



THE INFLUENCE OF SCIENCE LEARNING SET USING SCIENTIFIC APPROACH AND PROBLEM SOLVING MODEL ON LEARNING OUTCOMES OF JUNIOR HIGH SCHOOL STUDENTS IN THE SUBJECT OF HEAT AND TEMPERATURE

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ABSTRACT

This research aims to produce the scientific approach for science learning using a problem solving model on the topic of heat and temperature on the junior high school learning outcome. The curriculum used during the study was curriculum 2013 (valid, practical and effective). The development of the learning set followed the four-D model which was reduced to three-D model (without dissemination). The study was tested in Class VIIA, VIIB, and VIIC in SMP Negeri 5 Academic Year 2015/2016. The data collection technique employed the validation of the learning set, observation, testing, and questionnaire. The results of study show that the developed learning set has a decent (valid, practical, and effective). The competency in learning outcomes show N-Gain in high level with the average value ranged between 0.80 to 0.86. The impact of learning on three classes were tested by ANOVA on 0.05 significance level to produce F value \leq F table, meaning that there is no difference in the impact of learning on three classes with consistent value. The student competence skills and demeanor, the skills of each category showed good and positive response to learning. The research concludes that the scientific approach for science learning using a problem solving model is suitable for learning application (validity, practicality, and effectiveness). By mastery in learning management, the learning objectives can be achieved smoothly.

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Keywords: Scientific approach, problem solving model, Mastery, Learning Outcomes

INTRODUCTION

The progress of a nation is marked by increasing the quality of society life such as the human resources quality in utilizing and developing the appropriate technologies as well as tackling the impact. One of the indicators is education as an embodiment of the dynamic and evolving the human culture. Competition in information and technology has a tendency to change rapidly requiring prompt and effective response to 21st century education. The education evolution is directed to integrate various sources of knowledge to solve the problem effectively.

The curriculum 2013 was developed with the improvement of active mindset reinforced in learning approach to scientific learning, in line with Permendikbud about the standards process, which is set with student characteristics and learning outcome. The quality of learning can be observed in terms of process and in terms of outcome. The assessment in the educational process is an important component since it is a form of information weaknesses and strengths in teaching and learning. Before the learning assessment, teachers have a role to assist the students in achieving the learning objectives by employing the approaches, strategies, methods, techniques and learning models which are needed to facilitate students to easily in achieving optimal learning

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outcome.

According to the Government Regulation (PP) No. 104 of 2014 on the assessment of learning outcomes, the mastery learning is indicated by the achievement of the demeanor, knowledge and science lessons skills. An attempt to use the knowledge and understanding in solving the problems of everyday life aims to improve the quality of life and foster the idea. Students who can associate the learning with their daily phenomena tend to be a dynamic student in achieving the demands of the curriculum.

At the international level, Indonesia participates in Trends of International on Mathematics and Science Study (TIMSS), a four-year study conducted by the International Association for the Evaluation of Educational Achievement (IEA). Based on TIMSS, the science assessment consisted of two aspects, i.e. content and cognitive domains. These domains content includes subjects of chemistry, physics, biology, and earth science. While cognitive domains include aspects of knowing, applying, and reasoning. According to TIMSS data in 1999 about the ability of science student, Indonesia ranked at 32 out of 38 countries with an average score of 435. There was a decrease in score in 2003, Indonesia was at 37th position out of 46 countries with an average score of 420. Fluctuatively, in 2007, Indonesian ranked 35 out of 49 countries with an average score of 433. Lately, in 2011 Indonesia declined at 40th position out of 23 countries with a score of 406 and it categorized as Low International Benchmark (Martin M. O. et. al. 2012).

The study results of TIMSS show that Indonesian students currently in a very low category in the ability to understand complex information; low in theory, analysis and problem solving; the procedures and troubleshooting tool; as well as conducting the investigations (Kemendikbud, 2012a).

