



The Effect of Enrichment in The Concept of Pascal-Laws Based on STEM Education on Critical and Creative Thinking Skills of 8th Grade Student

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Abstract

The Research about investigation of The Effect of Enrichment in the Concept of Pascal-laws Based on STEM Education on Critical and Creative Thinking Skills of 8th grade Students are conducted as an effort to follow up the lack of development of Critical and Creative Thinking Skills on the students. The research was conducted using weak experiments designs, the type of the one group pretest-posttest designs and involved eighth graders aged between 14-15 years as research subjects for five meetings. The data was obtained through student worksheets and observations. Data processing to see N-Gain was used Microsoft Excel 2007 and the results showed that there was an increase in the percentage of critical thinking skill score from 58% (pretest) to 89% (post-test) with high category increase (N-gain.0.74). while student creativity also rise from 15% (pretest) to 81% (post-test) with moderate category increase (N-gain.0.68). Students' creation tools on STEM's educational enrichment program are Hydraulic Glass Cleaners.

Keywords: Critical thinking skills, creative, enrichment program, STEM education, Pascal Law

Pengaruh Kegiatan Pengayaan pada Konsep Hukum Pascal Berdasarkan Pendidikan STEM pada Keterampilan Berpikir Kritis dan Kreatif pada Siswa Kelas 8

Abstrak

Penelitian ini bertujuan untuk melakukan investigasi terhadap pengaruh kegiatan pengayaan pada konsep Hukum Pascal berdasarkan Pendidikan STEM pada keterampilan berpikir kritis dan kreatif pada siswa kelas 8. Penelitian ini dilakukan sebagai upaya untuk mengatasi rendahnya keterampilan berpikir kritis dan kreatif para siswa. Metode penelitian yang digunakan adalah metode eksperimen semu dengan desain one group pretest-posttest dan melibatkan delapan siswa berusia 14-15 tahun sebagai subjek penelitian selama lima kali pertemuan. Data diperoleh melalui lembar kerja siswa dan observasi. Analisis data untuk melihat N-Gain menggunakan Microsoft Excel 2007. Hasil penelitian menunjukkan terdapat peningkatan persentase keterampilan berpikir kritis dari 58% (pretes) menjadi 89% (postes) dengan kategori peningkatan tinggi (N-gain.0.74). Sedangkan, kreatifitas siswa juga meningkat dari 15% (pretes) menjadi 81% (postes) dengan kategori peningkatan sedang (N-gain.0.68). Alat yang dibuat siswa dalam program pengayaan pendidikan STEM adalah Pembersih Kaca Hidrolik.

Kata kunci: Keterampilan berpikir kritis, kreatif, program pengayaan, pendidikan STEM, Hukum Pascal

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INTRODUCTION

The teaching process is an information and environmental arrangement that facilitates the learning in order students can develop new knowledge, skills or attitudes through interaction with information and environment ([Departemen Pendidikan Nasional, 2005](#)). The success of the teaching process can be measure done of them with the value of assessment or evaluation. This value can be a picture of students' absorption and class absorption of a given concept.

The learning process is called successful if the students' absorption on a concept reaches the Minimum Exhaustiveness Criteria (KKM). In one class, the level of achievement of learning belief criteria is divided into three groups of achievement, that is students who scored below KKM, reach KKM and exceed KKM. Three groups of students are given different services. Students who scored below KKM received remedial services. Students who have fulfilled the KKM score undertook the learning process for the next concept, while the students whose daily test score exceeded the KKM got the enrichment service.

Currently more teachers are doing a remedial service for students who get daily test scores under the KKM, whereas students who get the scores above KKM rarely or even do not get enrichment services. Students who score above the KKM have a high potential for cognitive abilities. If this student's potential is not developed then it will be lost.

One reason that enrichment services are not done because teachers have difficulty determining appropriate models or approaches. Appropriate models or approaches for students with high cognitive ability must be challenged. One approach that challenges high-thinking students is STEM education.

Science, Technology, Engineering and Mathematics Education

Science, Technology, Engineering and Mathematics (STEM) education is a problem-based learning that places scientific investigation and application of mathematics in the context of designing technology as a form of problem solving. In general, scientific inquiry education is rare in technological education and the activity of technological design is rarely happened a science class. But in everyday life design and scientific inquiry are routinely used simultaneously as technical solutions to real-world problems ([Sanders, 2009](#)). As an emerging trend in education, STEM is used to address real-world situations through a process-based design of problem-solving as used by engineers and scientists ([Williams, 2011](#)). Some of the benefits of STEM education are making students a problem solver, inventor, innovator, independent, logical thinker, technology literate, able to link culture and history with education, and be able to connect STEM education with the world of work ([Morrison, 2006](#)).

Implementation of STEM education in the daily learning process is still constrained by the heterogeneity of cognitive abilities, interests and talents of students. Not all students are enjoy and interested in science. Therefore researchers are trying to develop STEM education not in regular class but classes in enrichment program.

