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The Inquiry Collaborative Learning Design Virtual Laboratory Based and Remote Virtual

Wilda Susanti[1*], Gusrio Tendra[2], Rangga Rahmadian Yuliendi[3], Arden Simeru[4], Johan[5], Rudi Mulya[6]

[1*] Teknik Informatika, Institut Bisnis dan Teknologi Pelita Indonesia, Indonesia

[2,3,5]Sistem Informasi, Institut Bisnis dan Teknologi Pelita Indonesia, Indonesia

[4]Sistem Informasi, Sekolah Tinggi Teknologi Pekanbaru, Indonesia

[6]Teknik Elektro Industri, Universitas Negeri Padang, Indonesia

Corresponding Email: wilda@lecturer.pelitaindonesia.ac.id

Abstract:

This study investigated the design of learning in a virtual laboratory through collaborative inquiry and its effect on student knowledge. Learning design produces learning models that are measured based on validity, practicality, and effectiveness. The research method uses research and development that produces products and product effectiveness. The trial results were conducted on a small scale on eight students to measure the quality of student learning. To test the validity of the product through expert assistance, all the answers of the validator were calculated using Aiken's V validity coefficient. Further findings implied that students have begun to accept technology as a learning tool and provided opportunities for universities in learning development.

Keywords: *Inquiry collaborative learning, Learning design, Virtual laboratory*

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Introduction

In the 21st century, it is required to have skills to master various skills, including (critical thinking and problem-solving), (collaboration), (communication) and (creativity, and innovation) (Bialik & Fadel, 2015) . The field of science and technology in the 21st century is proliferating, bringing human civilization into a new phase of the industrial revolution 4.0 era (Popkova et al., 2019). This phase implies the emergence of a Massive Open Online Course (MOOC), drastically changing the worldwide perspective and practice of education (Sudira, 2018). The framework of learning skills needed in the industrial revolution 4.0 implicitly includes digital literacy skills (Trilling & Fadel, 2010), (Ozer et al., 2015), (Vista et al., 2018), (Khasanova & Sanger, 2018), (Wrahatnolo & Munoto, 2018).

Remote laboratory development supports active learning with inquiry and collaborative learning strategies. Students can develop personal and interpersonal skills, communication, and collaborative work in teams (Maarouf et al., 2012), (Susanti, 2021). It is intended to encourage students to learn through inquiry and collaborate on problem-solving skills (Sturner et al., 2017) Figure 1.

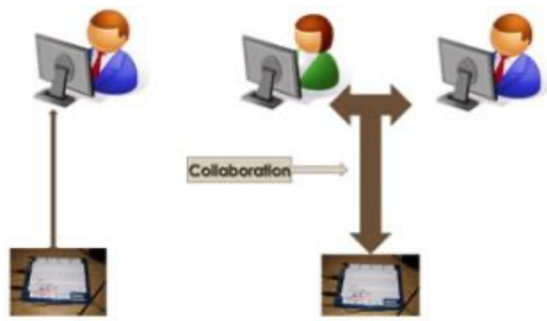

Figure 1. Collaborative experiment in ICT

Collaboration is an adjective, meaning the interaction of several people forming a group to achieve a common goal while respecting everyone's contribution (Sturner et al., 2017). Collaborative learning (Figure 2) is a social interaction that occurs in collaboration using social interaction as a method for gathering knowledge.

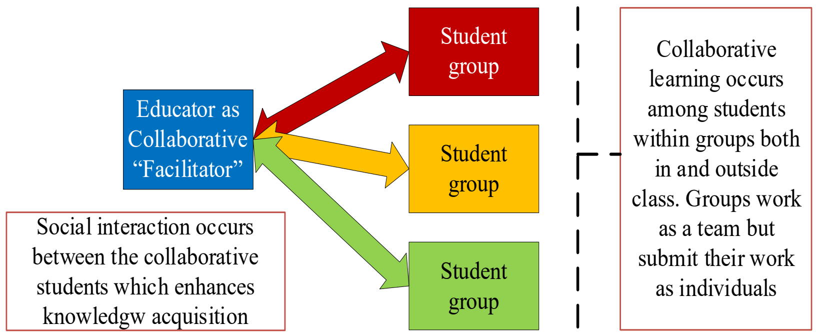

Figure 2. Collaborative learning

To improve high-level skills students, critical students are needed who can connect new knowledge with the knowledge that students have previously. Critical thinking will arise from social interactions between lecturers and students and between students and other students. In addition, learning styles and basic human abilities are important factors for growing critical thinking skills. The formation of critical thinking skills is based on the constructivism learning theory. Whereas constructivism focuses on the demand that students be able to construct or form new knowledge based on the knowledge, they have with the conditions experienced at that time (Kwan & Wong, 2015).