Preliminary studies conducted by researchers showed that students still have trouble in understanding the material taught. Therefore, there is a huge number of students who have not reached the minimum completeness criteria and the learning result is considered as low. Based on the test to measure the students' ability in the heat and temperature topic, 34 students met only 20% minimum completeness criteria. This statement is reinforced by the results of discussions with teachers of science who suggested that the low results of student science learning subjects are influenced by several factors, i.e. teachers find it difficult to implement a constructivist learning; students tend to be passive, where they always

wait the explanation from the serving teachers; (3) time limitation on preparing a learning device to complete the learning outcomes.

The application of science learning is where teachers are expected to select the appropriate learning models is important. It is with the hope that students can improve their ability of a concept. Problem solving is a model that can be used for achieving the learning outcomes. The implementation problem solving model encourages the student to think reflectively in teaching and learning process, since they will undergo the stages of learning, from the stage of formulating the problem, analysing problems, formulating hypotheses, collecting data and testing hypotheses, and also formulating troubleshooting recommendations. Problemsolving model for students is intended to embody the ability to solve their life problems skillfully and rationally according to the stages of logical process. Moreover, they can do it efficiently and it is expected to achieve the students' learning outcomes, where students are directly involved with the learning process experience.

METHOD

The research was conducted in class 5 SMP VII Batang Academic Year 2015/2016. The set of learning includes lesson plans, worksheets, BAS, and examination gradas conducted to VII A, B, and C where each class numbered 25 students. The development of learning sets was following the four-D models which were reduced to 3D (without dissemination). Moreover, the design of the trial was in one group pretest-posttest. The technique of data collection was the validation of the set, observations to obtain lesson plans achievement, student activities, demeanor, and skills, as well as the obstacles in learning. Moreover, the evaluation used to obtain data on learning outcomes of knowledge; and questionnaires were used to obtain data legibility of BAS and learning. Analysis of students' response used descriptive quantitative and qualitative approaches. Analysis of the learning set development results were conducted as follows:

Analysis of Learning Tool Quality

Learning device (RPP, BAS, LKS and Assessment of Learning Outcomes) was evaluated by a validator to proof its feasibility. RPP, BAS and LKS examined with instruments that have been developed. The learning outcome assessment formed a developed validated content, language and writing about the instrument. Data

validation results were analysed using descriptive qualitative approach. In this study, the acceptance limit of P was the average score of the assessment results of the validator, and then it was matched with the learning outcomes assessment criteria. The criteria for the assessment of learning outcomes by Ratumanan & Laurens, 2011, can be seen in Table 1.

Table 1. Criteria for the assessment of lesson plan, books, and student's worksheet

Interval of Score	Grading category
$3.6 \leq P \leq 4$	Very valid
$2.6 \leq P \leq 3.5$	Valid
$1.6 \leq P \leq 2.5$	Fairly valid
$1 \leq P \leq 1.5$	Invalid

(Source: Ratumanan & Laurens, 2011)

Analysis of Readability Level in Student's Book

Readability level set that has been developed through a textbook was in a form of students were given the instrument that contains materials of study. The readability of textbooks was analysed with a close procedure, where it is to divide the word of correct answer by the total number of words omitted then multiplied by 100%. The formula used is:

$$K_B = \frac{K}{\sum k} \times 100\% \tag{1}$$

Description:

K_B = readability level

K = correct answer of words

$\sum k$ = all words that must be filled

To get the value of the book readability, the readability test to students as responden was then analysed descriptively based on the level of readability. The result is presented in Table 2.

Table 2. Value of Set Readability (Textbook Student)

Score	Readability level
Test score > 60%	High
Test score 40%-60%	Fair
Test score < 40%	Low

(Source : Taylor in Winarni, 2011)

Analysis RPP Implementation

Observations were made by two observers to measure the implementation of lesson plan

where the implementation at each step was determined by comparing the average scale of assessment given the observer with the assessment criteria are presented in Table 3.

