.

Jain (1979) conducted a study and found that attitude towards Mathematics played a significant role in the mathematical achievement of the students.

Eshiwani (1983) conducted a study and reported that Girls in Kenya generally have negative attitude towards Mathematics and these attitudes tend to depress their achievement.

Kolhe (1985) conducted a study on 'Construction of attitude Scales and Measurement of attitude of students of Jalogan district towards Mathematics.' The major findings of the study showed that students had a favorable attitude towards Mathematics as a whole and mathematical achievement played a significant role in it.

Caraway's (1985) conducted a study and revealed that Mathematics competency and achievement were both positively correlated with attitude towards Mathematics.

Srinivasan and Sunderarajan (1990) conducted a study on "Higher secondary students attitude towards the study of Mathematics and their achievement in it." The results of the study showed that there was significant and positive correlation between the higher secondary student attitude towards the study of Mathematics and their achievement in it.

Rosalyn (1992) has conducted a study and found that attitude of high school students towards the learning of Mathematics and their achievement in Mathematics are highly correlated. He also found that urban boys and girls have more positive attitude towards Mathematics than rural boys and girls.

Burstein (1992) conducted a comparative study of factors influencing Mathematics achievement and found that there is a direct link between student's attitude towards Mathematics and students outcomes.

Imai (1993) study present findings which supported me opposite thus providing evidence of a two way influence between attitude towards Mathematics and achievements.

Cheung (1998) conducted a study and found a positive correlation between attitude and Mathematics achievement.

Ngailankim (2005) studied the "Attitude and study habits related to achievement in Mathematics of IX class students in Shillong." Major findings of the study were that there were no significant difference was found in the attitude towards Mathematics of students grouped high, average and low in Mathematics achievement.

Yee (2010) conducted a study that investigated students attitude towards Mathematics and its relationship with achievement are scarce in Singapore. To address this issue Mathematics achievement and attitude of 984 students were measured. Results indicates that students had positive attitude towards Mathematics but lacked intrinsic motivation to do Mathematics.

Choi and Chang (2011) conducted a study on 212 schools who participated in the trends in international Mathematics and science study 2007. The results revealed that there is positive and significant relationship between attitude towards Mathematics and achievement in Mathematics.

Lawsha and Hussain (2011) conducted a study. The purpose of this study is to find out the students attitude towards Mathematics and find out gender difference in attitude towards Mathematics in a selected school of Maldives. A total of 200 secondary students were administered with a questionnaire to find out their attitudes towards Mathematics. The students answered questions regarding their personal confidence to Mathematics and perceived usefulness of Mathematics. The results show that the students' positive attitude towards Mathematics and achievement in Mathematics and there is no gender difference in their attitudes.

Mahanta and Islam (2012) conducted a study on 1057 secondary school students of Kamrup district of Assam and found that attitude towards Mathematics and achievement in Mathematics are positively correlated.

Viji (2013) conducted a study on 300 ninth standard students from Government, Aided and Private in Kanchipuram district and found significant positive relationship between attitude towards Mathematics and achievement in Mathematics.

8. Emergence of the Problem

The review of related literature given above shows that there is a positive and significant relationship between Mathematical achievement and problem solving ability (Patricia & Eugene, 1955; Ashmanand & Conway, 1993; Rodriguez & Olivares, 2000; Ali, 2010; Parveen, 2010 and Jeotee, 2012). Positive and significant relationship between Mathematical achievement and attitude towards Mathematics (Jain, 1979; Kolhe, 1985; Srinivasan & Sunderarajan, 1990; Rosaly, 1992; Mahanta & Islam,; Yee, 2010 and Viji, 2013), where as Ngailiankim (2005) shows no significant relation between Mathematics Achievement and Attitude towards Mathematics.

Most these studies are conducted in foreign countries (Patricia & Eugene, 1955; Ashmanand & Conway, 1993; Rodriguez & Olivares, 2000; Ali, 2010; Yee, 2010; Parveen, 2010; Jeotee, 2012 and Rosaly, 1992). Some studies which are conducted in India are conducted in other states (Jain, 1979; Kolhe, 1985; Srinivasan & Sunderarajan, 1990; Mahanta & Islam 2012 and Viji, 2013). No study was found by investigator conducted on the Government Secondary School students of Punjab. So the proposed study seems fully justified.

9. Objectives

- To investigate the significance of relationship between Mathematical achievement and Problem solving ability of secondary school students.
- To investigate the significance of relationship between Mathematical achievement and Attitude towards Mathematics of secondary school students.
- To study the conjoint effect of Problem solving ability and Attitude towards Mathematics towards the prediction of Mathematical achievement of secondary school students.

10. Hypotheses

- H_{01} There will be no significant relationship between Mathematical achievement and Problem solving ability of secondary school students.
- H_{02} No significant relationship will exist between Mathematical achievement and Attitude towards Mathematics of secondary school students.
- H_{03} The prediction of Mathematical achievement among secondary school students on the basis of conjoint effect of Problem solving ability and Attitude towards Mathematics will not be significantly higher as compared to their separate prediction.

11. Sample

The sample of 200 students of 10th class was selected from Government secondary schools of Ludhiana city.

