# The effect of STEM education on students' digital literacy skill using coding block and electronic kit on physics of LED technology

**Y R Mubarok dan T I Hartini**

Physics Education Study Program Universitas Muhammadiyah Prof. DR. HAMKA

yunican.mubarok@gmail.com

**Abstract**. Research on STEM education and student digital literacy has been done. The purpose of the study was to determine the effect of STEM education on students' digital literacy. In this study, we used a pre-experimental pretest-posttest design method. STEM educational tools is in the form of coding blocks and electronic kits. We introduce the physics concept of LED technology by using this set of STEM tools. The LED concepts taught are its working principles, functions, types, and its variations of intensity. During the research, students learned about these materials and did several exercises, namely turning the LED on and off, setting the LED flash time, and adjusting the color intensity of various LEDs. All these exercises are done digitally based on block coding. The results showed that with this STEM education, students' digital literacy skills increased, which was seen from students being able to master and be able to do several digital exercises on the physics concept of the LED technology. Furthermore, this research is expected to have implications for students on the provision and skills of STEM for their future.

## 1. Introduction

The development of science and technology in the Industrial Revolution 4.0 and the 21st century is marked by increased connectivity, interaction and development of digital systems, artificial intelligence, and virtual, becoming a challenge as well as an opportunity to improve the development of national education. The presence of revolution 4.0 and the entry of the 21st century demands new abilities that must be possessed by every individual and also information technology has become the basis of human life. Digital literacy is one of the key skills of the 21st century that significantly increases the employability of graduates. The digital literacy ability is the ability to access, process, understand, and create information or media content in a digital environment [1]. Through digital literacy, students will develop skills to analyze and evaluate information to complete various activities, and transmit knowledge, skills, and ideas. Digital literacy refers to the skills, knowledge, and understanding needed to use new technologies and media to create and share meaning [2]. These skills also impact students' employability, with recruitment increasingly through social media and professional digital identities being key to future networking within a profession, seeking opportunities and ensuring mobility in careers [3]. When integrated into the curriculum and evidenced

in aligned assessments, good digital literacy practices will contribute to the effective engagement of learners in the learning environment.

The demands of digital literacy skills that must be possessed by students require new and innovative approaches to learning for students at schools, which are able to provide new experiences for students and provide provisions for an increasingly dynamic future in the direction of technological development. The right approach to lead students in the current trend of technological development that also supports improving students' digital literacy skills is to use an approach that integrates Science, Technology, Engineering and Mathematics (STEM). The STEM education is a meta-discipline at the school level where science, technology, engineering, and mathematics are carried out with an integrated approach and each discipline material is not divided and treated as a dynamic whole [4]. The STEM education applies problem-solving-based learning that deliberately places scientific inquiry and the application of mathematics in the context of designing technology as a form of problem solving. The application of STEM can help develop knowledge, help answer questions based on investigations, and can help students to create new knowledge [5], so that through the STEM approach it is expected to be able to produce students who have the competence of genius scientists and make students become problem solvers, inventors, innovators, able to be independent, logical thinker, technology literate, able to connect culture and history with education, and able to connect STEM education with the world of work [4].

In this study, the learning material provided was LED technology physics material, in the research phase there was a STEM exercise. This STEM exercise requires media for the learning process. The media in question consists of a set of hardware and software. The hardware consists of a computer/laptop, an Arduino module, some LED lights, resistors and capacitors, a protoboard, and a pin cable. The software consists of the Windows operating system and the mBlock application. The mBlock application can be web or desktop based. The students' digital literacy process utilizes mBlock, which is a block coding application. Furthermore, some of the student activities in the STEM exercise consist of: (1) creating a program to be able to turn on and off the LED, (2) varying the voltage based on PWM, (3) varying the PWM on various types of LED colors (red, yellow, green). and blue), (4) measure the change in LED light intensity as a function of voltage or digitally as PWM, and (5) program basic 1 and basic 2 traffic lights.

Referring to the importance of digital literacy skills to face global competition, especially in solving problems related to everyday life, this study aims to determine whether there is an the effect of STEM education on students' digital literacy skills using coding block and electronic kit on physics of LED technology at SMA Muhammadiyah 2 Depok.

