The Role of Digital Modules on Cognitive Ability of High School Students in Newton’s Law Material

Wirdiyatusyifa1, W Sunarno and A Supriyanto
123Physics Education of Post Graduate Program, Universitas Sebelas Maret, Surakarta, Indonesia
2Physics Education, Universitas Sebelas Maret, Surakarta, Indonesia
3Physics Department, Universitas Sebelas Maret, Surakarta, Indonesia
Email: 1wirdiyatusyifa@student.uns.ac.id

Abstract. Students perceive physics as a difficult subject to understand because the material contains a lot of formulas, mathematical calculations, and abstract concepts. One of the physics materials for high school students in Newton's law. Newton's law is one of the materials considered difficult to understand by students because the basic concepts in Newton's law material, namely the concept of force have not been fully mastered by students, resulting in students' cognitive physics abilities that are still low and have not reached the minimum completeness criteria (KKM). This study aims to examine the role of the digital module in improving students' cognitive abilities in Newton's Law material. The research subjects were 108 students of class X MIA in 3 high schools in the Surakarta residency. The study used a quantitative descriptive method with a test technique using 20 multiple choice questions about Newton's Law. Data were analyzed using N-gain. The results showed that the average scores before using the digital module at 3 SMA in Surakarta residency were 53, 58, and 60 respectively, while the average scores after using the digital module were 73, 74, and 75. Based on the N gain value, the increase in ability students' cognitive belonged to the medium category, namely > 0.3. The digital module has a significant effect on improving students' cognitive abilities in Newton's Law material.

1. Introduction
Physics is one of the important subjects to be mastered by students. However, most students still perceive physics as a difficult subject to understand because it contains many formulas, mathematical calculations, and abstract concepts [1]. This perception causes students to have difficulty in understanding and mastering the concept of physics. One of the physics concepts that are difficult for students to understand and master is the concept of force and its application in Newton's Laws [2]. This is evidenced by the results of mastery of the 2019 High School National Examination material in physics subjects reporting only 55.09% of students who answered correctly on the concept of Newton's Law. This result is still relatively low when compared to students' mastery of physics concepts in other materials. The low understanding of the concept of Newton's Law material affects the cognitive abilities of students in physics. The results of the study [3] that the concept of Newton's Law which is difficult for students to understand causes students' cognitive abilities to be low. This is evidenced by the results of the cognitive ability test of Newton's Law material showing that most students are still low and have not reached the minimum completeness criteria (KKM).
Efforts to improve the understanding of students' cognitive abilities on Newton's Law material have so far been carried out using student-centered learning models [4][5] and the application of modules as supporting teaching materials in learning Physics [6][7]. This study using a digital module as support in learning physics. The digital module was chosen as supporting teaching material in physics learning because it utilizes technology and is practical in its use. Digital modules provide various features that help students get learning materials quickly and easily. Students can easily access learning through digital modules anytime and anywhere via smartphones, tablets, and computers [8]. Several studies have been carried out, namely [7] the application of digital modules to Newton's Law material in the form of an android application. However, the digital module in this study only contains Newton's Law material which is equipped with interesting videos and pictures, evaluations, and student worksheets. This digital module is not yet equipped with physics animations and virtual laboratories that can help improve the understanding of physics concepts. The novelty of this research is adding animated physics content and virtual laboratory activities to Newton's Law digital module. The addition of this content is done so that students can better understand the concept so that students' cognitive abilities on Newton's Law material increase. The purpose of this study is to examine the role of digital modules to improve cognitive abilities.

