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An innovative model for the development of experimental learning science creativity in high school by online media

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ABSTRACT

The learning process and demonstration of experimental tools in secondary schools continue to be developed in order to achieve educational goals for teachers and students in schools. During the COVID-19 period, the experimental learning process was delayed due to the factors and conditions of spreading of COVID-19 pandemic. However, alternatives must be made to continue the experimental science learning process. In this paper, an innovative model to encourage creativity in science experiment learning model is proposed by online media. This activity is carried out through community service that does not hinder the learning process by combining online in a hybrid and integrated manner. The results of this activity indicate the success of the learning process where the equipment can be demonstrated and the interactive nature of the teacher and students are successfully achieved with the given model.

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1. INTRODUCTION

Education has a very important and major role in the development of one's personality, in accordance with UU No. 20 of 2003 which states that education creates potential in a person in the form of religious spiritual strength, self-control, personality, intelligence, noble character, and skills required to live in a society with conscious and planned efforts [1-3].

Studying and learning processes are interactive activities that are educative in nature to achieve educational goals [4]. Learning is a system and method contained in the learning process, consisting of several interacting components, consisting of teachers, students, objectives, materials, media, methods, and evaluations [5, 6]. Learning is teaching and learning activities related to education that will bring changes in behavior in the form of attitudes, skills, knowledge, and experience so that the learning process provides convenience and helps students to learn well in accordance with the goals to be achieved [7]. Successful learning requires collaboration with school components: teachers, facilities, infrastructure, parents, and the student environment [8, 9]. This

educational goal will be disrupted and difficult to achieve optimally, especially during the Corona Virus Disease (COVID)-19 pandemic where the learning system in schools is no longer carried out face-to-face and directly in class [10]. This is certainly a challenge for teachers and other components in preparing learning materials that will be delivered by online media so that learning objectives can be achieved and students can understand materials well even in the conditions of the COVID-19 pandemic.

Learning science, especially Physics, demands broader teacher competencies, not only carrying out activities in the form of transfer of knowledge in the form of theory but also in the form of visual images because understanding physics requires a broad understanding of natural phenomena, rational evidence, sensory experience and certainty of facts that it naturally occurs [11-13]. Practical experience in the laboratory as well as the use of teaching aids is believed to increase students' reasoning power and logical thinking which is very effective [14]. However, this learning process is very difficult to implement during the COVID-19 pandemic, so most of it is done only by giving structured assignments to students, both theory and introduction to practical knowledge of improvisation through available online media [15]. As a result, students are less motivated and enthusiastic in the learning process, resulting in an incomplete understanding of the material. Besides, the learning process that is far from students (remote learning) will be difficult to control, not only in terms of science but also limited mental, mental and social development and growth of students [16]. At the same time, students look for activity challenges, free opportunities, and other thoughts to keep themselves busy and reduce educational problems by spending a lot of time playing with gadgets or mobile phones. Affective, cognitive, and psychomotor disorders of students will be formed in a way that is no longer appropriate [17]. All of this is certainly a problem in achieving educational goals.

From the explanation above, it can be concluded that several of the causes are the teacher's lack of knowledge about learning tools that can be used as learning media during the COVID-19 pandemic. In addition, the lack of innovation, creativity, ability, and experience of teachers in using learning media obtained from substitute teaching tools or materials [18]. In fact, laboratory equipment and teaching aids do not always have to be purchased at high prices and well prepared in a special place. There are also substitute tools and materials that have the same purpose and instead develop some reasons, inspiration, and imagination that can lead teachers and students to innovate and to be creative [19, 20]. Through community service programs, efforts to motivate public service behavior, especially in the world of education for teachers and students are very urgent, important, and mandatory to increase awareness of the educational process through online media, remote practice, and adequate equipment/materials. With these efforts and solutions, universities offer opportunities to share, open up insights to take advantage of the potential of the environment, and use simple tools and materials for practical work as teaching aids by teachers to students by online media.

