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Developing Basic Computer Programming Virtual Laboratory for Senior High School

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Abstract

Recently, the Metaverse has emerged as a global focal point, drawing extensive attention thanks to rapid technological advancements. The forthcoming virtual reality promises amplified direct physical interactions, diminishing the significance of traditional constructs such as race, gender, and physical disabilities, ultimately offering profound societal advantages. Nonetheless, virtual reality development remains nascent, brimming with untapped potential. Despite proactive industry preparations and substantial investments, there's a pressing need for expanded scholarly discourse on virtual reality to provide the scientific guidance necessary for its maturation. A basic Programming laboratory for Senior High School has been developed using the ASSURE learning development method, including six steps: Analyze Learners, State Objectives, Select Media and Materials, Utilize Media and Materials, Require Learner Participation, and evaluate and revise. The research finding shows that it can be implemented in the learning process of Basic Computer Programming subjects to increase student understanding.

Keywords: laboratory, virtual reality, ASSURE, basic programming

I. Introduction

The scientific and technological revolution, which is used as a source of learning, is growing so that people can learn independently. In the current industrial era, the information age has changed so that it has made changes in various fields, not to be left behind in the field of learning. In its development, technology makes people increasingly switch from conventional to media that utilize technology increasingly being developed. The development of information also creates a learning system that allows students to get widespread information obtained from print and electronic media. Improvements and improvements to the quality of teaching develop continuously and to be sustainable, and require quite a long process.

The current learning process can take place without having to study in the classroom due to the development of the learning process, primarily through information and communication technology, which is developing very quickly. The learning process can occur without having a teacher as a teaching resource, but the learning process can take place anytime and anywhere. Thus, students can learn according to their wishes of the way and style of learning. Learning resources are in various ways that have yet to be implemented optimally. Learning resources are messages, people, materials, tools, techniques, and settings. Learning is a system, so the success of learning will be determined by the effectiveness of each component in interacting.

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A. Learning Process

The learning process will increase frequently using learning material sources. The more it is used, the better the learning process, and the more complete it, including the number of subjects studied, the clearer and easier it will be.

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The learning resources used to fulfill the various learning requirements are wider than printed materials such as books. Still, students can obtain them from other learning sources, for example, radio, television, interactive videos, e-mail, and e-mail, teleconferences and those on the internet. as well as other information technology to increase interaction and provide insight to students. The learning resources obtained, of course, have different roles or ways of learning activities, as seen from how learning resources are used. Students do not only get from interacting with the teacher but also from other sources. All of that can be obtained by interacting with many different learning resources to be used to achieve maximum results.

The learning process can also be carried out in every educational institution, including universities. Efforts are made by providing various systems and learning facilities, and with a learning system supported by technological developments, universities are always trying to improve the learning process.

Current technology development has also made the teaching process switch from conventional to virtual reality media as a learning resource medium. The learning process develops and innovates by utilizing information technology. Learning can be virtually used by utilizing metaverse technology. In a sense, metaverse technology is used to describe something by using a computer as a medium. The internet network can define a place and a specific object, such as meeting face-to-face, interacting, and so on.

B. Laboratory

Among the places of study is the opinion stating that a laboratory is a place for a group of people to conduct research experiments, observation, training, or scientific testing to prove the difference between theory and practice from various fields of science. Laboratory facilities are generally complete in the learning process [1]. Therefore, development and innovation will also support the success of teaching. A virtual laboratory is a laboratory facilitated by technology by maximizing the role of computer technology for presentation in the form of images, text, sound, graphics, videos, and animations that are displayed in an integrated and interactive manner so that students are more interested in learning. Virtual laboratories are necessary for solving existing life problems and are part of the context for critical learning for students oriented toward technology products. Virtual labs can be used at the teaching and subject level. [2]

Fundamentals of Computer Programming

This subject learns how to translate an algorithm by applying it in programming form using the C++ programming language. C++ is a procedural and object-oriented programming language that is widely used as a language for learning general programming concepts [3]. C++ can be useful for solving technical problems that are easier to start learning programming with. This programming language is easy and helps in understanding the basics of programming.

C++ programming is categorized as a procedural programming language whose implementation is based on solving problems/logic by relying on the sequential steps of several defined program functions and procedures. Understanding the program itself is a set of instructions that are ordered to the computer; it is different from the method at a systematic stage in the program itself, which is an algorithm. Writing program logic is done using a programming language; it can be said that a program is an implementation using a programming language. Learning a programming language is a way of learning about the logical methodology for solving a problem, which is then applied in the form of a certain notation so that it is easy for computers to read and understand. In general, the purpose of the Algorithm is the steps for solving a problem. The efforts are made in sequence, repetition, and selection. These three steps are used to develop the Algorithm. An algorithm is a collection of several basic structures in a sequence consisting of several instructions to be given. Each of these instructions is executed sequentially according to the sequence of writing.

