International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 5, Issue 4, Special Edition: ICET Malang City, 2019

Effectiveness of Problem Based Learning for Improving Motivation and Critical Thinking Skills

Yanti Fitria[a], Ratmi Yetti[b], Risda Amini[c], Rifda Eliyasni[d]
[a b c d]Primary Education, Universitas Negeri Padang
Email: [a]yanti_fitria@fip.unp.ac.id, [c]risdamini@yahoo.co.id, [d]rifdaeliyasni@yahoo.com

Critical thinking is a learning process and it is not a question of natural ability. It is a process of dealing with a problem in life. The phenomenon of low motivation and critical thinking skills of primary school (SD) students at Plus Aisyiyah 1in Padang City is the subject of this research. The purpose of this research is to describe the improvment of the motivation of critical thinking ability of learners in science by using a Problem Based Learning model in the fifth year students at Plus Aisyiyah 1 Padang city. The type of research used is classroom action research implemented in two cycles, while using the Problem Based Learning model. The results of the study show an increase in the critical thinking skills of students by achieving a score of 9.27%. Thus the problem based learning model can improves students' learning competencies.

Keywords: *problem-based learning model, science learning, motivation, critical thinking skill*

Introduction

Humans are born with uniqueness by having different thoughts. But if everyone has the ability to think critically, then humans will be able to solve the problem in a simple way. Although the problem is very complicated, humans will be able to solve their own problems. The ability to think critically is a crucial part of life. Critical thinking is also a learning process and it is not a question of natural ability (Luke, 2000; Pari & Shor, 1999). It is a process of dealing with a problem in life. Preferably, it is taught from an early age to a child. Learning is a change from not knowing to knowing and the learning process will lead to the goal of learning itself.

Efforts to educate and teach commence from birth by introducing the simplest things through environmental stimuli, such as sound, colour, taste, shape, and so on. A subjects that utilises the environment as a source of learning is Natural Science. Science is developed through questioning and debate with other members of the community and it is effected by many elements, such as society, politics, socioeconomic factors, philosophy and religion. The nature of science assumes an important role in science lessons since it helps students in the process of developing scientific literacy (Akerson, Buzzelli, & Donnelly, 2010; Lederman & Lederman, 2014; Ryder, Leach, & Driver, 1999).

Science education conducted in elementary schools should be able to develop the thinking ability of to produce students who are able to think creatively and critically to the problems around them. Therefore, in science classes teachers should provide direct experience for learners so that learning is meaningful (Duron, Limbach, & Waugh, 2006; Maudsley & Strivens, 2000; Nosich, 2005). Science is a subject that is important to understand because it is close to children, and there is no need to use expensive tools to learn it. Teachers can teach through simple practice with learning-based discovery and facilitate learners to be able to make observations and discussions where learning requires equipment and materials. Thus the teacher must also know the relevant procedures, concepts and skills (Susanto, 2013). With such learning it is expected that learners will have high motivation and ability to think in the learning activities.

The observations made in Plus Aisyiyah 1 Primary School in Padang city, emphasises the aspects of knowledge and understanding of the material. Teachers give more exercises on the task sheets or package books and this leads to poorly developed thinking skills in problem solving and application of concepts in the real world. Classroom learning is visible when asked and only a few students answer questions from teachers. The role of students in the learning process is still lacking. This is seen in that only a few learners show liveliness in the classroom by giving opinions and asking questions. The questions asked by the students have not shown critical thinking related to the material. The answers to the questions are limited to memory and understanding only, There is no attitude of learners who give well analysised to the teachers' questions. Learners are also not used to problem solving before investigation activities. If problem solving is applied in learning, then the learners can be trained to get used to self-critical thinking independently.

Learners are also not used to problem solving before investigation activities. If problem solving is applied in learning, then learners can be trained to self-critical think independently. Through observations of the implementation of the learning process, teachers only explain the material to learners, however students do experiments to develop the ability to think. Because learners do not understand the lessons they experience, there is less motivation to learn. The tendency of learning to be monotonous results in students having a lack of eagerness in the classroom.

As the learning process becomes less interesting and meaningful for learners, the results of science learning students class V SD Plus Aisyiyah 1 Padang District Nanggalo Padang is low. This is seen from the lower than expected standard of learning outcomes by students. The results are below the score of mastery learning (SML) with an average score of 60. Of the 21 students only 7 people who reached the SML, while 14 people are still under defined by the school that is 72.