Table 3. Criteria Rate implementation RPP at every step

Implementation result	Category
$1 \leq P \leq 1.5$	Poor
$1.6 \leq P \leq 2.5$	Fairly Good
$2.6 \leq P \leq 3.5$	Good
$3.6 \leq P \leq 4$	Very Good

Analysis of Student Results

Based on data from posttest results and data analysis using descriptive and qualitative approach, the learning outcomes demeanor, knowledge, and skills are resulted as follows:

Values are given for the learning outcomes in the aspect of demeanor by two observers and a self-assessment of students is determined by the average, then the results obtained are matched with the assessment criteria. Results of learning knowledge and skills were measured based on the posttest, while the learning outcomes are using individual completeness and classical. When students can individually complete the learning achievement, the average achievement indicators which are represented if the learning objectives meet the minimum completeness criteria score (KKM) at 70, it is calculated as follows:

$$P_{individual} = \frac{\sum skor\ yang\ dicapai\ siswa}{\sum skor\ maksimum} \times 100\% \tag{2}$$

The learning outcomes completion classically can be measured using this formula:

$$P_{klasikal} = \frac{\sum siswa\ yang\ tuntas}{\sum seluruh\ siswa} \times 100\% \tag{3}$$

The classical learning is said to be completed when it meets $\geq 75\%$ students can achieve the minimum criteria.

Normalized Gain

The analysis of treatment data is to show the difference in students' knowledge before and after treatment. The student's learning outcomes were measured at pretest and posttest, it was calculated using normalized gain formula as follows:

$$\langle g \rangle = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}} \tag{4}$$

Table 4. Conversion, score, and learning outcomes predicate

Demeanor		Knowledge		Skills	
Modus	Predicate	Average score	Letter	Optimum achievement	Letter
4.00	SB	3.85-4.00	A	3.85-4.00	A
		3.51-3.84	A-	3.51-3.84	A-
3.00	B	3.18-3.50	B+	3.18-3.50	B+
		2.85-3.17	B	2.85-3.17	B
		2.51-2.84	B-	2.51-2.84	B-
2.00	C	2.18-2.50	C+	2.18- 2.50	C+
		1.85-2.17	C	1.85-2.17	C
		1.51-1.84	C-	1.51-1.84	C-
1.00	K	1.18-1.50	D+	1.18-1.50	D+
		1.00-1..17	D	1.00-1.17	D

(Permendikbud, 104 year 2014)

Table 5. Category of *normalized gain* <g>:

N-Gain Score	Criteria of Normalized Gain
N-Gain ≥ 0.70	High
0.30 ≤ N-Gain < 0.70	Fair
N-Gain < 0.30	Poor

(Hake,1999)

Analysis of Varian (ANOVA)

Statistical analysis was performed ANOVA test aims to determine the impact of learning on the third-class model of problem solving that is VII.A, VII.B, and VII.C. Hypotheses were tested include:

Ho = there is no difference in the impact of problem solving learning model in the classroom VII.A, VII.B, and VII.C.

Ha = there is a difference in the impact of problem solving learning model in the classroom VII.A, VII.B, and VII.C.

Hypothesis according J. Surapto (2009) formulated:

$$H_o : \sigma_A^2 = \sigma_B^2 = \sigma_C^2$$

$$H_a : \sigma_A^2 \neq \sigma_B^2 \neq \sigma_C^2$$

The decision made according to:

If Sig. < 0.05 then Ho is rejected

If Sig. ≥ 0.05 then Ho is accepted, or

If $F_{value} > F_{table}$, then Ho is rejected

If $F_{value} \leq F_{table}$ then Ho is accepted

Problem sensitivity

The sensitivity of the items index is a measurement of how well a matter of distinguishing between students who have received a lesson with students who have not received the lesson. Sensi-

tivity indices to have a range between 0 and 1. To calculate the sensitivity of the matter, we used the following formula.

$$S = \frac{R_A - R_B}{T} \tag{5}$$

Description:

Ra = The number of students who give correct answers in post-test

Rb = The number of students who give correct answers in pre-test

T =The number of students who join the test

Sensitivity index ranged at 0.00 to 1.00 is said to be sensitive to the effects of learning. Moreover, the sensitivity is increased when it is greater than or equal to 0.30 (Gronlund, 1977).