In practice, this Basic Computer Programming subject is done in a computer laboratory using the C++ programming language. Students practice by practicing making C++ programs to apply an algorithm. Students follow the learning process within the time duration and with a predetermined schedule.

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C. Learning Module

The knowledge students gain comes from what the teacher has conveyed and can also be obtained from many other related learning sources.

Learning resources are limited to materials and tools used in the learning process, labor costs, and facilities. There are learning resources created or developed deliberately, and those used because they are already available, such as museums, beaches, markets, etc. In short, learning resources include anything that can be used to help everyone learn and display their competence [4]

This learning approach is expected to create independent learners. A module is a separate learning material that supports student learning independence.

Many factors, including teaching or teaching materials, determine success in achieving learning objectives. Teaching materials must be seen as anything teachers and students can use to facilitate learning activities. Hamdani defines teaching materials as a set of materials arranged systematically, both written and unwritten, to create an environment or atmosphere that allows students to learn [5]. The teachers themselves can make teaching materials or can be downloaded from the internet. Still, of course, they have to study the syllabus on the material that must be written in the syllabus.

1. Online Learning

Online learning, also called electronic learning, more precisely called learning through e-learning, is learning that is carried out through electronic devices such as computers connected to the internet network. Usually, to get online learning material, of course, you have to be connected to the internet network, website, internet, intranet [6]. The definition made by Nada Dabbagh and Brenda Bannad Ritland is online learning as an open learning environment that uses pedagogic tools, the internet, and web-based technological tools as a way to facilitate learning and build knowledge by interacting and meaningful activities [7]. Features such as e-mail, discussion forums, video conferences, and online lectures can be done with the web, and several components of learning facilitators can be done with web-based learning.

The development of information technology used so that online learning also takes advantage of these developments, of course, by using the internet network and taking advantage of its various advantages to make it a medium for delivering learning messages.

From the existing background, the research problem was determined and formulated as follows:

1. How to develop a practicum model for the Basic Computer Programming subject based on a virtual laboratory for teaching participants to facilitate practicum learning
2. How is the development carried out to produce a product through learning materials presented in electronic and visual text media that can be accessed online using computers and cellphones?
3. How learning development with a virtual laboratory can be used and applied.
4. How is the effectiveness of the practicum learning model?

From the background and research problems that have been previously disclosed, the research objectives are formulated as follows:

1. How to develop a practicum learning process for Basic Computer Programming subjects using C++ to facilitate practicum learning.
2. How will the development be carried out to produce a product in the form of an electronic textbook, an electronic practicum module book, an electronic practice manual for the Basic Computer Programming subject using the C ++ program, and displays videos on how to make programs and shows the results of the programs made which are presented via video making the program.
3. Implementing a virtual laboratory learning model for practical learning.
4. The target is for teachers and students who teach or take Basic Computer Programming courses using the C ++ program.

II. Research Method

A. ASSURE Development Model

The ASSURE development model is a model that formulates classroom-oriented learning activities [8], as hown in Figure 1. The development

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of the ASSURE learning system can be described as follows:

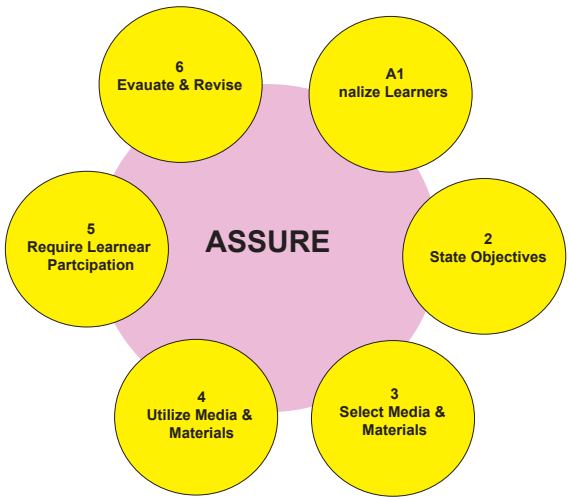

Figure 1. ASSURE Development Model

Heinrich argues that this model consists of six activity steps, namely:

a) Analyzing learners and finding out the needs and ability levels of students is done with three essential things to get to know them, namely (a) based on general characteristics, (b) initial or special skills, and (c) learning styles.
b) States Objectives, Reveals that learning objectives should be focused on new knowledge, skills, and attitudes to be learned.
c) Select Methods, Media, and Material, selecting the method through three essential things, namely: determining the method that is appropriate to the learning task according to the material and media to be used, choosing the appropriate existing media, and determining the selected media, and the last step is from the choice of media that has been determined by the design of the media that has been determined.
d) Utilize Media and materials. Proper use of media is carried out in five steps: previewing materials, providing materials, providing an environment, students, and learning experience.
e) Require Learner Participation: Students need to be directly involved in learning activities such as solving problems, simulations, quizzes, or presentations before students will be assessed formally.
f) Evaluate and Revise the aspects referred to in the assessment, including the resulting learning, assessing student achievement, choosing methods and media, media quality, teacher use, and student use [6].