Research Method

This research is based on Research and Development developments that produce products and will be tested for their effectiveness. The products produced are virtual and remote lab models through collaborative inquiry learning designs. Development is based on research studies for programming learning (Susanti, Jama, et al., 2021). The model developed from the research results of researchers (Susanti, Ry, et al., 2021) obtained six steps in the collaborative inquiry learning model.

The research development procedure adopted from Borg & Gall was adopted into four stages, namely only until small-scale trials, 1) conducting product analysis; 2) developing initial products; 3) expert validation and revision, and 4) small-scale trials and product revisions. Small-scale trials were conducted on eight students to measure the quality of student learning.

Product development begins with the first st age of needs analysis. We see the problem in the object of research. This is needed to design collaborative online learning based on virtual and remote labs for programming practice. A literature review needs analysis to determine the difference between desired or supposed conditions. The second stage of initial product development is to design learning by designing learning in network architecture for virtual labs and remote labs. Learning design is needed for the concept of a collaborative inquiry learning model developed by researchers (Susanti, Ry, et al., 2021). The third stage is validation and revision, where the resulting product must be validated first to see validity, effectiveness, and practicality. The fourth stage is a small-scale trial, aiming to measure the practicality of the designed learning model. The trial was conducted on eight students to see changes in behavior in participating in virtual lab-based inquiry collaborative learning for programming learning. Instruments for analyzing student needs with indicators (student perception, learning experience, model development needs) and lecturers with indicators (lecturer perception, learning experience, model development needs).

The questions given to the students above were assessed based on a Likert Scale with five weighting criteria, namely: strongly agree (SS) with a weight of 5, agree (S) with a weight of 4, doubtful (RR) with a weight of 3, disagree (KS) with a weight of 2, and disagree (TS) with a weight of 1. Table 1 and 2 are a grid of instruments for product validation and practicality, and Table 3 indicates student psychomotor assessment.

Table 1. Instrument Validation Grid

No	Indicator	Amount
1	Eligibility of the contents of the instrument validity	5
2	Eligibility of validity instrument language	8
3	Feasibility of the graphic content	5

Table 2. Grid of Product Practicality Validation Instruments

No	Aspect of Validation	Indicator
1	Eligibility of the contents of the instrument validity	1. Instructions in the assessment of complete practicality instruments. 2. Statements in the practicality instrument according to the instrument grid. 3. Assessment of the statement formulation in the practicality instrument is arranged according to the assessment indicators. 4. The statements in the practicality instrument are developed according to the needs of the practicality assessment. 5. The distribution of items in the practicality instrument has a balanced number of statements
2	Eligibility of validity instrument language	1. The language used in the practicality questionnaire is straightforward. 2. The language of the practicality questionnaire has good grammar. 3. The practicality instrument questionnaire uses the standard term Enhanced Spelling Guidelines. 4. The practicality instrument questionnaire has an easy-to-understand language. 5. The practicality instrument questionnaire has a communicative language.
3	Feasibility of the graphic content	1. The display of the text in the practicality instrument is clear and legible. 2. The display of the text in the practicality instrument has writing that is by the rules of scientific writing. 3. The display of text in the practicality instrument has line spacing by the rules of scientific writing. 4. The display of text in the practicality instrument looks like an orderly arrangement of columns. 5. The text in the practicality instrument is printed on paper with clear writing colors

To test the validity, it can go through the help of experts by looking at the construct, and suitability can be seen in Table 4—validity test analysis by calculating the average score of all validator answers using Aiken's V validity coefficient.

Aiken's V formula in calculating the Content Validity Coefficient is based on an expert's assessment of the item regarding the item representing the construct being measured. The assessment is given a weight of 1-5. Validity testing with the following criteria, where 1 = Very Poor (SK), 2 = Not Good (KB), 3 = Currently (SD), 4 = Good (B), and 5 = Very Good (SB). Here is the formula for Aiken's V, like Table 4.