2. Method
The study was conducted at 3 high schools in the residency of Surakarta in January 2021. The subjects of the study were 108 students of class X MIA in 3 high schools in the residency of Surakarta. The study used a quantitative descriptive method with a test technique using 20 multiple choice questions on Newton's Law. Improving students' cognitive abilities on Newton's Law material is done by comparing the results of the pre-test and post-test of Newton's Law cognitive test. A cognitive ability pre-test was conducted before applying the digital module in physics learning. A post-test of cognitive abilities was carried out after applying the digital module in learning physics. Data were analyzed using N-gain. The normalized N-gain score \(\langle g \rangle\) was used to obtain the criteria for increasing the value of students' cognitive abilities. The normalized N-gain score formula is shown in the equation below [9]:

\[
\langle g \rangle = \frac{\langle S_{post} - S_{pre} \rangle}{\langle S_{max} - S_{pre} \rangle} \tag{1}
\]

Table 1. Interpretation of Mean of N-Gain Value.

| Value \(\langle g \rangle\)  | Classification |
|--------------------------|----------------|
| \(\langle g \rangle \geq 0.7\) | High           |
| \(0.7 < \langle g \rangle \leq 0.3\) | Medium         |
| \(\langle g \rangle < 0.3\)  | Low            |

3. Result and Discussion
The results showed that the average value of the pre-test of cognitive physics abilities in each high school was relatively low when compared to the post-test average (Table 1 & Table 2). The average pre-test before using the digital module at 3 SMA in Surakarta Residency is 53 at the first school, 58 at the second school, and 60 at the third school. The post-test average of students' physical cognitive abilities in 3 SMA in Surakarta Residency namely in the first school of 76, the second school of 74, and the third school of 75.
Table 2. The Results of Student’s Pre-Test

| School  | Mean | Std. Deviation | Minimum | Maximum | Range |
|---------|------|----------------|---------|---------|-------|
| School 1 | 53  | 14.04          | 33      | 81      | 48    |
| School 2 | 58  | 10.89          | 38      | 85      | 47    |
| School 3 | 60  | 11.65          | 34      | 82      | 48    |

Table 3. The Results of Student’s Post-Test

| School  | Mean | Std. Deviation | Minimum | Maximum | Range |
|---------|------|----------------|---------|---------|-------|
| School 1 | 75.6 | 11.57          | 55      | 95      | 40    |
| School 2 | 73.6 | 10.93          | 50      | 90      | 40    |
| School 3 | 74.9 | 11.43          | 55      | 95      | 40    |

The results showed that the average value of the pre-test of cognitive physics abilities in each high school was relatively low when compared to the post-test average (Table 1 & Table 2). The average pre-test before using the digital module at 3 SMA in Surakarta Residency is 53 at the first school, 58 at the second school, and 60 at the third school. The post-test average of students' physical cognitive abilities in 3 SMA in Surakarta Residency namely in the first school of 76, the second school of 74, and the third school of 75.

The increase in students' cognitive abilities was seen from the average N-gain score from the pre-test and post-test results of students' cognitive abilities (Table 4). The results of the average N-Gain in the first school is 0.46, at the second school is 0.46 and at the third school is 0.37. Learning physics using digital modules can improve students' cognitive abilities on Newton's Law material. This can be seen from the increase in the average pre-test and post-test scores of students' cognitive physics abilities, namely the post-test average value is higher than the pre-test average value (Table 2 & Table 3). Improved cognitive abilities of students at 3 high schools in Surakarta residency with an average N-Gain score greater than 0.3 (> 0.3) in the medium category[9]. This proves that the process of learning physics on Newton's Law material using digital modules can improve the cognitive abilities of 3 high school students in Surakarta residency.

