Analysis of problem solving ability in social arithmetics

F Fajriah¹, R Salasi², S Suryawati² and S Fatimah¹

¹Departemen Pendidikan Matematika, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia
²Departemen Pendidikan Matematika, Universitas Syiah Kuala, Jl. Hasan Krueng Kalee Darussalam, Banda Aceh 23111, Indonesia

*fajriah@upi.edu

Abstract. Problem solving is additional curriculum important because in the learning and completion process, students use to the knowledge and skills they have mastered to solve problems in life every day. Therefore, purpose this research how the problem solving ability of students and the factors influence for the problem solving skills. The renovation used in this research is the mix quantitative and qualitative and type of research is descriptive. Sample research involved 28 students, grade VII students of state junior high school 7 Banda Aceh, data collected through tests and interviews. The data obtained were analyzed using Chi Square test. The results of this study indicate that grade VII students of state junior high school 7 Banda Aceh have good problem solving skills. When looking at the steps model problem solving Polya, the student not competent devising a plan the problem solving and checking again. Factors that influence student problem solving skills include cognitive factors (reading ability, analysis and logic, as well as skills appropriately), experience factors (background integration and familiarity with non-routine issues and strategy problem solving) and affective factors (interest in the given problem, motivation and perseverance).

1. Introduction
Mathematics is a collection of truths, rules, and not just counting. Mathematics is also a language, problem generating activities and problem solving, activities of finding and studying patterns and relationships [1]. Mathematics plays an important role in developing the human mind, bringing strategic, reasoning, systematic process used in problem analysis and solving [2]. It can help to anticipate, plan, decide, and solve problems in everyday life.

Problem solving is part of a very important mathematics curriculum because in the learning process and its completion, students are enabled to gain experience using the knowledge and skills they have to apply to solving problems in everyday life [3]. Gagne states that problem solving is the highest and most complex type of learning compared to other types of learning, learning, stimulus response learning, chaining, association, verbal association, discrimination learning, concept learning, rule learning and problem solving [4]. Problem solving in mathematics, it can improve students' ability to think critically, analytically, systematically and logically to find alternative problem solving through empirical data exportation in order to foster scientific attitude.

The process of mathematical problem solving is one of the basic skills of mathematics that must be mastered by high school students. The importance of having such abilities is reflected in [5] statement that mathematical problem solving is one of the important goals in mathematics learning even the
process of mathematical problem solving is the heart of mathematics. Problem solving has generally been accepted as means for advancing thinking skills, which means that problem solving has been generally accepted as a way of improving thinking skills [6]. Problem solving plays an important role in mathematics education [7].

The results of the study [8,9,10] the students' ability is relative better at solving the facts and procedure, but weak in solving non-routine problems related to justification or verification, problem solving requiring mathematical reasoning, find generalizations or conjectures, and find the relationship between data or facts given. In addition Phonapicat et al. shows that there are some difficulties experienced by students in problem solving that is student cannot know what to assume from the information on the problem, cannot determine the right strategy for solving the problem, every time students do not understand the problem they tend to guess answers without thinking process, and students are impatient and do not like to read complex mathematical problems [2]. Therefore, to improve the problem solving abilities of mathematics, it is necessary to develop problem-solving skills, create mathematical models, solve problems, and interpret solutions.

Problem solving in mathematics, systematic steps are needed to make the process of completion easy and directed. One of them with problem solving model Polya. Polya [11] states that in problem solving there are four steps that must be done that is (1) Understanding the problem; the student must be able to understand the problem condition or problem in question. (2) Devising a plan; students are able to prepare a settlement strategy. The exact strategies for solving mathematical problems are numerous and varied, among which the most widely used are drawing or diagrams, finding patterns, creating tables, simplifying problems, experimenting, experimenting and writing equations. (3) Carrying out the plan; students are ready to perform calculations with all kinds of necessary data including concepts and formulas or equations as appropriate. (4) Looking back; students should try to re-check and re-examine carefully every step of the solution is done. All these steps will be very effective if applied in mathematical problem solving [1]. The results of research conducted by [12] show that the application of Polya step can improve student learning outcomes in solving math problems. The indicators of problem solving ability is presented in table 1.