Table 3. Assessment Indicators from Psychomotor Aspects

No	Basic Competencies	Indicator	Instruments
1	Understand basic algorithms, languages programming, and algorithm writing techniques	Completeness of the contents of the summary and the truth of the contents of the summary	Final assignment assessment rubric
2	Resolve use cases of data types, variables, and constants. Resolve input and operator command use cases.	Logic thinking	Program Assessment Rubric
3	Translating algorithm design into programming language syntax	1. Communicate 2. Problem-solving creativity. Completeness of the syntax used.	Program Assessment Rubric
4	Solve branching or selection structure cases.	Structural selection accuracy	Program Assessment Rubric
5	Creating programs	1. Logic thinking 2. Syntax accuracy used	Program Assessment Rubric
6	Use a function that fits the case.	Subprogram selection accuracy	Program Assessment Rubric
7	Use procedures appropriate to the case.	Completeness of the syntax used.	Program Assessment Rubric
8	Analyze and choose the use of functions and procedures in a problem.		Program Assessment Rubric

Table 4. Expert Validation Criteria

No	Percentage (%)	Predicate
1	$0.80 < V \leq 1.00$	Very High
2	$0.60 < V \leq 0.80$	High
3	$0.40 < V \leq 0.60$	Enough
4	$0.20 < V \leq 0.40$	Low
5	$0.00 < V \leq 0.20$	Very Low