One learning model that is able to motivate learners and develop the potential of learners to think critically, creatively, innovatively, and systematically is a Problem Based Learning (PBL) model. Problem Based Learning model effectively improves the critical thinking skills of learners in facing the problems presented during the learning process (Kauchak,

Eggen, & Kirk, 1978). Problem-based learning is usually defined as a learning method in which students are given ill-structured problems and they try to put forward meaningful solutions to these problems. It is important that this becomes the basis of the learning process, because it determines the direction of the learning process and emphasises the formulation of a question rather than an answer. There are seven steps in using this PBL model, among others. The seven steps are clarifying the concept; defining problems; analysing problems; finding the explanation; formulating learning objectives; finding more information; and reporting and testing new information (Kolmos, 2017).

PBL education builds on the students' backgrounds, expectations, and interests. It is common for students to be motivated to work much harder with the PBL model than with traditional teaching methods. In general, students spend more time on their studies when working with a PBL model than with traditional models. Student participation is considerably less in conventional courses, where the students have no say in the problem formulation. Students are more motivated in this type of learning because of problem solving and students are more actively participating in all of the learning steps in the classroom. However the use of this PBL model requires a long time (Chin & Chia, 2004; Kolmos, 2017).

Problem Based Learning Model has the advantages and disadvantages of the model already mentioned above. The weakness of PBL model are: (1) students have no interest or no belief that the problem can be solved, then they will feel reluctant to try; (2) the success of the learning model through Problem Based Learning requires sufficient time for preparation; (3) without understanding why they are trying to solve the problem being studied, then they will not learn what they want to learn (Sanjaya, 2006).

The question of this research is “what is the effectiveness of learning action model of Problem Based Learning toward increasing motivation and critical thinking skill (CTS) of the fifth grade students in Plus Aisyiyah 1 Primary School in Padang city?” The purpose of this study is to describe the effectiveness of Problem Based Learning model in improving student’s motivation and critical thinking skills,

Research methods

This study uses a classroom action research design and has been implemented in Plus Aisyiyah 1 Primary School in Padang city. The study was conducted in two cycles and each cycle consisted of two meetings of 2 x 35 minutes per meeting. Classroom action research procedures applied include the stages of activities in each cycle of planning, implementating, observinh, and reflecting.

The subjects of this study were teachers, and the students of the fifth grade class in primary school in the academic year 2015/2016. This research focuses on improvement of motivation and critical thinking skills of primary school students. Motivation data and CTS were collected by an instrument questionnaire and observation sheet.

Data obtained in the study was analysed by using qualitative and quantitative analysis. Qualitative data was analysed with data analysis model offered by Milles and Hubberman (Creswell & Poth, 2016; Hashimov, 2014; Sugiyono, n.d.). That data analysis begins by reviewing data until all the data is collected. The data is reduced based on the problem of the study, followed by the presentation of the data and finally a conclusion of the research result. Data analysis in this study include, (1) Data about the implementation of science learning using Problem Based Learning and (2) Data about students' critical thinking skills in science learning (Arikunto, 2013; Huraerah, 1993). Increased motivation and critical thinking skills of each learner can be analysed by using a quantitative approach with the following formula:

$$NP = \frac{R}{SM} \times 100\%$$

Information :
NP : Percentage value searched
R : The raw score obtained
SM : The ideal maximum value
100 : Fixed numbers

Score A (very good) 86 - 100%; score B (good) 76 - 85%; score C (enough) 60 - 75%; score D (less) ≤ 59 %. (Huraerah, 1993)

The study observed the behaviours and activities performed by learners using field notes filled with the teacher with a checklist, then the results are scored with numbers. The value of learning motivation of learners per indicator was found by using the following formula:

$$N = \frac{R}{JS} \times 100\%$$

(Total number of learners)
Assessment Guidelines
85% -100% = very good (SB)
70% - 84% = good (B)
55% -69% = enough (C)
<54% = less (K)

If ≥ 75% of the number of learners received a score of 70 or more (good qualification) then the motivation of learners has increased and the research is successful. For data analysis of learning management by the teacher is the observation of teacher action to see process and development that happens during the learning progress. This data is analysed by percentage. A teachers learning process management is said to be good if teachers observed aspects of the learning process and obtained a percentage of ≥70%.