RESULT AND DISCUSSION

The learning set using a scientific approach with problem solving models have been developed by researchers and further validated by experts. The results are implemented in class VII A, B, C SMPN 5 Batang where each class numbered 25 students. Data obtained from the results of the validation and implementation of the learning set is described to determine the feasibility of the learning set and learning model and its impact on the student learning outcomes.

Results of Learning Set Validation

Data validation results are presented in the form of expert assessment in terms of content, construction, and language. The results of the validity assessment from some experts who are competent in the field of science teaching software development are presented in Table 6.

Table 6. Results of learning set validation

Learning set	Score	Category
RPP	3.80	Very valid
BAS	3.78	Very valid
LKS	3.86	Very valid
THB	3.78	Very valid
Process skills	3.76	Very valid
Demeanor learning outcomes	3.84	Very valid

Table 6 shows that the learning set developed by researchers was proved to have a good degree of validity. The learning set developed using a strong theoretical rationale basic and there was a consistency between the internal components of learning, content aspect, construction, and language learning that used to complete the learning outcomes of students.

Researchers distributed instrument legibility of textbooks students to know the extent to which students understand Textbook Student (BAS) has been studied, textbook for students to complete the incomplete word (dilesapkan). Results of the analysis of legibility BAS presented in Table 7.

Table 7. Readability of BAS classVII A, B, and C

Class	Readability BAS (%)
VII A	70.5
VII B	70.9
VII C	70.7

Lesson plan completeness

The results of lesson plan completeness in every aspect of the introduction, the core activities, the closing, time management and classroom atmosphere was measured at average to good. Following the statement of Dimiyati and Mudjiono (2009), the success of teachers in managing the learning process is indicated by learning environment as one factor that can affect the quality of learning observations. The results of completeness of learning set developed are shown in Table 8.

The completeness of lesson plan refers to the scientific approach of the problem solving model to formulate the problem (observed), analyze the problem (queries), formulate hypotheses, collect data (information gathering) and hypothesis testing (associate / process information), formulating troubleshooting recommendations (communicating).

Table 8. Lesson plan completeness

Class	Σ Lesson plan completeness score	Category
VII A	3.63	Good
VII B	3.71	Very good
VII C	3.77	Very good

At the first phase, apperception was delivered to motivate and communicate the learning goals to the students. The students were asked to explore living phenomena and to review the material that has been studied before. They were then directed to a phenomenon that is often experienced by students to formulate a problem (observation). As suggested by Nur (2008a), students who are motivated to learn something will have higher cognitive and thinking skills on studying the material. Therefore, students will understand and listen to the explanation properly. Slavin, 2011 stated that students learn best when the concept from their nearest development zone.

The second phase, based on the phenomenon that encourages students to analyze problems, students were then asked to submit questions related to the phenomenon. Newell and Simon (1970) suggested that problem solving must focus on questions. It is a question that is directed to the scope of the problem and the answer is a key principle to question which will expand problem-solving heuristic search theory. Jonassen (2011) states that problem arising is an activity to assemble all the information and a few relevant sentences or translations into an accurate understanding of the problem as a whole information. Students need to understand what is the real meaning in question in the problem.

The third phase of formulating hypotheses guide the students to formulate hypotheses for answering the problems where students are directed to identify the control variables, manipulation of variables and the response variable consistent with the cognitive constructivist by Piaget. Moreover, students were asked to organize the material and to recall information-related information that can be used to assist in integrating the new information for learning (Arends, 2013: 105).

The fourth phase was data collection and hypothesis testing (associating and processing the information) where students plan to work in steps. The hypothesis testing at this phase is in accordance with the opinion of cognitive psychology by John Dewey. In fact, the number of student at school will reflect the community, whereas classroom is a laboratory for invention and solving

real problems (Democracy and Education, 1916). The theory of constructivist by Vygotsky scaffolding proved that students more easily understand on the procedural knowledge, in which with the help of structured step at the beginning of the lesson. Then, it gradually transfers the responsibility for learning to the students to work on their referrals themselves. It is in line with the theory of Jerome Bruner; a learning model emphasizes the importance of helping students to understand the key ideas structure. The need for active involvement of students in the learning process takes place through personal discovery (Nur, 2008b: 24).