This model focuses on teaching students with different learning styles. The learning process by positioning students requires them to be able to interact in their environment and receive information not only passively. It assures that the model is used as a reference for educators to teach students in learning that is planned and arranged systematically and class-oriented by linking technology and media. It is hoped that learning will be more effective and meaningful for students. The weakness of this model is that it does not involve expert judges, so it is likely that there will be deficiencies, errors, or discrepancies between the learning tools implemented and produced.

B. Place and Time of Research

The Basic Subject of Computer Programming using the C++ programming language, which is used as a research topic, is studied at Vocational High Schools in Natural Sciences. Practically learning this subject is conducted in a computer laboratory equipped with C++ application software as a programming language for making an application. These subjects can be studied in various tertiary institutions or other educational institutions using designed learning methods.

The research began in September 2020 and carried out research activities with initial observations and then carried out research until December 2020.

C. Research Design

After determining the objectives of this research and its development (Research and Development), using the development method will make certain products, and then the product's effectiveness will be tested [9].

It is known that learning is a process starting from determining its goals in order to be able to solve problems and gaps that occur. Learning approaches that are still conventional, which only rely on lectures, will be improved, and device support for learning will also be prepared. Allows the learning process to be more effective if students play an active role in implementing

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learning. Ultimately, students will follow and live the lesson as their experience. The learning outcomes are part of the thoughts and experiences. Learning outcomes from learning experiences will stick to the mind, thereby making students more creative in thinking:

1. Needs Analysis - Information obtained on students is collected. The design is carried out related to student characteristics such as the learning environment, the demographic background of students, knowing how early students are, and knowing how students learn and will influence student readiness in the learning process so that the needs of the learning process can be met.
2. Formulating Instructional Objectives - For how to formulate learning objectives, consideration is needed, including determining the knowledge and skills that will be possessed when students carry out learning and can demonstrate their ability to use the knowledge that has been learned; This can be used to assess success during learning.
3. Determine Tools to Assess Learning Outcomes - Determine tools to assess learning outcomes using the 2nd stage after setting instructional objectives. Based on the principle based on objectives, namely assessing whether an existing instructional system is following the achievement of results.

E. Unit of Analysis

1. Respondents

Students at the Vocational High School in the field of Natural Sciences

2. Learning Materials

Practicum learning materials consist of (1) reference books, (2) a practicum module, (3) guidebooks, (4) Basic Computer Programming Tutorial with C++ (5) Programming exercises. Learning materials will be provided online through online classes, which can be downloaded so that they can be studied offline. Students will also be given exercises to understand algorithms with C++ programs, which can be done after students understand the tutorials given.

III. Results and Discussion

A. Research Results

1. Analysis of Student Needs

Based on the results of observations of the learning process in the computer laboratory and interviews with teachers in charge of these subjects, information was obtained that learning has been carried out by studying and practicing the algorithms studied in the form of programs using the C++ programming language which is carried out in computer laboratories. Submission of lecture material is carried out in the same way as lectures for other subjects. However, after the delivery of the lecture material, practical exercises or proof of the lecture material are carried out through practicum in a computer laboratory. Through this practice, students translate algorithms into a programming language using C++. This learning process is carried out in a computer laboratory according to the practicum schedule in a predetermined laboratory. Available teaching materials are in the form of books on making C++ programs, and materials for practicums are obtained from examples of programs given from the discussion of the lecture material presented.

The learning process in the Basic Computer Programming subject is carried out employing a demonstration in front of the class or the laboratory room by the instructor, followed by students. Next, the teacher provides exercises or sample programs that apply an algorithm that can be used as practicum material. In addition, the teacher also gives assignments to work on for students to practice from the example program given or other examples of algorithms to make the program. The learning process is felt to be less time-consuming because, in addition to explaining the material being studied, it also has to be done in practice. Meanwhile, making the program itself it takes a long time even though it has been assisted by a laboratory assistant who helps during the practicum, not to mention when there are students who ask for an explanation of the material that has been presented, or students ask about making the program that is being practiced.

The difficulty experienced by teachers is to use time according to the practicum schedule.

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Besides having to explain teaching material, it also helps students practice lecture material in the form of a C ++ program. Besides that, it must teach how to make and teach the making of the C ++ program itself. Collecting information about students is carried out and studied to determine the needs of the learning process.