| Steps of Problem Solving by Polya | Indicator |
|----------------------------------|----------|
| Understanding problem            | The students can name the information provided and understand the problem / question given. |
| Devising a plan                  | The student has a problem-solving plan that he uses and the reasons for its use |
| Carrying out the plan            | The student can solve the problem according to the problem-solving steps he has planned with the correct results. |
| Looking back                     | The student re-examines the problem-solving steps she is working on. |

The factors that influence the ability of problem solving are (1) cognitive factors consisting of the ability to read, the ability of analysis and logic, and skill to calculate exactly. (2) Experience factor: background of previous mathematical knowledge and familiar with non-routine problem and problem solving strategies with age. And (3) Affective factor consists of an interest in a given problem, motivation and perseverance, anxiety and patience [13].

Social Arithmetic is one of the materials taught in the junior high school in class VII. In this material there are problems related to everyday life. The results of interviews with teachers in the field of
mathematics studies, social arithmetic materials including complicated for students. In general, the complexity for students in learning social arithmetic materials include students' ability in conceptual understanding, basic operational ability, and ability to analyze the problem itself. The form of problems in social arithmetic material is usually a matter of story, so it takes the ability of problem solving is how to solve a problem gradually in accordance with the steps that have been determined. Therefore, problem solving becomes an important thing that must be possessed by learners for various levels of education.

Related to the background, purpose this research how the problem solving ability of students and the factors influence for the problem solving skills junior high school students of class VII in social arithmetic problem solving.

2. Experimental method
This research uses quantitative as well as qualitative approach. The goal is to describe the problem solving ability of Polya model in social arithmetic problem solving. This is consistent with the assertion [14] that "qualitative research has an inductive nature and prioritizes the process of outcome". This research took place in State junior high school 7 Banda Aceh and was conducted in even semester. The sample in this study was taken randomly one class from seven existing classes, selected is class VII-7 with the number of students 28 people. Data collection is done in two stages, namely test and interview. The test is done by giving four items of descriptions pertaining to social arithmetic. While the interview is conducted to explore more deeply problem solving ability of students covering understanding of the problem, plan solutions, solve problems based on predetermined plans, and review the results that have been obtained and know the factors that affect the ability of problem solving students.

The data were analyzed using Chi-Square test ($\chi^2$) to know the students' problem solving ability in every step of Polya. Each step will be assess based on predetermined indicators and following the assessment rubric. The hypothesis tested in this study are:

$H_0$: Grade VII students of state junior high school 7 Banda Aceh have problem solving skills that are not good in social arithmetic problem solving.

$H_a$: Grade VII students of state junior high school 7 Banda Aceh have good problem solving skills in social arithmetic problem solving.

In addition to testing the hypothesis above, will be described also about the problem solving ability of students on each step Polya and also will explain the factors that affect problem solving ability in social arithmetic problem solving. The descriptions were based on interviews.

3. Result and discussion
Based on the results of the test, the level of problem solving ability of VII grade students of junior high schools 7 Banda Aceh in completing the social arithmetic is shown in table 2.

| Ability Category | Step I (Understanding problem) | Step II (Divising a plan) | Step III (Carrying out the plan) | Step IV (Looking back) |
|------------------|-------------------------------|---------------------------|---------------------------------|------------------------|
| Good             | 20 students                   | 8 students                | 12 students                     | 11 students            |
| Not Good         | 8 students                    | 20 students               | 16 students                     | 17 students            |

Data on student ability level in the table will be used for hypothesis testing. The statistical test used is Chi Square test statistic ($\chi^2$). This is done to determine the ability of students in completing social arithmetic through steps problem solving model Polya. Hypothesis to be tested at significant level $\alpha = 0.05$.