Table 4. Data on N-Gain of Students' Cognitive Abilities

| School  | Mean | Std. Deviation | Minimum | Maximum | Range |
|---------|------|----------------|---------|---------|-------|
| School 1 | 0.46 | 0.24           | 0.04    | 0.92    | 0.88  |
| School 2 | 0.46 | 0.33           | 0.01    | 1.26    | 1.25  |
| School 3 | 0.37 | 0.23           | 0.03    | 0.37    | 0.34  |

The use of Newton's Law digital module in physics learning is proven to improve students' cognitive abilities. This is because Newton's Law material in the digital module is presented contextually, namely connecting Newton's Law material with phenomena that occur in real life. This phenomenon is presented in the form of video shows, images, animations, and simple virtual experiments. Contextual presentation is done to make it easier for students to learn Newton's Law material. This study uses a digital module that begins with watching a short video or observing the images available in the digital module. This video contains natural phenomena, interesting events, or situations that illustrate real-life problems in Newton's Law material such as the phenomenon of a bus speeding and braking, rowing a boat, and the traditional game of marbles. The digital module also presents Newton's Law phenomena in the form of pictures of
real-life phenomena such as the event of a person pushing a sand cart. The presentation of Newton's Law phenomena in digital modules contextually based on real-life can facilitate students in mastering Newton's Law concepts so that students' cognitive physics abilities increase (Table 4). This supports the research results of [10] that contextual physics learning can improve students' physics learning outcomes, especially learning outcomes in the cognitive domain.

![Figure 1. Presentation of Newton's Law Material Contextually](image1.png)

The improvement of students' physical cognitive abilities at 3 SMA Residency Surakarta is also influenced by the presentation of Newton's Law material on digital modules that are supported by visualization of video shows, images, and physics animations. Through the visualization, it can make it easier for students to understand and master Newton's Law concepts. High understanding and mastery of students' physics concepts have a positive effect on increasing students' physical cognitive abilities[11]. The results of research by [12][13] that the use of digital modules as physics teaching materials equipped with multimedia elements such as audio, video, and images can create more interesting learning. Presentation of physical phenomena in the form of visualization of video shows, images, and animations can increase students' interest and curiosity so that students are more motivated in learning physics and easier to understand the concept of learning material.

![Figure 2. Virtual Laboratory of Newton's Law Digital Module](image2.png)

The digital module in this study is equipped with virtual laboratory activities. Virtual laboratory activities in the form of experimental simulations for Newton's First Law, Second Law, Newton's Third Law, and Frictional Force. For example, in the experimental simulation of Newton's First Law, the phenomenon of pulling paper quickly and slowly under the glass. Students can observe the movement of the paper when it is pulled at different speeds. Through this activity, students have direct experience so that they better understand the concept of inertia is Newton's First Law. This is evidenced by the results of
the study that the average post-test of cognitive abilities is higher than the pre-test of cognitive abilities (Table 2 and Table 3). A high understanding of physics concepts has a positive effect on increasing students' cognitive abilities [14]. Through virtual laboratory activities, students have real experiences by actively participating in direct experimental activities. Students can also find and prove a physics concept through the process of taking and analyzing experimental data so that students get a complete physics concept. This discovery activity makes students better understand the concept of physics. This is in line with the research results of [15] & [1] that the implementation of virtual laboratory activities in physics learning can improve students' understanding of physics concepts. Through virtual laboratory activities, students get hands-on experience.

The use of digital modules equipped with media in the form of animations, videos, and virtual laboratories can make it easier for students to master the concepts presented and increase student motivation in learning physics. This is supported by the results of research by [16] that students who study with digital modules have higher learning motivation than students who study traditionally. The increase in student motivation is due to the presentation of material in the module equipped with animation, video shows, and a virtual laboratory. The attractive display of the digital module will increase student interest so that students do not feel bored in learning physics. Students' high interest in learning physics will increase students' learning motivation. High student learning motivation will improve students' cognitive abilities.

4. Conclusions
The average pre-test score at three high school in Surakarta residency is 53 at the first school, 58 at the second school, and 60 at the third school. After using the digital modules the first school becomes 76, the second school is 74, and the third school is 75. The N-gain scores in three high schools in Surakarta residency are 0.46, 0.46, and 0.37. This proves that the use of digital modules as supporting teaching materials in learning physics can improve the cognitive abilities of 3 high school students in Surakarta residency.

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