After obtaining the percentage of teacher activities in managing learning at each meeting is calculated. If the average rate of cycles reaches 70%, then the activities of teacher management the learning is considered good. Analysis of observational data of critical thinking ability includes; (1) providing simple explanations include focusing questions, analysing questions, asking questions and answering explanations, seeking similarities and differences, (2) building basic skills including considering resources, observing, reasoning skills, noting things that are urgently needed, (3) concluding by deducting and considering the results of deduction, inducing and considering induced results, making and determining outcomes, considering alternatives, (4) further explaining including defining terms, identifying assumptions, giving examples, giving reasons, explaining further, (5) managing strategies and tactics including defining problems, selecting possible criteria as problem solving solutions, formulating alternatives to solutions, and presenting (Ishtiaq, 2019; Steen, 1997).

Research result

Research findings include activities undertaken from the process of planning, implementating, observing, and reflecting in accordance with the research procedures. In implementating action learning, researchers actred as teachers while the classroom teacher acted as observer (observer). Learning in cycle 1 was observed by 2 observers, ie researchers (observer 1) observed the motivation of learning and the ability of ktiris and teacher thinking (observer 2) observed the process of teachers and the activities of pesertra. Observers note the course of the implementation of learning and use teacher observation sheets.

Learning Process Activity

Results of the outcome of teaching activities of teachers Cycle I as a whole obtained an average of 70% with enough interpretation and an increase in cycle II with an average of 88% with a very good interpretation with a score increase of 22%. This indicates that the teacher as a facilitator has the ability to select an effective learning model which will improve critical thinking skills and increase learners motivation. From the activities undertaken by teachers, their efforts to encourage learning by using PBL model is clear.

The result of observation of the student's activity as a whole is obtained from the increase of cycle I with average 69% and in cycle 2 with average 86% with very good category. Based on the improvement obtained it can be said that mamfaat PBL model can motivate learners. The PBL model can help learners to develop critical thinking skills (Cheng, Canuto, & ..., 2002; Mosier, Gulizia, Baird, Wilson, & ..., 1991; Whitehurst & Lonigan, 1998).

The learning process that was carried out was preceded by the implementation of learning according to the guidelines for the design of learning. The results of the observations of teacher activity in the first cycle of first meeting was 65.71% to 74.25%, and in the second cycle this increased from 85.82% to 91, 42%. Observations on the activities of learners in first cycle increased from 62.50% to 75%. In the second cycle it increased from 83.92% to 89.28%. Increased teacher activity in implementing the stages of problem-based learning shows that the learning process that uses the Problem Based Learning model on science learning can be applied, as evidenced by the increase in activity by 22%.

There was a 17% increase in learning activities of learners. This is in accordance with the characteristics of Problem Based Learning model. The characteristics of Problem Based Learning are as follows: (1) problem-centered learning, (2) the problem used is a real world issue that participants may encounter in their professional work in the future, and (3) the knowledge expected by the participants in the learning process is based on the problem (Ertmer & Simons, 2006; Gauduin, Parren, Weir, Barbas, & ..., 1997; Park & Ertmer, 2007). PBL is a teaching methodology that uses problems as the starting point for the development of students' new knowledge. Students learn while searching for solutions to those problems, learning is purposeful and self-motivating. Students are actively involved and learn within the context in which knowledge is to be used. The role of the teacher is to facilitate this process of problem. (Chin & Chia, 2004)

Motivation to Learn

Student motivation data at cycle I and II was collected by a questionnaire sheet by the learner and an observation sheet filled out by the observer. Questionnaires summarises as many as 20 items from the questionnaire items. Motivated learners are at 90%. While learners who have motivation with very good criteria is 10% (two students are RK and VPR). 66.20 was found in the first meeting and second meeting. The average learner is motivated by a questionnaire score of magnitude while in second cycle obtained an average of 66 and 79 for the meeting. The research results also show that the achievement of intrinsic motivation and extrinsic motivation is 59 and 70 at first meeting. The results of the average score of intrinsic and extrinsic motivation are 60 and 72. The result of intrinsic motivation and extrinsic motivation score in second cycle obtained the number of 60 and 72 (first meeting) whereas in the second meeting obtained the average data of motivation questionnaire score of 79. Learners who have motivation with very good criteria is RK and VPR.

