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Investigating the impact of main factors on problem-solving confidence using cooperative learning: A case study

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Abstract

Low self-confidence in problem solving is one of the main issues in terms of mathematics education between high school students, and this issue led to decreasing the mathematic learning. Mathematic educators always faced a challenge with learners for not being proactive in solving the problems and avoiding them, hence this study aimed to explore the main factors that influence self-confidence problem solving. A total of 20 questions are designed based on different literature and principle components, and confirmatory factor analysis was used for analysing the data. The results of the study indicated that the main influence factors are ability, motivation, perseverance, sense of helplessness and inhibitor. Finally, recommendation and some policies are presented to increase the self-confidence in educational system.

Keywords: Mathematics education, problem solving, self-confidence, cooperative learning;

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1. Introduction

Based on Falkenberg's (2006) definition, education is any pre-planned activity that aimed to facilitate learning. Mathematic educators always faced a challenge with learners for not being proactive in solving the problems and avoiding them. Sometimes, students do not act to present their solutions, which represent the low level of their self-confidence on solving the problems (Falkenberg, 2006). Problem solving is a moral activity and is known as a type of learning. Changing on learner's behaviour that was shaped based on problem solving is more sustainable than changes that appear by simple learning (Falkenberge & Noyes, 2010).

The issues that arise from this manner swiped other criteria of science. Students completely learned the mathematical concepts, but they avoided solving the issues or had least willingness to enter into it. These problems in mathematics education criteria led to exploration and extraction of the main factors that impacted the self-confidence for solving the problems among the students. By this technique, a better solution could be found to solve this issue.

Some studies conducted by different researchers regarding this criterion are summarised as follows.

Gok (2012) developed and validated a problem-solving confidence questionnaire which would help teachers and researchers to have a better understanding of problem-solving confidence of students. According to the results of Gok's study the problem-solving confidence questionnaire is a valid and reliable instrument that can be used in the field of science education. He also pointed out that the high level of self-confidence that existed among the students challenged their understanding while solving the problem. Self-confidence is an attitude that led to feeling of his or her control on life and their positive perspectives (Bishop, 2008).

The characteristics of successful students in mathematics were described by Serkoak (2000). Based on his definition, the students who are successful in mathematics are competent in not only arithmetic but also in a wide variety of mathematical skills, have more self confidence in problem-solving situations, are better prepared to make informed decisions, are more capable of processing information, are more competent in understanding the world around them, have many more career opportunities open to them, can apply mathematical process to many areas of their life and work, appreciate the value of mathematics as a useful tool in everyday living and are better prepared to live in a world of changing technology.

Falkenberg and Noyes (2010) presented a conceptual framework that links the teaching of school mathematics with moral education. This framework is used to explore the affordances and constraints faced by mathematics teachers in those countries if they want to intentionally practice moral education in the classroom. Cooperative learning refers to the use of small groups in which students are being trained to enhance their knowledge with each other and their peers to engage in activities (Johnson & Johnson, 1996). The results of the study conducted by Good, Mccaslin and Reys (1992) showed that when the students solved the problems in small groups, their attitude towards problem solving developed and allowed them to become applicable learners. In the same way, the research of Zachariah and Zanatolksan (2007) in University Technology Malaysia included a series of studies involving cooperative learning, and after the success of this method, the mathematic education system was amended by cooperative learning. Bishop's (2008) contributions can be conveniently outlined through a consideration of the following six issues as they relate to mathematics education research:

- Teacher decision making.
- Spatial abilities, visualisation and geometry.
- Cultural and social aspects of mathematics education.
- Socio political issues for mathematics education.
- Teachers and research.
- Values and teaching mathematics.

This study aimed to explore and find the factors that influenced self-confidence problem solving by using cooperative learning. The man research question is 'What are the factors influenced on self-confidence problem solving between students?'

