The Use of Physics Tricks to Practice Critical Thinking Skills in Senior High School Students

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Abstract. The purpose of this study was to determine the effectiveness of using physics tricks to practice the critical thinking skills of senior high school students. The critical thinking skills determined are analyzing, evaluating, applying, generating ideas, and exploring ideas. This type of research is pre-experimental using one-shot case study design. The effectiveness of the use of physics tricks is seen from the critical thinking skills and student responses. Research subjects were 50 senior high school students. Analysis of the data used is descriptive statistics. Effectiveness scores are measured using a Likert scale. Physics tricks are effective if the scores of critical thinking skills and student responses indicate more than 60% are good and very good. The results obtained are 1) the score of students' critical thinking skills is categorized good and student responses are categorized very good. The results concluded that the physics trick was qualified to be used to practice the critical thinking skills of senior high school students.

1. Introduction

Physics is the result of scientific ideas and investigations about the physical properties of the universe. The concept of physics requires learning that trains critical thinking and scientific processes, namely thinking and processing to find, develop, and apply the knowledge that involves intellectual, psychomotor, and affective based on the basic abilities of students [1]. Critical thinking is an attempt to ask and answer questions systematically to produce a coherent and credible explanation [2]. The world is always changing, so students must be able to absorb new ideas, filter information, apply knowledge, and overcome life problems. Critical thinking skills are very important in the 21st century because students are required to be able to develop coherent ways of thinking and reasoning [3]. Students can solve problems if learning provides opportunities for students to think critically, namely the process of directing, monitoring, and correcting themselves. The ability to think critically a person can be seen from the way of thinking that is clear, accurate, relevant, logical, broad, precise, significant, complete, fair, and profound [4]. People who think critically, their lives will be rational, empathetic, and realize that the human mind is imperfect. Some elements of critical thinking are: analyzing, evaluating, applying, generating ideas, and expressing ideas [5]. Current learning trends are student-centered. Learning must provide opportunities for students to explore questions, develop, and test hypotheses. Students should be given more opportunities to reflect on their own learning and gain a deeper understanding of the concept so that it is more integrated which makes students think critically. Science learning emphasizes the process, so that science teachers avoid memorization that only conveys small facts from science alone [6]. Physics Learning must be able to integrate the nature of Physics in real life.
and accommodate students' thinking skills. The fundamental purpose of educational assessment is high-level thinking skills that aim to introduce students' thinking skills and learning experiences that do not merely repeat information or mere facts [7].

Educational Physics is science related to facts, processes, theories, concepts, and generalizations. Learning physics is not just memorizing, but also students do the process of connecting one concept with another concept to express meaningful relationships between the two. Physics must be able to present phenomena in everyday life that can encourage and train students to think analytically, critically and creatively. Physics learning must be able to provide opportunities for students to develop that ability by giving opportunities to students to investigate physics phenomena in daily life. Physics learning requires investigation as part of the scientific process. One effective method that can be used for scientific processing in physics learning is a practicum because it can train three domains of intelligence (cognitive, psychomotor, and affective) simultaneously.

Practicum is used in learning that develops scientific methods, critical thinking, scientific attitudes, problem-solving approaches, discovery methods, and inquiry methods [6]. Activities in the laboratory are very important so students can conduct investigations like a scientist [8]. Investigation can improve students' scientific literacy and research skills [9], while increasing student achievement [10]. Factually, Science and technology use more experimental methods [11]. Investigation activities have a positive impact on students' research skills, but teachers should not provide excessive experience [12]. The 21st century requires learning methods that enable critical thinking, inquiry and creative thinking skills for students [13]. Learning models must be able to produce abilities in students how knowledge, skills, and attitudes are obtained [14]. Learning must integrate science process skills [15], must help students learn to learn, and help students gain knowledge by discovering it themselves [16]. Science-based learning process skills emphasize the development of higher-order thinking skills [17].

Scientific abilities in physics practicum are scientific processing abilities that require adequate intellectual and psychomotor abilities. Scientific abilities can be maximized if the skills of thinking and scientific process in Physics practicum can be trained in an integrated manner.