Table 1.The Result of Content of Intrinsic and Extrinsic Motivation the First Cycle

Dimension of motivation	Score		Interpretation	
	Pt1	Pt2	Pt1	Pt2
Intrinsic	59	60	K	K
Extrinsic	70	72	C	B
Sum	129	132		
Average	64	66	C	C

The observation aspect is filled on the observation sheet of the learning motivation in the learning process using the PBL model, (a) observing the displayed media images, (b) asking questions about the contextual problems presented, (c) sitting in groups regularly, (d) present the results of the science lessons given by the teacher, (e) present the results or respond to them, (f) summarise the final outcome of the problem solving, (g) make the report, (h) working on the evaluation provided.

The results clearly, show that the motivation of learners in science learning with PBL model is in sufficient criteria in the first cycle and criteria is very good in second cycle with score of 67.66 in cycle I and 93.11 in cycle II. This can be observed only in the aspect of doing the evaluation, given the learners are motivated because the value of 100 in which all learners are motivated to carry out the evaluation provided. However doing the evaluating learners in is important to do the evaluation without considering about the results obtained, but nine other aspects of the participants. From observation of the motivation cycle II results show that learners have the motivation to learn with percentage 93.11% with very good criteria.

Table 2. The Results of Intrinsic and Extrinsic Motivation in The Second Cycle

Dimension of motivation	Score		Interpretation	
	Pt1	Pt2		Pt1
Intrinsic	60	79	K	B
Extrinsic	72	79	B	B
Sum	132	132		
Average	66	79	C	B

Table 2 shows that the motivation questionnaire in the second cycle imcreased from the first cycle. In the first cycle of 11 statements obtained value ≥70 with 52%. While in the second cycle of 20 statements on the motivation questionnaire obtained the value of ≥70. This is

based on the questionnaire that the motivation of learners have increased and the research is successful. Learners have a good motivation with the average value obtained for each aspect that is above 70. On observation of motivation, the second cycle results show that learners have the motivation to learn with the percentage of 84.69% with good category, where more than 75 % of learners got a score of ≥70 (good qualification). In this instance the motivation of learners has increased and the research is successful.

PBL is considered to be very important in science teaching since it may enhance the emotional domain of the students' learning process, improve their performance on complex tasks, and foster a better knowledge retention (Aiuti et al., 2002; Alkhasawneh, Mrayyan, Docherty, & ..., 2008; Allen, Donham, & Bernhardt, 2011; Choi, 2004; Strobel & Barneveld, 2009). In experimental activities learners cooperate and communicate among each other in solving the problem. In the activity of developing and presenting the results of the inquiry, the learner looks active to listen to other groups presenting reports and other learners respond.

During the learning process in first cycle and second cycle the motivation of learners increased. This is evidenced by the active learners in the group discussing, asking questions, cooperating with members of the group to find solutions to the problems posed, and are able to do the evaluation very well. PBL learning model can make learning more meaningful for as they become stronger in themselves as they find their own learning solutions to problem solving. Learners are directed to be actively involved in efforts to solve the problems.

Critical Thinking Skill (CTS)

Learners who have critical thinking skills (CTS) with very good category namely MAH, RK, VPR. The average score obtained by learners in the assessment based on the observation of the critical thinking ability of learners can be seen in Table 3.

Table 3. Recapitulation of Observation Results Overall Critical Thinking Skill.

Average Score	**Observation**	
	Pt1	**Pt2**
First cycle	60.47	65.23
Average	60.35	
Second cycle	72.62	77.61
Average	75.11	
Criteria	Good (B)	

The data presented in the table above shows that in the first cycle of the acquisition of students' critical thinking ability reaches an average score of 60.35, while in second cycle there is an increase to the average gain of 75.11 (meet the criteria of Good/B). The aspects observed for the assessment of critical thinking skills consist of: (a) providing a simple explanation, (b) building basic skills, (c) concluding, (d) explaining further, (e) managing strategies and tactics.

Discussion

Stages of the PBL process are able to demonstrate students' overall critical thinking skills by increasing the average score from first cycle to next cycle (60.35 to 75.11). This means that with the PBL model increased the critical thinking ability of learners is 13.55%.