12. Tools

- Mathematics Achievement Test (2012) by Imam and Khatoon
- Problem Solving Ability (2011) by Dubey
- Mathematics Attitude Scale (2012) by Imam and Khatoon

13. Results and Discussion

13.1. Relation Mathematical achievement and Problem solving ability

Karl Pearson's coefficient of correlation was used to find the relation between Mathematical achievement and Problem solving ability has been worked out. The value of correlation is given in table given below:

Variable	r
Mathematical Achievement and Problem Solving Ability	0.819*

Table 1 Relation between Mathematical Achievement and Problem Solving Ability of secondary school students (N= 200)

*Significant at 0.01 level of significance (0.182)

Table 1 reveals that correlation between Mathematical Achievement and Problem Solving Ability is 0.819. This value shows that there is positive significant relation between Mathematical Achievement and Problem Solving Ability. Thus hypothesis H_{01} which states that "There will be no significant relation between Mathematical Achievement and Problem Solving Ability of secondary school students" is thus rejected. This result is well supported by the students conducted earlier by Patricia and Eugne (1955), Ashamanand and Conway (1993), Rodriguez and Olivares (2000), Ali (2010) and Joette (2012).

13.2. Relation between Mathematical Achievement and Attitude towards Mathematics

With the help of Karl Pearson’s coefficient of correlation, the relation between Mathematical Achievement and Attitude towards Mathematics has been worked out.

Variable	r
Mathematical Achievement and Attitude towards Mathematics	0.737*

Table 2: Relation between Mathematical Achievement and Attitude towards Mathematics (N=200)

*Significant at 0.01 level of significance (0.182)

Table 2 reveals that value of correlation between Mathematical Achievement and Attitude towards Mathematics is 0.737. This value shows that there is positive significant relation between Mathematical Achievement and Attitude towards Mathematics. Thus hypothesis H₀₂ which states that there will be no significant relation between Mathematical Achievement and Attitude towards Mathematics of secondary school students is rejected. This finding is well supported by the studies conducted earlier by Jain (1979), Kolhe (1985), Srinivasan and Sunderajan (1990), Roslay (1992) and Mahanta and Islam (2012).

13.3. The prediction of Mathematical Achievement among secondary school students on the basis of conjoint effect of Problem Solving Ability and Attitude towards Mathematics

R² along with R and F values were worked out for the prediction of Mathematical Achievement on the basis of Problem Solving Ability and Attitude towards Mathematics among secondary school students. Step-up regression equation was also developed. These values are given in the table below:

Variables	Degree of Freedom	R ²	R	F	Step up regression equation
Problem solving ability	1 198	0.67	0.819	402.3*	Y= 1.73 + 2.698X ₁
Attitude towards Mathematics	1 198	0.544	0.737	235.9*	Y= -0.561 + 0.386X ₂
Problem Solving Ability + Attitude towards Mathematics	2 197	0.730	0.854	266.9*	Y= -4.034 + 1.945X ₁ + 0.175X ₂

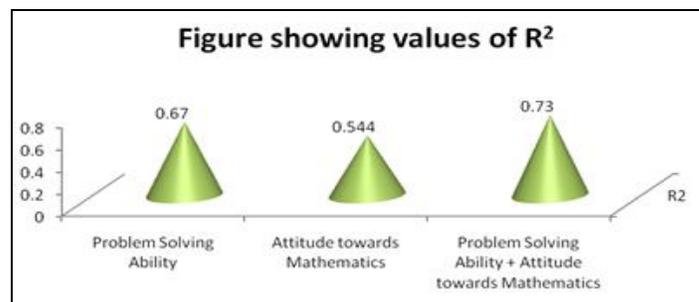
Table 3: Step up regression equation

*Significant at 0.01 level of significance

Table 3 reveals that the value of R² for Problem Solving Ability is 0.67, for Attitude towards Mathematics is 0.544 and for Problem Solving Ability and Attitude towards Mathematics taken together is 0.73. Therefore 67% of Mathematical Achievement is predicted by Problem Solving Ability, 54.4% by Attitude towards Mathematics and 73.0% by Problem Solving Ability and Attitude towards Mathematics taken together. The F value for Problem Solving Ability and Attitude towards Mathematics taken together is 266.9 which is significant at 0.01 level of significance. The conjoint prediction of Mathematical Achievement by Problem Solving Ability and Attitude towards Mathematics is significantly more as compared to their separate predictions. This leads to rejection of hypothesis H₀₃ which states that ‘The prediction of Mathematical Achievement among secondary school students on the basis of conjoint effect of Problem Solving Ability and Attitude towards Mathematics will not be significantly higher as compared to their separate prediction.’

14. Discussion

The above result shows that the Problem Solving Ability and Attitude towards Mathematics conjointly predict Mathematical Achievement significantly higher as compared to their separate predictions for secondary school students. This may be due to the positive and significant relation between Mathematical Achievement and Problem Solving Ability (Table 1); Mathematical Achievement and Attitude towards Mathematics (Table 2).



15. Conclusion

- There exists positive and significant relation between Mathematical Achievement and Problem Solving Ability of secondary school students.
- There exists positive and significant relation between Mathematical Achievement and Attitude towards Mathematics of secondary school students.
- The Problem Solving Ability and Attitude towards Mathematics conjointly predict Mathematical achievement significantly higher as compared to their separate prediction for secondary school students.

16. Educational implications

The results of the study show significant positive relation between Mathematical Achievement and Problem Solving Ability also between Mathematical Achievement and Attitude towards Mathematics. It is suggested to the parents and teachers that they should create conditions conducive for the development of Problem Solving Ability and proper Attitude towards Mathematics among the students. Development of Problem Solving Ability and proper Attitude towards Mathematics among the students will help in the improvement in their Mathematical Achievement.

17. References

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