2. FORMS AND METHODS OF ACTIVITIES

The proposed form of activity is in the form of teaching and learning through the development of experiments and teaching aids for science teachers, especially physics. Basic experimental learning about understanding concepts from simple to complex natural phenomena by displaying equipment and practicum materials as well as teaching aids through online media. Furthermore, it will be tested on students and introduced to parents. This practicum tools can be displayed both in mechanical and non-mechanical (electromagnetic) forms physically in the form of simulations and real practices that can be accepted by the senses, hearing, and sight, especially on Zoom, Google, Webex, and others.

This activity is also carried out using synchronous and asynchronous methods. The development of innovation and creativity in the practicum learning process with this demonstration includes understanding:

a. Systematic approach: understanding natural events that have a causal relationship, the flow of events that produce a work or product which can then be concluded.
b. Historical approach: activities in the process and flow of changing time and events that show consequences and benefits that result in understanding.
c. Summary approach: the premises of events that are clearly and precisely related to a series of natural events, are connected, analyzed, and compared to produce a conclusion from an event.

d. Comparative approach: providing analogies of events and comparisons of both the process and the results of a natural phenomenon that can be developed and concluded.

The activity and evaluation method is an innovation model in the form of:
a. Submission of materials online: Basic concepts of science/physics
b. Demonstration of equipment and practicum materials
c. Process and testing of experimental tools and materials
d. Approach to understanding iteration and simulation: Measurement and calculation
e. Oral and written evaluation: Simulation exercises and self-demonstration

Activities are detailed in the following modules:
a. Uniform rectilinear motion, average velocity, and instantaneous velocity: to determine velocity, dynamics, and to explain the characteristics of uniform linear motion based on its kinematic quantities
b. Free fall motion: to understand the characteristics of free fall motion and to determine the speed of free fall motion.
c. Simple pendulum: to calculate the effect of mass, and length of rope with deviation on a simple pendulum swing.
d. Spring constant and Hooke's law: to determine the gravitational acceleration through a simple pendulum experiment, explanation of Hooke's law, and verification of the relationship between period and mass of the load on spring oscillations.
e. Standing waves and sounds: an explanation of the formation of standing waves and the difference between knots and bellies. Explanation of the pressure shift in the frequency range.
f. Magnetism and electromagnetic induction: an explanation of the right-hand rule and an explanation of Faraday's law of induction and know Lenz's law and magnetic permeability.
g. Ohm's law and electric circuits: to distinguish Ohmic and non-ohmic resistance, determine the relationship between current and voltage using ohm's law, and to use ohm's law to obtain the values of current and voltage.
h. Viscosity of Fluids and Archimedes' Law: an explanation of measuring viscosity and seeing the effect of temperature on viscosity as well as proving Archimedes' law and determining the density of liquids using Archimedes' law equations.
i. Potential and Coulomb Fields: an explanation of the relationship between electric field strength as a function of charge voltage as a function of distance from the sphere and an explanation of the relationship between electric potential as a function of charge voltage and a function of distance from the sphere (optional).
j. Electric field and plate potential of a capacitor: determination of the relationship between potential and electric field strength at a fixed capacitor plate distance and an explanation of the relationship between electric field strength and the distance between two capacitor plates.
k. Wheatstone bridge: determination of the basic principle and operation of the Wheatstone bridge and determination of the unknown resistance.
l. Joule's law: an explanation of the joule heat, the factors that affect the joule heat, and an explanation of the experimental measurement of the joule heat.
m. Mirrors and lenses: an explanation between diverging and converging lenses and mirrors, determination of the properties of lenses and mirrors using beam diagrams, and analysis using mirror Equations and Equation factors.
n. Prism: explanation of light dispersion in dispersing medium, explanation of spectrometer operation, and determination of prism's refractive index.
o. Lens focus: determination of the focus of convex and concave lenses.