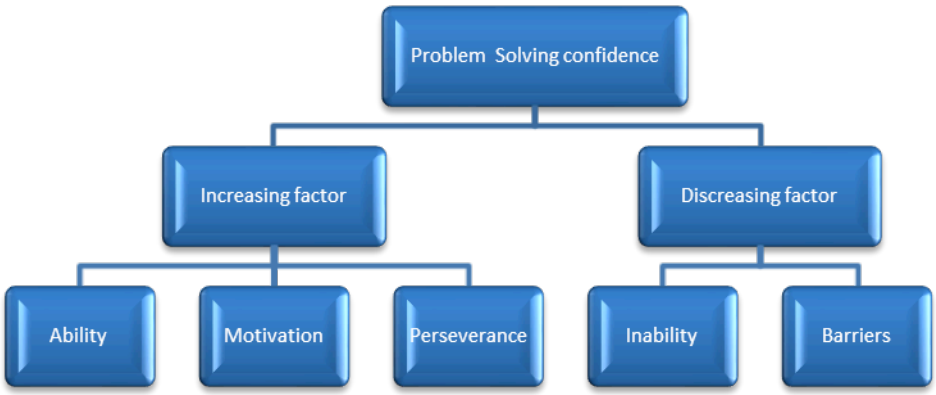

Figure 1. Modelling of problem-solving confidence

2. Methodology

2.1. Participants

In this study, 20 questions for evaluating the self-confidence among students of Sanandaj city were designed. The participants selected in this study were 120 students. The author was present to answer any queries raised by the participants. The participants took about 10 minutes to complete the entire set of scale. Participants' involvement in this study was voluntary, and their confidentiality as well as anonymity was ensured as the participants were assigned and identified by a unique code known only to the investigator.

2.2. Procedures

The open literature was reviewed to develop the basis for problem-solving confidence questionnaire. Respondents rated each item on a 5-point Likert-type scale, with the following scale anchors: 1 = strongly disagree, 2 = disagree, 3 = undecided, 4 = agree and 5 = strongly agree. The validation and verification analyses were performed by giving the scale to students. Some of the statistical analyses (Explanatory Factor Analysis and Cronbach's alpha) were performed with SPSS, and the rest of them (Confirmatory Factor Analysis) were performed with LISREL. Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. This technique aims to explore the inner relationship among lots of variables and finally group them into some specific factors.

Validity of the scale was tested with the varimax rotation and principal component analysis. The items were selected considering the rule anticipating that the item factor load should be over 0.40 as a result of the varimax rotation. The construct validity of the scale was obtained by Bartlett's Test of

Sphericity. For reliability analysis of the scale, Cronbach's alpha was used to examine the reliability of the proposed items within each subscale of the scale. The eigenvalues for the factors, variance percentages and total variance percentages for the scale were obtained. Also, within the context of reliability analysis of the scale, Kolmogorov–Smirnov test was applied to test whether the scale showed a normal distribution.

Table 1. Problem-solving confidence questionnaire

	Question
A1	I like to solve to a problem
A2	I enjoy solving a problem
A3	I like to solve a numeric problem
A4	I do my best to be successful in problem solving
A5	I am interested in problem solving
A6	I like to struggle with solving problem even if I cannot solve the problem
A7	I like to solve problems from different sources
A8	I struggle with a problem until I find the correct answer
A9	I try too hard when I cannot solve the problem
A10	I am sure that I can solve a problem
A11	I am self-confident in problem solving
A12	I am sure that I am able to solve even a difficult problem
A13	I do my best for solving the problem no matter how difficult a problem
A14	I lose track of time while solving a problem
A15	I demoralize if I cannot solve a problem
A16	I am stressed while solving a problem
A17	I lose self-confidence if I cannot solve a problem
A18	I am upset when I find incorrect answer of a problem
A19	I am afraid of making numerical mistakes
A20	Preconceptions prevent me from solving a problem

3. Results

The statistical analysis indicated that the result of Bartlett's Test of Sphericity was 0.817. Thus, multivariate normal distribution was accepted for factor analysis. The value of 0.817 was obtained from Kaiser–Meyer–Olkin (KMO) test from the principal component analysis. KMO test was confirmed with the small partial correlations and sufficient distribution for the factor analysis.

The percentage of total obtained variance is 65.97, and the calculated variance for each factor is more than 1, hence it could be concluded that the validity of these variables is suitable.