Enrichment

Competency-based curriculum gives meaning that the education process must be able to deliver the students to master with the predefined standards. National standards have a mission to make education excellence and equitable for all. Students learn in their own way to achieve that standard. Competency-based curriculum relies on social reconstruction and technology, meaning learning is done by emphasizing individual interaction with the environment so that students can gain their own knowledge (self-regulated). The learning which done in the classroom should be able to help the students to understand the meaning of knowledge through methods that give creation to find. Students are trained to be able to have high competitiveness with a number of competitors in the community. Assessments in a curriculum based on competency consist of grade assessment, basic skills tests, final

assessment of educational units and certification. Classroom assessments are conducted by the teacher to determine the level of progress and student learning outcomes, diagnose learning difficulties, provide feedback on the learning process, and the determinants of classroom increases (Susilana, 2009). The results of the class assessment can be used as the basis for the preparation of improvement programs and enrichment programs.

The form of enrichment program can be either deepening or extending the concept that has been learned in the lesson material presented. The deepening or extension of this concept is not taught in the next unit of lesson units. The enrichment program can also add some activities that have not been included in the subject lesson. These activities may include activities relating to socio-cultural activities that not be related to the subject matter or activities that are still within the scope of the subject matter. Motivate, attract and challenge students to gain additional knowledge (Suryosubroto, 1997). But now science teachers still rarely use the enrichment program as expressed by the Suryosubroto. In general, science teachers do not have enrichment programs for students who have values that exceed KKM. Some science teachers who have enrichment programs contain only exercise questions. Therefore, it is necessary to develop enrichment program that can develop students' competence which exceeds KKM value even better. Based on this STEM education is very suitable for use on enrichment program. Through STEM education students are expected to practice developing critical thinking skills and creative which is a skill that must be owned by 21st century students.

Critical Thinking and Creation

Krulik and Rudnick (1995) make the reasoning divide that is part of thinking. The rate is above remembering. In reasoning categorized in basic thinking, critical thinking and creative thinking. The category is not discrete and is very difficult to define precisely. Critical Thinking is a reasonable, or reasonably-based, reflective thinking way to determine what to do and believe. Wade (1995) identifies eight critical thinking characteristics, which include: Formulate questions, Restricting problems, Testing data, Analyze various information, Avoiding highly emotional considerations, Avoid over-simplification, Consider various interpretations, Tolerate ambiguity.

Johnson (2002) explains that critical thinking organizes processes used in mental activities such as problem solving, decision making, convincing, analyzing scientific assumptions and discoveries. Critical thinking is an ability to reason in an organized way. Critical thinking is also an ability to systematically evaluate the quality of self-thinking and others. Creative thinking is a mental activity that considers authenticity and insight (idea). Thinking critically and creatively allows students to study the problem systematically, bringing together many challenges in an organized way, formulating innovative questions and designing or designing original solutions. Creative thinking as opposed to destructive thinking involves searching for opportunities to change things for the better. Creative thinking does not explicitly organize processes, such as critical thinking. Creative thinking is a habit of sharp thinking with intuition, moving imagination, revealing new possibilities, unveiling amazing ideas and inspiring unexpected ideas. This understanding distinguishes firmly from creative thinking and critical thinking. Creative thinking involves intensive production that meets newness, one is said to be creative when it comes to making something new, even if something new has been produced by others, it can still be said to be creative (Weisberg, 2006). A person's creativity can help in solving problems.

Fluency in problem solving refers to the ability of students to provide answers to various and correct problems, while in the filing of problems refers to the ability of students to make the problem as well as completion of a variety and true. Some answers to the problem are said to vary, when the answers appear different and follow a certain pattern. In the case of a problem, some problems are said to vary, if the problem uses the same concepts as the previous problem but with different attributes or problems that are

generally recognized by the students. Flexibility in problem solving refers to the ability of learners to solve problems in different ways.

Flexibility in filing issues refers to students' ability to pose problems that have different ways of resolving. The novelty in problem solving refers to the ability of the student to answer the problem with several different but valuable answers or one "unusual" answer done by the individual (student) at his or her level of knowledge. Some answers are said to be different, if they look different and do not follow a particular pattern. The novelty in filing a problem refers to a student's ability to pose a problem different from the previously proposed problem. Two problems are raised differently when the mathematical or contextual concepts used are different or unusual for students to make at their level of knowledge. These three indicators are used as the basis for categorizing the characteristics of students' creative thinking in solving and raising daily problems with the application of Pascal's law, in particular the concept of hydraulic pumps.

Based on the problem and relevant research above, the researcher did an investigation investigation of effect of enrichment in the concept of Pascal-laws based on STEM Education on critical and creative thinking skills

METHOD

This research uses experiments designs, types of the one group pretest-posttest designs. Therefore in this study did not use control class. This study was conducted 4 times a meeting, to observe the development of critical and creative thinking skills. The subjects involved were 8th grade SMPN academic year of 2017-2018 with 22 males and 20 females. Samples were chosen by using cluster random sampling method (Fraenkel & Wallen, 2006).