The results show that the indicator of achievement of the CTS with the highest score at the end of the cycle is indicated a (focus the question) is above the score of 75. The achievement of the 50-70 score range is indicated by indicators b.d, and e (ask and answer about explaining further, and organising strategies and tactics). For indicators looking for similarities and differences in average scores below 50 scores. In other words of the five indicators CTS observed during the process. The indicator focuses the question of showing the highest score. With the students learning based on problems, self-study and group seeking problems are important to improve the sharpness of thinking with the appearance of almost all learners able to focus questions that will be answered and discussed in the presentation stage of the work. To increase the coping ability students need critical thinking

skills to cultivate flexibility and creativity in decision-making and problem solving. Critical thinking is the process of searching, obtaining, evaluating, analysing, synthesising and conceptualising information as a guide for developing one's thinking with self-awareness, and the ability to use this information by adding creativity and taking risks (Ennis, 2011; Hooks, 2010; Luke, 2012; McPeck, 2016; Paul & Binker, 1990). PBL can accommodate this. In fact,rarely teachers apply the model of PBL students have not been trained.

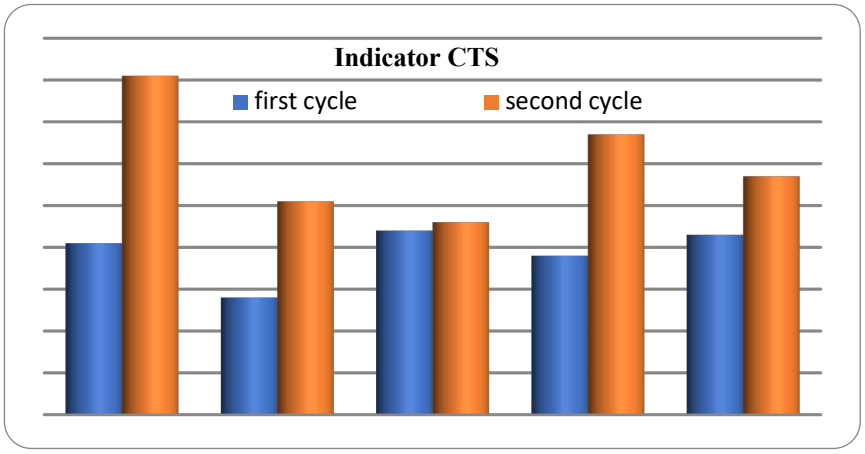

Figure 1. Average Score Achievement of each Indicator CTS in cycles

The definition for critical thinking, formulated by The American Philosophical Association is that we understand critical thinking to be purposeful, self-regulatory judgment that results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteriological, or contextual considerations upon which that judgment is based (Hobbs, 1999).

These results indicate that teacher can still maximize students' perceived gains of critical thinking by giving more assignments or exams that require students to compare and contrast diverse perspectives as well as by providing more frequent feedback on these assignments through PBL (Kolmos, 2017; Prince, Eijs, Boshuizen, & ..., 2005; Strobel & Barneveld, 2009). Learners have demonstrated good critical thinking skills with the ability to ask questions, give ideas, analyse, present and conclude solutions of problems. Although not shown from the scores, but with the increase of the score from cycle to cycle it has shown that the PBL model can improve thinking ability Critical learners (Black, 2018; Facione,

Sanchez, Facione, & ..., 1995; Hooks, 2010). They are active, creative and have the initiative to take the necessary action in an effort to troubleshoot the problem.

Conclusion

Learning by using PBL model in the fifth grade in Plus Aisyiyah 1 primary school in Padang city has shown the result of improving the process of teacher and students activity. This is evidenced by the observations of teachers and learners. Motivation to learn and skills and critical thinking skills of learners also showed improvement despite not reaching above 50%. This need to be realised by teachers to always be trained to them how to develop the potential of thinking through learning model PBL. Teachers should be able to facilitate learners to diligently understand the problem. The advantage of this model is that learners are invited directly to solve problems with the orientation stages of the problem, organise learners, guide individual and group investigations, develop and present the work and evaluate and analyse the problem-solving process. Problems displayed are the problems that exist in everyday life and are close to learners in this model. Learners are invited to work together and make the lessons fun. The use of this model allows learners to work with friends, guide friends and help friends in the process of troubleshooting.