Table 2. Rotated component matrix[a]

	Component				
	1	**2**	**3**	**4**	**5**
A1	0.440	0.537	0.449	−0.138	0.162
A2	0.281	0.687	0.407	−0.143	0.168
A3	0.068	0.123	0.779	0.025	0.079
A4	0.497	0.658	0.263	−0.136	0.089
A5	0.618	0.226	0.172	−0.002	0.235
A6	0.299	0.591	0.279	0.239	−0.131
A7	0.185	0.658	0.049	0.179	−0.106
A8	0.231	0.248	0.816	0.088	0.080
A9	0.463	0.101	0.513	−0.130	−0.103

A10	0.830	0.118	0.172	0.119	–0.002
A11	0.799	0.145	0.120	0.200	–0.069
A12	0.731	0.228	0.181	0.046	0.021
A13	0.275	0.036	0.758	0.074	–0.002
A14	–0.064	0.137	0.148	–0.770	0.041
A15	0.168	0.383	0.107	0.735	0.126
A16	0.113	0.637	–0.112	0.239	0.265
A17	0.041	0.364	0.186	0.741	0.297
A18	0.035	0.113	0.098	0.482	0.587
A19	0.028	–0.024	0.038	0.039	0.854
A20	–0.065	0.496	0.310	0.352	–0.256

Based on the following list, self-confidence was grouped into five major categories, and as could be seen, the reliability of the questions was confirmed:

- Group 1 of questions (5, 9, 10, 11, 12): indicate ability of solving problem.
- Group 2 of questions (1, 2, 4, 6, 20, 16, 7): relate to motivation in solving problem.
- Group 3 of questions (3, 8, 13): indicate perseverance.
- Group 4 of questions (17, 14, 15): refer to disability in solving the problem.
- Group 5 of questions (18, 19): indicate barriers factor to solving the problems.

3.1. Confirmatory factor analysis of research

In this section, results of confirmatory factor analysis of each variable were computed based on LISREL separately. It should be noted that the reduction of variable and considering it as one factor, the loading factor should be more than 0.3.

For evaluating the affecting factors, a structure modelling equation by LISREL was used.

3.1.1. First level of confirmatory factor analysis of self-confidence

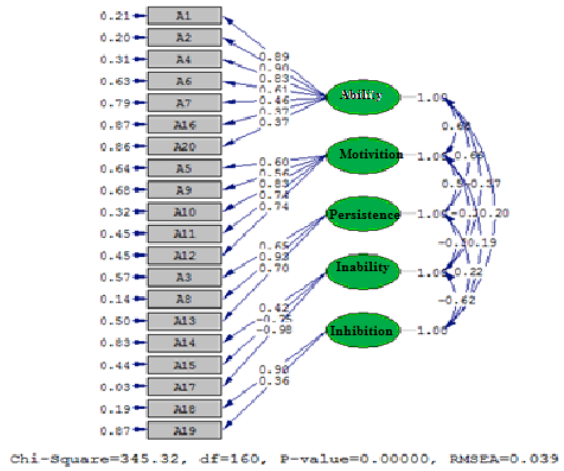

Figure 2. Path diagram of 5 factor model

Figure 2 shows the measuring model of self-confidence variables in standard estimation. The results of estimation (indicated at the bottom of Figure 2) indicated that the model is suitable. With respect to the output of LISREL, computed value of chi-square is 272.82 (the chi-square statistic), and the other fit indices selected for this study is the goodness-of-fit index.

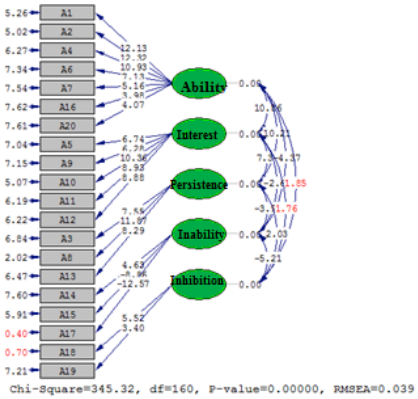

Figure 3. Diagram of 5 factor model

3.1.2. Second level of confirmatory factor analysis of self-confidence

In first level of confirmatory factor analysis, from the questionnaire, we received dimensions of self-confidence. Continuously from second confirmatory factor analysis, we achieved the self-confidence required for problem solving. The fit indices of the model illustrated that the data are suitable and how well the data fit the a priori hypothesised model. The chi-square value obtained is below 3, and also the root mean square error of approximation is below 0.08.