The fifth phase was formulating the troubleshooting recommendations (communicating) where students analyzed and evaluated learning outcomes by group discussion. Then, they presented in front of the class. At this phase, it served for strengthening a smaller given immediately generally have much greater compared to large gains were given delayed (Nur, 1998: 24). Dewey theory emphasizes the importance of reflective thinking and processes that should be used by teachers to help students acquire the skills and thought a productive processes.

In this study, student learning outcomes were divided into demeanor, knowledge and skill aspects. This is in accordance with the mandate of the curriculum in 2013 which states that the graduate competence includes qualified graduates capabilities ondemeanors, knowledge and skills aspects needs to be achieved from the educational unit from the level of primary and secondary education (Department of Education, 2013).

The results of students' knowledge competencies in this study was obtained by the test results which were underway to learn, and before the learning process, students were given by the the initial test (pretest). The results of student learning competencies on knowledge by pretest and posttest were analysed using Normalized Gain Score which shows the difference in students' knowledge before and after treatment. Results competencies knowledge data was taken on average VII A, B, and C are presented in Table 9.

The results of calculation of the learning outcomes by average of N-Gain knowledge of three classes with 75 students expressed at a highest number. This is according to Hake (1998) which states N-Gain can show differences in the understanding of students before and after being treated, the statement of Hake (1999) show that if $\langle g \rangle \geq 0.70$, it is categorized as "high gain".

Table 9. THB of knowledge

Class	Pretest	posttest	N-Gain	Category
VII A	35.00	86.80	0.80	High
VII B	41.00	89.60	0.84	High
VII C	41.20	91.80	0.86	High

These results are similar to the results of research that has been done by Liezza, N (2011), there is an increase in student learning outcomes in the experimental group after being treated with the approach of problem solving dengan calculation result a gain of 0.52. Each student has a different N-Gain (score improvement), this is because the cognitive abilities of each individual is different, students require time, guidance and direction to master concepts. According to the opinion of Piaget (in Slavin, 1994) who state that all students grow past the same sequence of development, but the growth is taking place at different speeds.

Based on Permendikbud number 104 on assessment of learning outcomes by educators on the elementary education and secondary education, the mastery in learning set with a mean score of 2.67. Also, the criteria of completeness are achieved when the students complete the basic competence minimum criteria at 66.7.

The completeness of individual was measured based on the results of knowledge learning by providing the knowledge achievement test in all students in grade VII.A, VII.B, and VII.C. During the pretest, the result achieved in the classical style was 0% and it was not complete, then when it was measured by classical posttest, it was 100% completed.

Test of variance (ANOVA = Analisis of Variance) was performed using N-gain achievement test score using tools SPSS.19 software. Data is presented in Table 10.

Table 10. Result of Analysis of Variance (ANOVA)

F value	Significance
2.018	0.140
$\overline{F\text{-table}(5\%, 2.72)} = 3.15$	

According to Table 10, based on F value it is concluded that H0 is accepted. There is no difference between N-Gain of VII.A, VII.B, and VII.C at significance level of 5%. It means that the problem solving learning model impacted consistently in three classes on student learning outcomes.

The completeness indicator is the most im-

portant thing to know the achievement of learning objectives. Based Permendikbud number 104 on assessment of learning outcomes by educators in primary and secondary education, the indicators of competency achievement is derived from the knowledge of basic competence. Moreover, competence achievement indicator uses the operational word and is used as a reference in determining the items. The percentage of achievement indicators is obtained by students in the pretest or posttest and it is divided by the maximum score multiplied by 100%. The average N-gain values of class VII A, B, and C is presented in Table 11.

Table 11. The average N-gain value of class VII A, B, and C

Class	Score percentage		N-Gain	Category
	pretest	posttest		
VII A	34.00	86.00	0.79	High
VII B	33.00	74.60	0.82	High
VII C	33.20	76.00	0.85	High

A test to measure the effect on student learning in problem solving is necessary to find the level of sensitivity. Interest sensitivity is employed to know the number of questions, and to measure whether the student is affected by the learning process or not affected. The equation used to calculate the sensitivity is the equation 3.9. The results of the sensitivity of class VII A, B, and C according to the learning results and the sensitivity analysis for the academic study are presented in Table 12.