Based on the results of research on the use of PBL model on science learning to improve learning motivation and critical thinking ability of learners, the researcher suggested that: 1) Elementary school teachers can apply learning using this PBL model in the science-learning process, perhaps even in other learning materials, 2) Schools can make the results of this study as one model of learning to increase learning motivation and critical thinking skills of students, 3) The principal should identify the teacher's ability to use the learning model and the model that can be an alternative for the principal to teacher, 4) For Teachers Working Group (TWG) in order to schedule workshop on the use of PBL model in learning.

References

Aiuti, A., Vai, S., Mortellaro, A., Casorati, G., Ficara, F., & ... (2002). Immune reconstitution in ADA-SCID after PBL gene therapy and discontinuation of enzyme replacement. *Nature Medicine*. Retrieved from https://www.nature.com/articles/nm0502-423

Akerson, V. L., Buzzelli, C. A., & Donnelly, L. A. (2010). On the nature of teaching nature of science: Preservice early childhood teachers' instruction in preschool and elementary settings. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *47*(2), 213–233.

Alkhasawneh, I. M., Mrayyan, M. T., Docherty, C., & ... (2008). Problem-based learning (PBL): assessing students' learning preferences using VARK. *Nurse Education ….* Retrieved from https://www.sciencedirect.com/science/article/pii/S0260691707001426

Allen, D. E., Donham, R. S., & Bernhardt, S. A. (2011). Problem-based learning. *New Directions for Teaching and Learning*, *2011*(128), 21–29.

Arikunto, S. (2013). Prosedur penelitian atau pendekatan praktik. *Cet XV*.

Black, M. (2018). *Critical thinking: An introduction to logic and scientific method*. Retrieved from https://books.google.com/books?hl=en&lr=&id=C1ykDwAAQBAJ&oi=fnd&pg=PT6&dq=critical+thinking&ots=Qv7CYCH-I9&sig=8pzy6ZbQKeoAeQdBDHD386pnTGg

Cheng, Y., Canuto, V. M., & ... (2002). An improved model for the turbulent PBL. *Journal of the Atmospheric ….* Retrieved from https://journals.ametsoc.org/doi/abs/10.1175/1520-0469(2002)059%3C1550:AIMFTT%3E2.0.CO

Chin, C., & Chia, L.-G. (2004). Problem-based learning: Using students' questions to drive knowledge construction. *Science Education*, *88*(5), 707–727. https://doi.org/10.1002/sce.10144

Choi, H. J. (2004). The effects of PBL (Problem-Based Learning) on the metacognition, critical thinking, and problem solving process of nursing students. *Journal of Korean Academy of Nursing*. Retrieved from https://synapse.koreamed.org/search.php?where=aview&id=10.4040/jkan.2004.34.5.712&code=1006JKAN&vmode=FULL

Creswell, J. W., & Poth, C. N. (2016). *Qualitative inquiry and research design: Choosing*

among five approaches. Sage publications.

Duron, R., Limbach, B., & Waugh, W. (2006). Critical thinking framework for any discipline. ... *Journal of Teaching and Learning in* .... Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.503.9461&rep=rep1&type=pdf

Ennis, R. (2011). *Critical thinking*. Retrieved from https://philpapers.org/rec/ENNCT-3

Ertmer, P. A., & Simons, K. D. (2006). Jumping the PBL implementation hurdle: Supporting the efforts of K-12 teachers. *Interdisciplinary Journal of Problem* .... Retrieved from https://docs.lib.purdue.edu/cgi/viewcontent.cgi?article=1005&context=ijpbl

Facione, P. A., Sanchez, C. A., Facione, N. C., & ... (1995). The disposition toward critical thinking. *The Journal of General* .... Retrieved from https://www.jstor.org/stable/27797240

Gauduin, M. C., Parren, P., Weir, R., Barbas, C. F., & ... (1997). Passive immunization with a human monoclonal antibody protects hu-PBL-SCID mice against challenge by primary isolates of HIV-1. *Nature Medicine*. Retrieved from https://www.nature.com/articles/nm1297-1389

Hashimov, E. (2014). Qualitative Data Analysis: A Methods Sourcebook and The Coding Manual for Qualitative Researchers. *Technical Communication Quarterly*, *24*(1), 109–112. https://doi.org/10.1080/10572252.2015.975966

Hobbs, R. (1999). *The seven great debates in the media literacy movement.* Retrieved from https://eric.ed.gov/?id=ED439454

Hooks, B. (2010). *Teaching critical thinking: Practical wisdom*. Routledge New York.