3. ACTIVITY IMPLEMENTATION

The target of this activity is not only for partners as teachers of science subjects, especially Physics in Junior High Schools (SMP/SMA/Equivalent) in Riau Province but also for additional targets, namely lecturers and students who are involved to improve their learning in this community service activity in the form of Real Work Lectures (Kuliah Kerja Nyata). School teachers are

coordinated with the main partners of the Riau Provincial Education Office and the Riau Teacher Association of the Republic of Indonesia (PGRI) and include the schools that will be appointed in the implementation. The targets are:

a. Teachers: Science and Physics teachers at the junior and senior high school levels. These general and overall targets are used because not all teachers are available according to their field of study, not all schools have science/physics teachers and there are even teachers in other fields of study who teach science/physics in these schools.
b. Students: Training and evaluation will also be conducted for students as examples and trials in the form of online learning media simulations using these practical and visual aids.
c. Lecturer: Besides having a competence, knowledge, and experience, the development of innovation and creativity is also shown in the type and form of practicum and teaching aids that will be produced in a complete experiment that can be compared in the form of innovation.
d. College students: Participating in preparing materials about tools and laboratories/exhibitions that will be displayed is also a challenge.

The implementation of service activities with the theme of fostering teacher creativity and innovation in the use of physics teaching aids during the COVID-19 pandemic was carried out with online teaching facilities. This activity will be carried out jointly between lecturers and students in mutual cooperation by involving more than 100 participants in the field of Physics expertise in particular. Likewise in schools, teachers, students in junior high/high school/equivalent and universities, lecturers, students, local governments, PGRI, and the Indonesian Physics Association (PSI) also play an active role in realizing successful activities for the community as shown in Figure 1.

Figure 1. Implementation of online science experimental learning activities.

These external activities include:

a. Student experience learning off campus: Student experiences provide new insights, potential, and abilities as well as experience in actualizing knowledge in compiling theoretical, practical, and demonstration materials that will be displayed in online media. The experience of designing, assembling, measuring, and calculating physical quantities on various simple natural phenomena has an extraordinary experience. This output can also be received by students in the form of training certificates in preparing practicums and demonstrations of online learning media. 10 students who are experienced in teaching are involved in the preparation of the module and the experimental learning process.
b. College Cooperation with Partners: The teaching and learning process in this service activity is the birth of collaboration between Universitas Riau lecturers and Riau teachers, especially in districts/cities for the benefit of education for students. In educating students, students, and teachers and even developing lecturers' ideas, they also increase collaboration in effective and efficient online learning. Other results are also realized in the form of cooperation in the preparation of innovation modules that are developed automatically.

c. Learning Innovation in School: The creation of online media-oriented learning is created and developed by schools so that teachers have the anticipation of creativity and materials to display activities in the laboratory by showing tools and computers, laptops, or mobile phones. There are 15 types of innovation systems that are displayed in the material for the preparation module and one activity for developing creativity and innovation which is described in the form of practicum/components and materials.
d. Innovation increases community resilience: Innovations created and developed by lecturers and students that are oriented towards the use of the same practical/demonstrative tools and materials but have basic philosophical concepts for teachers and students to understand and study natural phenomena. Simplicity in technology and innovation is still emphasized in order to anticipate advanced technology and high costs, while simplification of technology for teaching tools and materials is no less important and the main aims is the basic understanding and philosophy of natural phenomena, especially physics. To measure this base is much more important than those based on high technology.
e. Publication: This service is not only published in print and electronic media but can also be in the form of video. The printed publication of this activity has also been recorded in the form of a module as a complementary book for teachers, higher students, and senior students.

Figure 2. Group photo of students at integration level community service at Universitas Riau in 2022.

Figure 2 illustrates one of the activities of the second group integration real work lecture which was carried out in Labuhbaru Barat Village, Payung Sekaki District, Pekanbaru City in 2022.

4. CONCLUSION

Innovative learning models to increase the creativity of teachers and students in physics demonstrations and experiments have been succesfully completed and provide significant results, including; fostering teachers' confidence to conduct experiments by online media, believing that science and physics experiments can be carried out with simple equipment and tools, and successfully show some misconceptions about science and physics material that have not been fully revealed understood.

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