## 2. Methods

The research used in this study was a pre-experiment with the type of pre-test and post-test one group design. This method was given to one group as an experimental class without a comparison group (control class). This study involved 19 students of class XI at SMA Muhammadiyah 2 Depok based on simple random sampling technique, namely the technique of determining the sample randomly without considering the existing strata in the population. The instruments used in this research include test instruments in the form of 10 description questions and response questionnaires to STEM and digital literacy. The test instrument in the form of description questions is used to measure students' digital literacy skills through a pre-test, namely before being given the treatment (STEM education) and post-testing after being given treatment (STEM education). Students' digital technology literacy data is converted into values with a scale of 0 –100. The digital literacy scores of students from both classes were tested using a series of statistical tests to determine the significance of differences in the treatment results in the experimental class, the data were analyzed using t-test [6].

At this stage of the study, students were given STEM education treatment for three meetings which were conducted online through Google Meet, while this learning stage was called STEM exercise. Through STEM exercise, this LED technology material requires media for the learning process. The media in question consists of a set of hardware and software. The hardware consists of a

computer/laptop, an Arduino module, some LED lights, resistors and capacitors, a protoboard, and a pin cable. The software consists of the Windows operating system and the mBlock application. The students' digital literacy process utilizes mBlock, which is a block coding application. Furthermore, some of the student activities in the STEM exercise consist of: (1) creating a program to be able to turn on and off the LED, (2) varying the voltage based on PWM, (3) varying the PWM on various types of LED colors (red, yellow, green). and blue), (4) measure the change in LED light intensity as a function of voltage or digitally as PWM, and (5) program basic 1 and basic 2 traffic lights.

## 3. Results and Discussions

The results obtained from STEM learning provide a significant difference between before being given treatment and after being given the STEM education to students' digital literacy abilities. Before being given treatment, students were given a pre-test using 10 questions describing LED technology, after giving the pre-test, students were then given treatment. This treatment is given through a STEM learning stage, namely STEM exercise on LED technology material using mBlock as a learning medium as shown in figure 1.

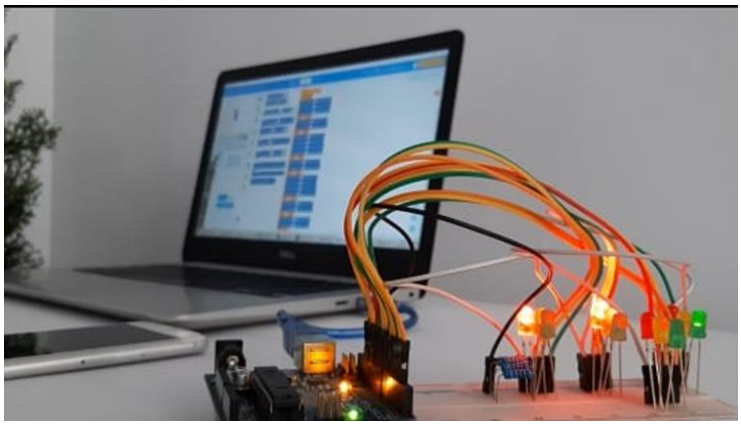

**Figure 1.** STEM exercise on LED technology.

Physics content was chosen in this research because Physics is a science that integrates with the behavior and symptoms of natural phenomena that are associated with current or current phenomena [7]. So that in learning it is not enough just to understand text, but it is necessary to have activities that can visualize an abstract object. The selected physics content is about LED technology in class XI, in the STEM exercise activity, students are asked to design a program using block coding-based mBlcok to be able to turn the LED on and off, vary the voltage based on PWM, vary the PWM on a variety of LED color types (red, yellow). , green and blue), measuring changes in LED light intensity as a function of voltage or digitally as PWM and making a basic 1 and basic 2 traffic light program. Based on this activity, students were very enthusiastic because they got something new, namely applying block coding as a STEM medium in LED technology learning, however, there are some obstacles during learning such as the difficulty of active interaction with students because learning is done online so students cannot try mBlock media directly and students' lack of understanding of the material so it must be explained slowly. Of all the STEM exercise activities that have been carried out, students still find it difficult to design basic traffic light programs 1 and 2, because this requires a high level of computational thinking and complicated logic. research used in this stud.

After the treatment, the students were then given a post test with the same questions as before. The results of the pre-test and post-test are presented in table 1.