Based on the calculation with Chi Square test ($\chi^2$), the value of 11.33 < 7.815. Since the value of $\chi^2_{\text{count}} < \chi^2_{\text{table}}$ then $H_0$ is rejected. Thus it can be said that "Grade VII students of state junior high school 7 Banda Aceh have good problem solving skills in social arithmetic problem solving".
Furthermore, interviews with selected students were selected based on test results. Interviews conducted to describe the problem solving ability of students in social arithmetic problem solving using Polya step. Here are excerpts of interviews by some students:

3.1. *Ability to understanding problem*
Excerpt interviews on Maria (R = Researcher, S = Student):
R: What is known from the problem? And what is asked?
S: (Students explain what is known and what is asked but not complete only part of which can be explained).
R: Is the data provided sufficient to solve the problem?
S: I do not know the book, because the problem is very complicated, and the form of a story
R: Do you have difficulty in understanding the given problem?
S: Yes, yes.
R: On what number and why do you find it difficult?
S: Problem number 1, I cannot write down what is known from the problem because in that part I find it difficult to analyze complex story problems, and beforehand had never encountered a problem almost identical to the matter.
R: In item 2, 3, and 4, are you having trouble understanding the problem?
S: There is no book, I was just confused at first, but after I read over and over because I understand what is known and what is asked from the problem
Based on the excerpt of the interview it can be seen that the student has not been able to write the data that are known and asked in detail and complete. They can only write down some of the known data in the question. Factors that influence the reading factor, analysis, and experience of solving the problem.

3.2. *Ability to devising a plan*
Excerpt interviews on Radit (R = Researcher, S = Student):
R: Have you encountered similar problems with the problem?
S: Never, no. The problem is almost the same with the intelligent question that I follow first.
R: What strategy do you use in solving the given problem?
R: First I remember the rules that fit the problem, then I try to use a formula or formula that matches the problem, after that I finish with the formula.
R: Why do you use that strategy?
S: More suitable and appropriate to solve the problem on that matter, and I have also tried it.
R: Do you have difficulty in determining which strategy to use? Why?
S: Not a book, because I understand the condition of the problem.
Based on the excerpt of the interview it can be seen that the student can determine the right formula or strategy if the student can understand the problem and also influenced by skill factor, logic, analysis, patience in determining the right strategy either way of guessing or by other way, and also previous experience. And part of the student's answer finds that in this step the student does not write a strategy or formula, for reason unfamiliar with problem solving Polya.

3.3. *Ability to carrying out the plan*
Excerpt interviews on Mira (R = Researcher, S = Student):
R: Is the predefined strategy / formula there used in the problem solving process?
S: Sure the book, but only part of the problem I have made strategy / formula in the second step.
R: Is there a difficulty in the process of problem solving?
S: Some questions have a book, because it is difficult because in the form of a story. And at the completion of number 1 I did not finish it, while question number 4 seems to me wrong in the calculation. So the results I can seem to be less precise. While questions 2 and 3 there is no significant
difficulty in solving the problem, just need focus and thoroughness when performing the calculation operations. Based on interview excerpts can be concluded that in this step is required by the students is the basic concepts, skills to calculate precisely, and perseverance in solving problems.

3.4. Ability to looking back
Excerpt interviews on Akmal (R = Researcher, S = Student):
R: Once you get the answer, is it convinced by the answer? Why?
S: Less sure, because there are some problems that I have solved but the formula was I guessed because I forgot.
R: Are you checking out the troubleshooting steps?
S: For question number 4 I have checked the book, but for question 2 and 3 I do not know how to check the answer is right or wrong. If it's about number 1 I do not answer, so I do not check the answer.
R: During this time, have you ever checked back the answers that have been obtained?
S: Rarely a book, because there is not enough time and our teacher has never given way to solving this problem.

Excerpts of the interviews indicate that the ability to check is still low. Students often assume that there is no need to check the answers that have been obtained. There are also some who do not know how to check back the answers that have been obtained or not enough time. Nevertheless, there are also students who do check back answers that have been obtained.

Based on the results of the analysis that has been described, it is found that Grade VII students of state junior high school 7 Banda Aceh have good problem solving skills in social arithmetic problem solving. But that does not mean there is no shortage in every step problem solving. This is in line with the research [15] showed that with the application of problem solving can improve the ability in learning mathematics. The same thing is also found by [16] showed that the students’ ability to use problem solving method of Polya model in mathematics learning can increase.