Result and Discussion

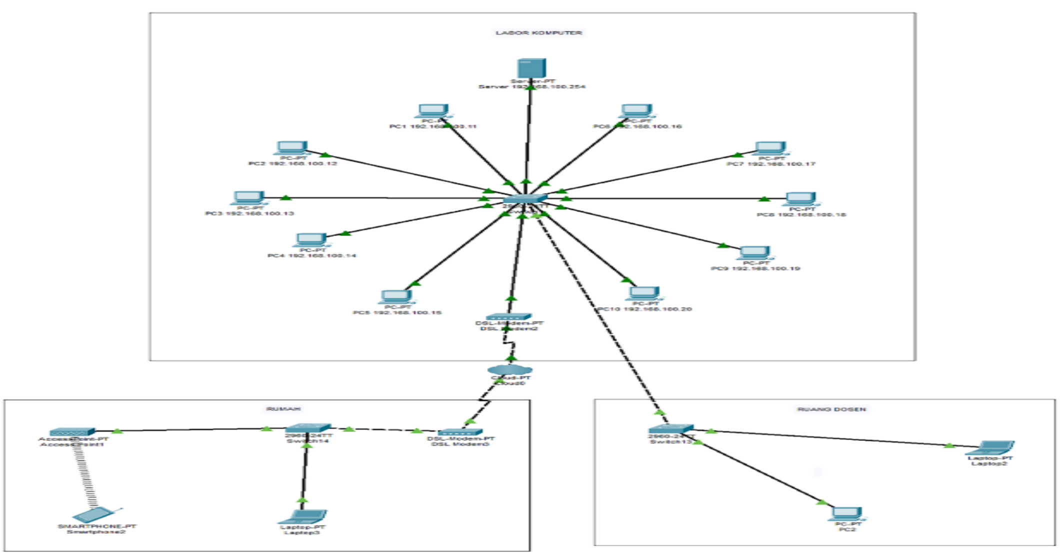

Figure 3. Network topology for virtual lab and remote lab

Table 5. Steps of Inquiry Collaborative Learning

No	Step Description	Lecturer Activities	Student Activities
1	Goals and Motivation	1. Provide information related to learning outcomes and expected final abilities and Intro-duce the Inquiry-based OCL model in Algorithm and Programming courses. 2. Provide information on the form of independent assignments and group assignments that will be made. 3. Guide access to E-Learning 4. Explain the characteristics of the course and the importance of the concept of algorithms in solving problems. 5. Explain the assessment criteria for one semester 6. Motivate students why Algorithm and Programming are important 7. Reflect on students' prior knowledge 8. Doing a pretest	1. Take the pretest given by the lecturer to determine the initial ability. 2. Students get text-books and student guidebooks. 3. Students hear an explanation from the lecturer about the learning process for this one semester.
2	Information Presentation	1. Prepare and organize learning resources as a means for students to collaborate. 2. Explain the basic concepts of algorithms and programming 3. Explain the basic concept of the algorithm 4. Explain the programming language used to open the student's flow of thinking Give examples of cases in everyday life	1. Students ask about the lecturer's explanation. 2. Students face problems that students consider to be challenging to solve.
3	Identification of problems	1. The lecturer asks each student to identify and formulate problems in everyday life 2. Lecturer asks students to identify problems related to learning materials	1. Every student detects problems in life 2. Each student identifies and formulates problems.
4	Forming an Online Discussion Group	1. Lecturers divide study groups heterogeneously 2. Provide facilities for online discussions 3. Lecturers raise awareness of social interaction through online applications. 4. The lecturer gives a case to be solved 5. Lecturers provide opportunities for students to participate in the learning process actively 6. The lecturer observes each discussion in the group	1. Each student plays an active role in discussions related to the given case 2. Students work together, discuss and conclude the results of the discussion.
5	Inquiry Process	1. The lecturer asks students to make presentation related to the finding of the problem-solving given 2. The lecturer asks students to test the knowledge gained by using a programming language	1. The lecturer asks students to make presentations related to the findings of the problem-solving given. 2. The lecturer asks students to test the knowledge gained by using a programming language.

6	Establishing New Knowledge	Assess the resulting program	Students present the results of the knowledge provided in the form of algorithmic and program syntax using a programming language
7	Evaluation	Final evaluation	

Based on the results of the needs analysis conducted based on the perceptions, experiences, and needs of the learning model, it was found that there was a gap between reality and expectations. The lack of student motivation and interest in learning was because it needed to be supported by a flexible learning model. For the results of the needs analysis according to the lecturer's perception during teaching programming courses, lack of motivation in learning, lack of interest in learning, and difficulty in encouraging student activity. Computers did not support collaborative learning.

Students' lack of active participation in every learning activity in understanding the concepts of the lecture material, resulting in the understanding of the subject matter, is still considered less than optimal, which in turn, the learning outcomes achieved by students still need to be higher. So that this does not happen, various efforts need to be made, one of which is to determine learning methods that can actively involve students in learning activities. In this case, the researcher tries to offer and describe a virtual and remote lab-based learning design, using the inquiry collaboration method to improve the connection skills of lecture material in students.

According to Rivera and Petrie (2016) virtualization schemes can provide experiences for students, and lecturers can act as a team for students with a system in a collaborative concept. The Virtual lab model allows network topologies to be configured to communicate internally (Rivera & Petrie, 2016). The network architecture design for virtual lab-based learning in this study can be seen in Figure 3.

Figure 3 shows the network topology when learning. The computers in the laboratory are connected to the client-server network. The server computer is on the lecturer's computer, and the computer in the laboratory is a client computer. Utilization of net support is needed to connect the server computer and the client computer. The connection to the laboratory for the lecturer's room uses a switch with the same IP. Meanwhile, at home, the connection to the computer laboratory uses an Indi-home modem, and remotely the server computer uses the team viewer application with the team viewer id. Furthermore, there will be a learning process through inquiry collaboration, as seen in Table 5.

The effectiveness of the designs and models used is measured based on discipline, cooperation, discussion, and responsibility, as shown in Table 6.

Table 6. Affective Aspect Learning Outcomes

Observer	Discipline	Cooperation	Discussion	Responsibility
1	82	86.2	87.2	86
2	81.5	84	86.8	88.2
Average	81.75	85.1	87	87.1

Table 6 shows that there are seven learning steps based on research results (Krismadinata & Susanti, 2021). This model can be applied in the development of learning based on virtual labs and remote labs. Thus, the students' effective results are shown in Table 6; the average value of discipline, cooperation, discussion, and responsibility is 85.23. These results show that students can work together using virtual-based technology for programming learning.

Conclusion

Based on the study's results, it was found that the design of a virtual lab-based and remote lab-based model with a collaborative inquiry learning model can improve the student experience in practicing skills in discipline, collaboration, discussion, and a sense of responsibility. Experts have validated this learning design. The results of the practicality of the design and learning model are declared valid and practical. This model can be recommended for programming learning by designing computer labor connected with net support so that the lecturer's computer can be used as a server computer to act as a controller of the client computer in the computer lab.

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