Table 12. Students' sensitivity

Class	Sensitivity	Description
VII A	0.52	Sensitive
VII B	0.49	Sensitive
VII C	0.51	Sensitive

The level of sensitivity about the learning process can be seen in Table 12. It shows asensitive index of 0.32 to 0.76. This is consistent with the statement of W.J.Kryspin and J.T. Feldhusen in Groundlund (1981: 266) where some items were said to be sensitive to learning when ≥ 0.30 , the average index of sensitivity by researchers is worth at an average grade which is categorized as sensitive to learning.

In the realm of abstract skills assessment process skills, students are given the test one of the phenomena associated with the activities of the student in student activity sheet. The tests

were in a form of pretest and posttest before and after the learning process. The results of the test were then analysed using the Normalized Gain which shows the difference in students' knowledge before and after treatment. The learning outcomes assessment model of problem solving process can be seen in Table 13.

Table 13. Results of analysis of skills learning outcome

Class	pretest	posttest	N-Gain	Category
VII A	42.67	90.00	0.82	High
VII B	42.67	88.44	0.84	High
VII C	45.56	92.22	0.86	High

Students are successfully completing the learning process when they achieve the minimum value (B-) with a minimum score at 66.7. The process of learning affect the student's skills using practicum and guidance for students to observe phenomena like putting variables manipulation, response and control. Moreover, after 8 activities, the students have the trial skills of a good process. It is seen by the results of the N-gain of all classes with average at 0.84 which means as a high average category. This is similar to the discovery of the theory of Bruner (1996) that argues about the teaching of subjects is not only to produce a library but also induce the students to think for themselves to know the process and the product.

Learning outcomes competences demeanor in the learning process consists of spiritual demeanors and social demeanors. Assessment conducted by researchers at the spiritual demeanor of observation, assessment of social demeanors do a self-assessment. Students are said to be complete if the achievement of at least getting good value category (B). As for the analysis of demeanors presented in Table16 states that all students of class VII A, B, and C completed within the competence of demeanor.

Table 14. Results of demeanor score in learning

Class	Demeanor score and student's number	
	Good	Very Good
VII A	14	11
VII B	19	6
VII C	15	10

The results obtained from the four meetings showed100%completeness. The completeness is realized as indicators o demeanor. Trai-

ning in teaching social demeanor measures the curiosity, thoroughness and honesty adapted to the character of learning. It is conducted in the hope that students will have a great curiosity in learning. Therefore, when they face a difficult problem, students are eager to learn and sustain their study since the material of heat and temperature are always applied in everyday life. Accuracy in measuring the student learning required to use a measuring instrument which has a measuring scale that is well suited to train the student accuracy. Honesty, related to measurement with direct measurement of students directly or indirectly embedded honest demeanor with indicators honesty. This is in accordance with the opinion of Sulhan (2011) who state that to build character (demeanor) of a nation is not easy like turning back your hand. However, it does not mean that it is impossible. The results of demeanor assessment using an average value for the learning with only four meetings can not be used to infer the social demeanors of the students. Honesty means to the average value of the demeanor of each meeting. Then, it was converted to the value of the ideal demeanor, then students get their demeanors in accordance with the predicate, the assessment will continue at the next KD up to one semester and take place on the entire assessment of teachers. Therefore, at the end of the semester, it can be inferred demeanors of students' learning outcomes for one semester.

CONCLUSION

Based on the results of the learning set achievement test, data analysis, discussion, and the findings of the research, it can be concluded that the science learning using scientific approach with problem solving models are developed in compliance with the eligible criteria (validity, practicality, and effectiveness). The impact is consistent with the results of student learning. Researchers and teachers need to coordinate and further discuss the suggestion obtained from the observers after the learning process. Therefore, a problem solution is found in a common perception in order to improve future learning. Further research in the form of improving critical and creative thinking skills is needed.

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