In order for this research directional, scope of the study is limited to the following points. Measurements of critical and creative thinking levels on the subject were done at the beginning of the study before treatment and after receiving treatment using the same instrument in the form of student sub-topic work the concepts studied were Pressure Substances consisting of Solids Pressure, Liquid Pressure and Pascal's Law. Data on the development of critical and creative thinking is obtained from the result of the measurement of student worksheet scores, exhibition board scores and products of students' creations. The rubric of critical students' criterion assessment criteria is adapted from the identification of eight critical thinking characteristics (Wade, 1995), whereas the Rubric assessment of creative product results is based on the skill of creative thinking (Siswono, 2008). Data collection techniques and instrument completely were listed in Table 1.

Table 1. Data Collection Techniques

No.	Data Type Level of ability	Data collection technique	Instrument
1.	Critical thinking skills	Performance tests	Student worksheet, observation sheet
2.	Creative	Performance tests	Student worksheet, observation sheet

The data derived from skill score of student skill and observation sheet were processed by using formula:

$$P = \frac{f}{n} \times 100\%$$

P : percentage of answers

f : frequency of answers

n : many respondents

(Sudjana, 2009)

Then calculated the value of the increase by calculating the gain index using the following formula.

$$N - Gain = (\text{post-test score} - \text{pretest score}) / (\text{maximum score} - \text{pretest score})$$

(Meltzer, 2002)

To create a score category the scores of enhanced critical and creative thinking skills are determined by the criteria as high ($g > 0,70$), medium ($0,30 \leq g \leq 0,70$), low ($g \leq 0,30$). Furthermore, the research was conducted into some stages below :

Stage of Preparation

Activities under taken in the preparation of research are:

- 1) Conducting a literature study on STEM Education, critical and creative thinking skills
- 2) Conducting preliminary study to the school of research location, to get information about the condition of the class to be studied, to know the initial condition of the student's value and to discuss the problems faced by the teacher at this time.
- 3) Sets the sample of the study as an experimental class.
- 4) Develop learning tools consisting of (1) Syllabus; (2) Learning implementation plan (RPP); (3) Pretest / postes problem of written test, critical and creative thinking; (4) STEM educational student worksheets (5) criteria for critical thinking and creative thinking

Implementation Phase Research

The implementation of the research begins by holding a pretest activity. Pretest activities are filled by testing the skills of critical and creative thinking. This research was conducted 5 times meeting. The enrichment program starts with the second stage of STEM, because in the regular learning process the first stage is students make observations on various phenomena contained in the everyday environment that has links with the concept of Pascal law. The enrichment program lasted five meetings, consisting of one meeting of students who continued the STEM education stage to the second stage of the students having to think about ideas or products related to Pascal's law different from those already existed.

The next 2 meetings of students perform the stages of Innovation and Creation which is the phase of the application phase of pascal legal concepts and skills in using technology in creating a way or tool that has benefits. At this stage students must describe the steps that must be done to realize the new idea, continued Students make product based on the new idea in accordance with the information previously obtained. The final stages of students communicate the benefits of the products they make for everyday life.

Observation stage

Observations were made from the 1st to 5th meeting. The observed variables were the development of critical and creative thinking skills. All variables are measured and observed before and after the enrichment program. The results of measurements in the form of data score of student worksheets for the development of critical and creative thinking skills

FINDINGS AND DISCUSSION

In this study obtained the percentage of students' work sheet score for critical and creative thinking skills. The average percentage score of pretest critical thinking skills is 58%. This means that students before the treatment already have moderate category critical thinking skills, while the percentage of creative pretest score is 15%, including in the category of creative ability level 1. The percentage of this score indicates students are still less creative in finding new ideas. After the enrichment program obtained the percentage score of creative ability increased to 73% (posttest) this value including good category (creative) and critical thinking skills increased to 81% including very good

category. The N-gain calculation of 0.73 (high) and creative thinking is 0.68 (medium). Average recapitulation Score Pre-Post Test and N-gain are listed in the Table 2.

Table 2. Average Recapitulation Percentage Score Pre-Post Test and N-gain

	Pre (%)	Post (%)	N-Gain
Critical thinking	58	81	0.73
Creative	15	73	0.68

The process of enrichment programming using STEM education begins with students formulating questions, limiting problems, testing data, analyzing various information about technology relating to the utilization of pascal law in everyday life. This activity is proven to improve the skills of critical category thinking (N-Gain = 0.73). Enrichment activities are continuing by identifying the problems that exist in everyday life, one of which is the difficulty of cleaning glass in high windows. Students then design a window glass cleaner using a hydraulic system that can maintain a high place.

The process of solving the problem, mathematically calculating it, to design and assemble the hydraulic glass cleaner tool was to increase the creativity of the students, as seen from the increase of creativity percentage score of students from 15% to 73% of this improvement including the medium category.

Through this STEM-based educational enrichment program is created a new tool that is a hydraulic glass cleaner that can solve problems in everyday life. STEM education stage is able to train skilled students to think critically and creatively in using science concepts to solve problems in everyday life. Skills are needed in the community and the workplace of the 21st century.

CONCLUSION

According to the research data results, it is concluded that: 1) STEM-based enrichment can enhance critical thinking and creative skills of 8th Grade students on the Pascal Law concept, 2) STEM-based enrichment on pascal legal concepts guides students to create hydraulic glass cleaning tools as a science-based problem-solving implementation.

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