Huraerah, A. (1993). Purwanto. 2006. *Dinamika Kelompok, Konsep Dan Aplikasi*.

Ishtiaq, M. (2019). Book Review Creswell, J. W. (2014). Research Design: Qualitative, Quantitative and Mixed Methods Approaches (4th ed.). Thousand Oaks, CA: Sage. *English Language Teaching*, *12*(5), 40. https://doi.org/10.5539/elt.v12n5p40

Kauchak, D., Eggen, P., & Kirk, S. (1978). The effect of cue specificity on learning from graphical materials in science. *Journal of Research in Science Teaching*, *15*(6), 499–503. https://doi.org/10.1002/tea.3660150609

Kolmos, A. (2017). PBL Curriculum Strategies: From Course Based PBL to a Systemic PBL Approach. In *PBL in Engineering Education* (pp. 1–12). Brill Sense.

Lederman, N. G., & Lederman, J. S. (2014). *Research on teaching and learning of nature of science*.

Luke, A. (2000). Critical literacy in Australia. *Journal of Adolescent and Adult Literacy*. Retrieved from http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.600.3812&rep=rep1&type=pdf

Luke, A. (2012). Critical literacy: Foundational notes. *Theory into Practice*. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/00405841.2012.636324

Maudsley, G., & Strivens, J. (2000). Promoting professional knowledge, experiential learning and critical thinking for medical students. *Medical Education*. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1046/j.1365-2923.2000.00632.x

McPeck, J. E. (2016). *Critical thinking and education*. Retrieved from https://content.taylorfrancis.com/books/download?dac=C2016-0-00708-7&isbn=9781315463681&format=googlePreviewPdf

Mosier, D. E., Gulizia, R. J., Baird, S. M., Wilson, D. B., & ... (1991). Human immunodeficiency virus infection of human-PBL-SCID mice. …. Retrieved from https://science.sciencemag.org/content/251/4995/791.short

Nosich, G. M. (2005). *Learning to think things through: A guide to critical thinking across the curriculum*. Pearson/Prentice Hall Upper Saddle ….

Pari, C., & Shor, I. (1999). *Critical literacy in action: Writing words, changing worlds*. Boynton/Cook Publishers.

Park, S. H., & Ertmer, P. A. (2007). Impact of problem-based learning (PBL) on teachers' beliefs regarding technology use. *Journal of Research on Technology in* …. Retrieved from https://www.tandfonline.com/doi/abs/10.1080/15391523.2007.10782507

Paul, R. W., & Binker, A. J. A. (1990). *Critical thinking: What every person needs to survive in a rapidly changing world.* Retrieved from https://eric.ed.gov/?id=ED338557

Prince, K., Eijs, P. Van, Boshuizen, H. P. A., & ... (2005). General competencies of problem-based learning (PBL) and non-PBL graduates. *Medical* …. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1365-2929.2005.02107.x

Ryder, J., Leach, J., & Driver, R. (1999). Undergraduate science students' images of science. *Journal of Research in Science Teaching: The Official Journal of the National Association for Research in Science Teaching*, *36*(2), 201–219.

Sanjaya, W. (2006). *Strategi pembelajaran berorientasi standar proses pendidikan*. Jakarta: kencana.

Steen, L. A. (1997). *Why numbers count: Quantitative literacy for tomorrow's America*. Retrieved from https://halshs.archives-ouvertes.fr/hal-00699761/

Strobel, J., & Barneveld, A. Van. (2009). When is PBL more effective? A meta-synthesis of meta-analyses comparing PBL to conventional classrooms. *Interdisciplinary Journal of* .... Retrieved from https://docs.lib.purdue.edu/ijpbl/vol3/iss1/4/

Sugiyono, P. (n.d.). Dr. 2010. *Metode Penelitian Kuantitatif, Kualitatif, Dan R&D. Bandung: CV Alfabeta*.

Susanto, A. (2013). *Teori belajar dan pembelajaran di sekolah dasar*. Jakarta: Kencana prenada media group.

Whitehurst, G. J., & Lonigan, C. J. (1998). Child development and emergent literacy. *Child Development*. Retrieved from https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-8624.1998.tb06247.x