Mobile devices in the field of education are of great potential in helping students process information and knowledge sharing through computers or mobile devices [18]. Education systems around the world emphasize the use of new information and communication technology to teach students the knowledge and skills they need in the 21st century. The application of messages can strengthen learning the material in the classroom and positively influence the results of discussions, collaborative work, and writing. The use of these technologies can potentially stimulate critical thinking skills, collaborate, and construct knowledge [19]. The practicality of the use of mobile learning can be viewed from the implementation and the obstacles encountered include technical and instructional aspects [20]. The video-sharing feature can be used to train students' critical thinking skills with good results [21]. The use of video can be used to increase students' knowledge of a phenomenon [22] and [23]. Teachers can display videos related to phenomena or physics applications, then students can be asked to explain these phenomena with four dimensions of knowledge including facts, concepts, processes and metacognitive [24]. The phenomenon in the uploaded video will attract and arouse students' curiosity if the phenomenon shows an extraordinary physics phenomenon (Amazing Physics) and a trick that uses a physics phenomenon (Trick Physics). Amazing Physics and Trick Physics videos are found on youtube links and teachers can download them for free. Understanding physics concepts through students' critical thinking skills can be trained by allowing each student to comment, criticize, expand and enrich the explanation of the Amazing Physics or Trick Physics video that is displayed. Understanding of students' physics concepts can be seen from the qualifications of explanations and comments of each student based on indicators: clarity, accuracy, precision, relevance, depth, breadth, logic, significance and fairness. Understanding of students' physics concepts is better if more explanations or comments are made by students who meet these indicators. Teachers can use models and teaching aids that are compatible with Amazing Physics or Trick Physics videos that are displayed to support student understanding. This research uses physics tricks which are extraordinary physics phenomena in learning to train students to think critically.
2. Method
This type of research is pre-experimental with a one-shot case study design, which treats one group and observes the results. The treatment is a manipulation variable and the result is the dependent variable [25]. The manipulation variable in this study is learning using physics tricks, while the dependent variable is the critical thinking ability of students, and student responses to learning. The research procedure is: 1) selecting some physics phenomena that can be conveyed to students through tricks, 2) applying to learn using physics tricks, 3) providing opportunities for students to practice physics tricks, 4) providing opportunities for students to think critically about physics tricks, 5). Measuring students' critical thinking skills through the elements of analyzing, assessing, applying, generating ideas, and expressing ideas, and expressing ideas, 6) giving questionnaires to students to find out students' responses to the use of physics tricks in learning. The topic of physics used in this study was elasticity, and the research subjects were 50 students of class XI in SMA Negeri 13 Surabaya. Data collection techniques used tests of critical thinking performance through the presentation of experimental results, and questionnaires to capture student responses. Critical thinking scores and student responses use a Likert scale (very less = 1, less = 2, good = 3, and very good = 4). Data analysis uses score descriptions obtained by students for critical thinking skills, and student responses. Learning by using physics tricks is effective if ≥ 61% score of each element of students' critical thinking is categorized as good and very good. Also, the percentage of effectiveness of student responses was ≥ 61%. Physics tricks can be used in learning physics in high school if they can effectively train critical thinking and student responses with good results.

3. Results and Discussion

3.1. Application of physics tricks
Learning with physics tricks starts by choosing physics phenomena that can be conveyed to students through tricks. The next step is to use physics tricks and allow students to try these physics tricks. The selected phenomena are: 1) stabbing a balloon that has been blown with a needle but not erupting, 2) heating a balloon that has been blown but not erupting. Student activities in trying the physics trick are shown in Figure 1.

![Figure 1](image)

Figure 1. Student activities in trying the physics trick

Figure 1 shows the activities of students who tried the trick to walk well. Students look happy to try these physics tricks and are expected to have a positive impact on their critical thinking skills. Physics tricks used in learning can students' attention. Physics symptoms presented through tricks also encourage students' curiosity and motivation. Activities given to students in learning are also able to encourage students to think.
3.2. Student's critical thinking ability

Students' critical thinking ability is observed based on presentations them after trying physics tricks by looking at the elements: analyzing, evaluating, applying, generating ideas, and expressing ideas. Measurements were made by considering 5 things: clarity, breadth, depth, systematics, and truth. The results of students' critical thinking ability are shown in Figure 2.