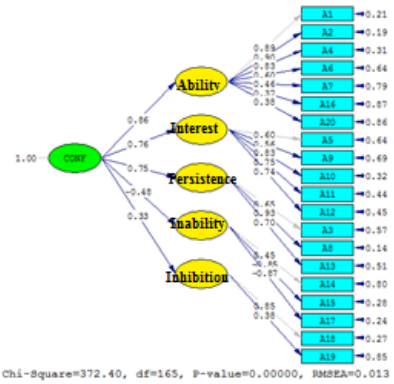

Figure 4. The first significance digit diagram

Also measuring models in standard estimating situation shows the impact of each variables or factors in distribution of variance of variable marks or main factor.

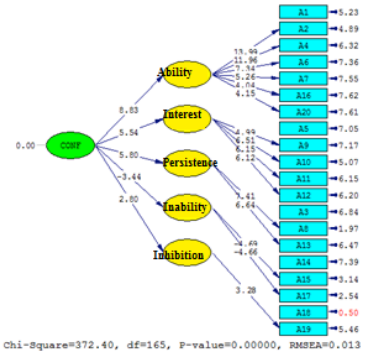

Figure 5. Second standard estimate factor

Figure 5 shows the ratio of main factors that have impact on self-confidence problem solving: problem-solving ability factor (ratio: 0/86; significant number: 8/83) had the greatest impact on self-confidence, problem solving with an interest factor named motivation factor (factor: 0/76, number between 0 and 5/54) had the second largest impact on self-confidence, perseverance to solve the problem (factor: 0/75, or numbers between 5/80) was the third factor, barriers to problem solving (factor: 0/33; significant number: −3/44) the impact on self-confidence, inability to solve the problem and ultimately finished fourth in problem solving (coefficient significant number of −0/48 and 2/80) esteem problem has negative effects.

4. Recommendation

Problem solving is viewed as a fundamental part of learning mathematics. 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 (NCTM, 2000).

The first substantive point this research wants to make is that improving self-confidence in an educational system especially for high school students is not designed into the mathematics curriculum especially in the study area. The second issue this study illustrated is the increased impact of assessment on mathematics learning and the potential of self-confidence in problem solving (Cohen, 1994)

Subjects who underwent the procedure designed to reduce problem-solving confidence showed significantly lower self-ratings of problem-solving confidence than subjects who underwent the procedure designed to increase confidence. However, the mood manipulation did not appear to be successful in changing mood in the expected directions (Davey, Jubb & Cameron, 1996).

The main finding of the study was that the problem-solving confidence manipulation did have a significant effect on catastrophising: subjects who experienced the confidence-reducing procedure emitted significantly more catastrophising steps than subjects who experienced the confidence-enhancing manipulation (Davey et al., 1996).

This suggests that changes in problem-solving confidence can have a causal effect on catastrophic worrying; this reflects an increase in how bad the potential outcomes of the worry are conceived and the amount of time the subject is willing to spend ruminating on a particular worry (Good et al., 1992). This is consistent with Davey's argument that low levels of problem-solving confidence may thwart effective problem solving and exacerbate worrying (Davey et al., 1996).

The following good instructions could be suitable for increasing self-confidence especially in mathematics education:

- Using the standard practices to solve problems that led to decreasing the level of disability.
- Developing and constructing attractive and incentive plans for student can affected the level of self-confidence to solving problems.
- Using qualitative evaluation in classroom, such as Math Cad, led to decrease the failure.

Teacher's patience for solving problems and making the teachers to present solutions for each problem, listen to other solutions proposed by others and encourage the students to continue on their work led to an attractive classroom environment for better solving of problems.

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