The needs analysis stage is carried out by observing the problems and the existence of the characteristics and conditions of students. An analysis of what is needed and what will be done is helpful to be used as the primary source of a research development step. Students should not be passive because there is no limited material and time in the learning process.

2. Assessment of Learning Outcomes

After formulating the instructional objectives, the tools for assessing learning outcomes are prepared in the second stage. The process is based on a goal-oriented assessment of an instructional system for the results achieved. Learning outcomes assessment tools need to be developed by first determining the types of tests to be used, written and oral tests, and practices that can be measured.

3. Develop Instructional Strategies

Learning materials consist of student worksheets and e-learning facilities. Student worksheets consist of 16 learning activities contained in a predetermined lesson plan. The student worksheets are equipped with several examples of programs used for training in making programs used for practicum in the Basic Computer Programming subject. 80% of learning presentations are carried out by practicum, which includes (a) the practice of understanding C++ programming and (b) understanding algorithms in the form of a programming language as well as various functions and features in it, such as essential algorithm functions, text functions, logic functions, making processing data and modifying programs based on several cases the algorithm is translated into the form of a programming language. (c) introduction to the C++ programming language environment and its modifications, (d) data processing and steps to modify the program data storage file. While the other 30% is used for face-to-face learning, which is carried out with a teaching model explaining how to use C++ algorithms and programs as practical applications. This series of learning processes is carried out in a way that is inseparable from the curriculum for selecting the learning strategies used.

4. Develop Instructional Materials

Designing a lesson needs to be designed starting from the teaching materials that will be used and the material in order to achieve the learning objectives. Through the development of learning materials, two things are carried out, namely contextually in terms of the form of the learning activities to be carried out and the place where the education is held. These considerations are aimed at determining what kind of packaging the subject matter will be packaged. With the support of existing e-learning facilities, it will be able to realize the implementation of the learning process in accordance with the objectives of delivering the desired instructional material.

Produce teaching materials that students can use when they are going to study theoretically about learning discussed in teaching material. Students obtain textbook material and obtain it by downloading it. In addition to the textbooks that can be obtained, students can also view practice modules at each teaching meeting, which can be viewed, downloaded, and printed as practicum material.

5. Evaluation and Revision

The steps for developing the development model research (research & development) are carried out in a planned and structured manner in three stages, namely: (1) Evaluating experts, (2) Student evaluating and (3) Student evaluating.

1. Evaluating experts - The evaluation process is carried out by making an evaluation instrument in the form of a questionnaire or in the form of a checklist by our experts. They have competency in programming, language, and information technology.
2. Student evaluating - The resulting learning materials have several sections consisting of electronic textbooks and practicum modules.
3. Small group testing - This testing was given to small group students, with results using laboratory practicum and learning with a virtual laboratory, as shown in Figure 2.

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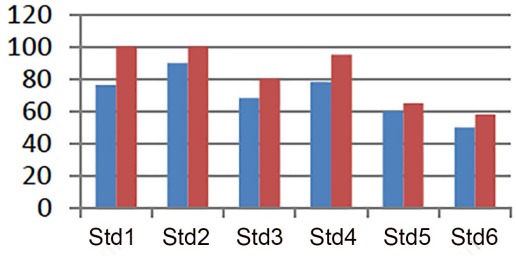

Figure 2 Graph of small group learning outcomes

V. Conclusion

The practicum subject of Basic Computer Programming uses the C++ programming language, used as a research topic to study. Practically learning this subject is carried out in a computer laboratory equipped with C++ application software as a programming language for practical implementation, but it can be done using this practical learning model virtually.

The discussion and results of this study, the following conclusions can be drawn:

1) Before this model was implemented, learning Basic Computer Programming subjects were usually carried out through lecture and demonstration methods followed by making computer programs using the C++ programming language in a computer laboratory. The teacher delivers the subject matter in front of the class or laboratory; then students follow the teacher's directions to practice by developing the program. After testing the virtual-based learning model, students can study the material and see tutorials for making programs outside the laboratory apart from the existing practicum schedule.

2) Using existing concepts, A virtual-based learning model in the Basic Computer Programming subject is prepared. Virtual learning is a form of learning with the help of and utilizing existing e-learning facilities, which, use the internet for activities outside the classroom. Students carry out these activities using laptops or PC computers or smartphone.

3) Virtual-based learning materials for the Basic Computer Programming subject have gone through formative evaluations, including (1) Evaluating experts, (2) Student evaluating and (3) Student evaluating.

The results of the evaluation show an increase in achievement. After carrying out a formative evaluation of the learning materials, the results can be implemented in the learning process of Basic Computer Programming subjects to increase student understanding.

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