From the four steps Polya which has been described several factors that affect the ability of problem solving students in social arithmetic problem solving. These factors are: (1) Cognitive factors consisting of: the ability of students in reading; this ability is very important role in understanding the problem given, students who have good reading ability will be easier in understanding the problem, the ability of analysis and logic; needed at every step of problem solving, skill ability to calculate precisely; This skill is very necessary because if the calculation is wrong then the final result is also wrong. (2) Experience factors include: previous mathematical background; familiar with non-routine problems and problem solving strategies, familiar here means that when students have been getting the same problem or almost the same that he was facing the student will be easier in solving the problem. (3) Affective factors include interest, patience, and persistence.

In the research that has been done, it is found that students who have problem solving ability with good category have all three factors are cognitive, experiential, and affective factors. Thus, these factors affect the problem solving ability of students in arithmetic problem solving. As the result of [12] shows that the problem solving of Polya model in every step/stage is influenced by several factors namely cognitive, affective, and experience factors.

4. Conclusion
Based on the result of the research, it is found Grade VII students of state junior high school 7 Banda Aceh have good problem solving skills in social arithmetic problem solving. But that does not mean there is no shortage in every step problem solving. In the step of planning the completion and re-checking students have difficulties. This is because students are not familiar with solving problems of Polya model. And there are several factors that affect the problem solving ability of students are cognitive factors, affective and experience. These three factors play an important role in social arithmetic problems solving.
Acknowledgments
We thank all students and teacher for supporting us to collect the data in this paper.

References
[1] Ruseffendi E T 2006 Membantu Guru Mengembangkan Kompetensinya dalam Pengajaran Matematika (Bandung: Tarsito)
[2] Phonapichat P, Wongwanich S, Sujiva S 2014 An analysis of elementary school students difficulties in mathematical problem solving Procedia - Soc. Behav Sci. (Elsevier) 3169–74
[3] Suherman H E 2003 Strategi pembelajaran matematika kontemporer (Bandung: UPI)
[4] Lerch C M 2004 Control decisions and personal beliefs:Their effect on solving mathematical problems J Math Behav. (Elsevier) 23 1 p21–36
[5] Branca A N 1980 Problem solving as a goal, process, and basic skills In Problem Solving in School Mathematics (electronic) ed Krulik S (Reston RER, VA: NCTM)
[6] Pehkonen E 2008 Problem solving in mathematics education in Finland Proc. ICMI Symp. (Ncsn) 7–11
[7] National Council of Teachers of Mathematics 2010 Why Is Teaching With Problem Solving Important To Student Learning? (Reston, VA: NCTM)
[8] Tambychik T, Meerah Thamby S M 2010 Students' difficulties in mathematics problem solving: what do they say? Procedia - Soc. Behav Sci. (Elsevier) 8 142–1
[9] Yongchim P, Pasiphol S, Sujiva S 2015 Development of a mathematical problem solving diagnostic method: An application of bayesian networks and multidimensional item respond theory Procedia - Soc. Behav Sci. (Elsevier) 191 742–7
[10] Lane C P, Harkness S S 2012 Game show mathematics: Specializing, conjecturing, generalizing, and convincing J.Math Behav. (Elsevier) 31 2 163–73
[11] Polya G 1973 How to solve it (New Jersey: Princeton University Press)
[12] Yavuz G, E rbay H N 2014 The analysis of the preservice teachers' beliefs about mathematical problem solving Procedia - Soc. Behav Sci. (Elsevier) 174 2687–92
[13] Căprioară D 2015 Problem solving-purpose and means of learning mathematics in school Procedia - Soc. Behav Sci. (Elsevier) 191 1859–64
[14] Creswell JW 2014 Research design: qualitative, quantitative, and mixed methods Approaches (fourth edition) SAGE 250
[15] Guven B, Cabakcor B O 2013 Factor influencing mathematical problem solving achievement of seventh grade Turkis students (Elsevier) 23 131–7
[16] Nunokawa K 2005 Mathematical problem solving and learning mathematics: what we expect students to obtain J.Math Behav. (Elsevier) 24 2 325–40