**Table 1.** Results pre test and post test.

| | Mean | *N* | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|
| **Pre test** | 17.2105 | 19 | 6.02383 | 1.38196 |
| **Post test** | 59.6842 | 19 | 11.14576 | 2.55701 |

Based on table 1 shows that the average value of the pre test and post test is different, where the mean value of the pre test is 17.21 and the mean value of the post test is 59.68, meaning that there is an increase from before being treated and after being given treatment. To be able to see whether or not there is an influence on the STEM education to students' digital literacy skills, a statistical test is carried out using a t-test that has met the normal distribution requirements. Paired t-test (paired t-test) is one method of testing the hypothesis where the data used are not independent (pairs) [8]. The characteristics that are most often found in paired cases are that one individual (object of research) is subjected to 2 different treatments. Even though using the same individual, researchers still obtained 2 kinds of sample data, namely data from the first treatment and data from the second treatment [9]. In this study, the differences in the treatment given were pre-test before being given the STEM education and post-test after being given the STEM education. The results of the paired t-test using SPSS in the pre-test and post-test are shown in table 2. results in the experimental class.

**Table 2.** Paired t-test.

| | Paired Differences | | | | | t | df | Sig. (2 -talled) |
|---|---|---|---|---|---|---|---|---|
| | Mean | Std. Deviation | Std. Error Mean | Interval of The | | | | |
| | | | | Lower | Upper | | | |
| **Pre test-pos test** | -42.47368 | 11.18714 | 2.56651 | -47.86571 | -37.08166 | -16.549 | 18 | 0.001 |

Based on table 2, it can be seen that the average value is -42.47 and is negative, this shows that there is an increase in the post test results after being given treatment. As for determining whether or not the effect can be seen in the t-value of 16.54 and the sig. (2 -talled) which is 0.01. If t count > t table then there is a significant effect, meaning that there is a difference between before and after being given treatment, seen from the acquisition t count 16.54 > t table 2.878, then there is an effect of the STEM education on students' digital literacy skills, as well as on the acquisition of sig. . (2-talled) is 0.001 < 0.05, which means that there is an effect of the STEM education on students' digital literacy skills.

The influence of the STEM education on students' digital literacy skills can show that in physics education today the core components of the STEM education in learning conceptual understanding and problem solving remain to be emphasized. However, a rapidly changing environment and a technology-driven world require a new set of core knowledge, skills, and habits of mind to solve complex cross-disciplinary problems, collect and evaluate evidence, and make sense of information from multiple sources [10]. Physics learning today must shift towards capacity building as well as expansion and integration with STEM disciplines to suit the changing world driven by technological developments, so STEM learning is required to create skills that overshadow current needs, coupled with the emergence of new skills that must be developed. owned by students whose main skill is digital literacy. This ability is rarely owned by students, especially applied to physics learning, this can be seen from the first impressions of students who show commonness in the latest educational technology trends. Block coding which is one of the STEM learning media in this study is a trigger to be able to realize the existence of technology to be applied to more modern and advanced physics learning, therefore, during the treatment period in STEM exercise activities, students are continuously guided to be able to use , collaborate, coordinate, and utilize technology as a method in solving a

problem through coding blocks on LED technology materials. Of all the STEM exercise activities that have been carried out, students are very interested in designing programs using block coding, but it would be even better if the learning was done directly, so that students could practice directly the media used. So far, students' understanding of block coding is quite good when viewed from the questions given to students to create block coding based on this block, almost all students answered the questions correctly. The hope from this research is that students have digital literacy skills although they still need to be further improved, however, getting to know mBlock media based on block coding and the STEM education opens students' awareness to be able to master the future with digital literacy skills.

## 4. Conclusion

Based on the results of research and discussion on the effect of the STEM education on students' digital literacy skills, it shows that the average pre-test and post-test scores are different, where the pre-test average value is 17.21 and the post-test average value is 59.68, meaning that there is an increase from before being given treatment and after being given treatment, in addition to the acquisition of the t count 16.54 > t table 2.878, then there is an effect of the STEM education on students' digital literacy skills, as well as on the acquisition of sig. (2-talled) is 0.001 < 0.05, which means that there is an effect of the STEM education on students' digital literacy skills. Therefore, it can be concluded that the STEM education has an effect on students' digital literacy skills using coding block and electronic kit on physics of LED technology at SMA Muhammadiyah 2 Depok. The hope from this research is that students have digital literacy skills although they still need to be further improved, however, getting to know mBlock media based on block coding and the STEM approach opens students' awareness to be able to master the future with digital literacy skills.

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