![Figure 2](image)

**Figure 2.** The average score of critical thinking abilities

Figure 2 shows that students' critical thinking skills which include analyzing, evaluating, applying, generating ideas, and expressing ideas have an average score of ≥ 3.1 with a range of scores (3.30-3.43). These results indicate that the use of physics tricks in learning is effective for training students' critical thinking skills.

3.3. The effectiveness of physics tricks based on critical thinking ability

The percentage of the effectiveness of the use of physics tricks in learning based on students' critical thinking skills is shown in Figure 3.

![Figure 3](image)

**Figure 3.** The percentage of students' critical thinking skills
Figure 3 shows that the percentage of critical thinking elements which includes analysis, evaluating, applying, generating ideas, and expressing ideas are all ≥ 61% categorized as good and very good. These results indicate that the use of physics tricks in learning is effective.

3.4. Student responses to physics trick learning

The effectiveness of the use of physics tricks in learning that is based on student responses from technical aspects and aspects of learning can be shown in Figure 4.

3.5. Discussion

Conceptually the use of tricks in learning Physics can attract attention, encourage curiosity, and provide motivation to students. Learning activities that use these tricks can be used to practice students' critical thinking skills. The use of tricks in learning physics enables students to have the opportunity to express opinions and explore ideas, so they can build and share knowledge through discussion forums [22]. Physics tricks in learning can be used to overcome the availability of practicum equipment which is generally very limited in school-schools. The use of tricks in learning physics is expected to eliminate the impression that physics is a difficult and unpleasant subject because there are too many mathematical formulas. Submission of the results of their thinking allows students to interact together, build, and share knowledge. The interaction that develops through the presentation of students' thoughts about physical phenomena presented through these tricks can create an effective learning environment [26]. Physics tricks are physical phenomena that can be found every day in real life. But the phenomenon is often separated from physics lessons because we often ignore it. On the other hand, physics tricks can be very interesting because some physics phenomena are very spectacular. Meanwhile, practicum equipment in schools is very limited, so the use of physical phenomena in daily life becomes a very positive alternative. that is the reason why the use of tricks in learning physics becomes very necessary.

Physics tricks in learning can practice critical thinking skills because all students are required to think about physical phenomena that seem strange but are real. Students' critical thinking skills are trained by allowing each student to comment, criticize friends, expand and enrich the explanatory descriptions of other peers. Students not only demonstrate tricks on the physics phenomenon, but they must explain and give reasons why the physics phenomenon can occur. Students not only observe physics phenomena, but they must also explain how the concepts of physics that exist in the phenomena that are displayed or
observed. Therefore, this learning becomes effective for practicing critical thinking skills, because students are trained to analyze, assess, apply, produce ideas, and express ideas, which are reflected in students’ explanations and comments. Critical thinking skills score of students in terms of aspects of clarity, breadth, depth, systematics, and the truth of students’ explanations and comments. The results of the research prove that physics tricks ineffective learning can train students' critical thinking skills. Research data shows that the ability to think critically which consists of: analyzing, evaluating, applying, generating ideas, and expressing ideas all get average scores $\geq 3.1$ or in the good category.

The percentage of effectiveness of the use of physics tricks both in terms of critical thinking skills and student responses all get a score of $\geq 61$ or categorized as good. Very good response from students is that the use of physics tricks can attract attention, add to motivation, encourage curiosity, and encourage thinking from students.

4. Conclusion
The effectiveness of the use of physics tricks in learning can be met from the technical and learning aspects. Tricks in learning physics can train critical thinking (analyzing, evaluating, implementing, generating ideas, and expressing ideas) with good results. Critical thinking skills are assessed based on clarity, breadth, depth, systematics, and truth. Tricks in learning get a good response from students because it attracts interest and encourages students to think critically. It can be concluded that learning using physics tricks can effectively train critical thinking of high school students.

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