Learning Flexibility and Innovation in the Post-Covid-19 Pandemic Era

Oriza Candra
Universitas Negeri Padang

Dony Novaliendry
Universitas Negeri Padang

Putra Jaya
Universitas Negeri Padang

Yasdinul Huda
Universitas Negeri Padang

Irdayanti Mat Nashir
Universiti Pendidikan Sultan Idris

Educators employ technology in the twenty-first century to build knowledge and soft skills to enhance competencies that fit with the demands of the workplace. With the advent of new technologies in education, instructors' perspectives on the learning process have shifted. We employ a research-based method to assist students in learning to program. Analysing an online collaboration environment enables the use of several solutions. In a group, collaboration does not occur spontaneously. This project aims to build student understanding of the COVID-19 pandemic both during and after it occurs. The findings indicated that in an online and offline collaboration setting, student learning success, particularly in computer programming abilities, rose compared to traditional collaborative classrooms. Additionally, students who studied using the suggested strategy improved their cognitive, emotional, and psychomotor learning outcomes.

Keywords: education, student learning, COVID-19, online, offline

INTRODUCTION

The outbreak of the Covid-19 pandemic has resulted in all learning being applied online, including in universities. Online learning started two semesters ago, namely from the even semester of 2019/2020 and the odd semester of 2020/2021. Since the Indonesian government declared March 1, 2020, Covid-19 is a contagious pandemic disease that enters through breathing, social distancing, and physical distancing, policies have begun to be implemented (Abanyam & Onimawo, 2020). The learning process was initially conventionally. Lecturers and students met face-to-face and immediately turned into online learning. The online learning model requires educators and students to have creativity and skills in using technology

(Roth, 2015). Because of the pandemic decries at the end of 2021, the government will make a new policy about the learning process (Pratama, et.al., 2020). It will be half online and half offline.

Universities as a place for students to study are expected to provide the right atmosphere. Students are accustomed to completing complex and challenging tasks that require them to think deeply and organize their way of learning in their style. Students are conditioned to have the ability to work well with friends, teachers, or experts that involve higher-order thinking. Students must be proficient in using technology to make decisions, solve problems, and create creative and innovative new ideas (Roth, 2015; Novaliendry, et.al., 2021; Novaliendry, et.al., 2021).

Along with institutions' attempts to achieve educational success criteria, students need to navigate the 21st-century learning process (Pikhart & Klímová, 2020). Education experts define a variety of academic achievements or skills required of 21st-century students, including the following: 1) having a thinker's character, capable of innovative, creative thinking characterized by high adaptability, solving complex problems, strong self-control, and self-direction; and 2) being self-directed. 2) Productive and very motivated in work. 3) Possessing the capacity to establish priorities, create strategies, and track the outcomes obtained 4) Communication skill, as shown by the capacity to work in various teams, interact, and create interpersonal connections (Hendriyani, et.al., 2020).

The development of an inquiry-based online collaborative learning model in the field of Informatics Engineering expertise needs to be developed. This is due to changes in knowledge in the 21st century that require learning to be integrated with technology (Kandakatla, 2020). This change affects the delivery process in education, including the teaching and learning process. Lecturers are already required to utilize emerging technologies to develop graduate knowledge and soft skills to improve student competence in meeting employer requirements (Verawardina, 2020; Verawardina, et.al., 2020).

Learning in the twenty-first century prepares and allows future generations to acquire the knowledge, skills, and abilities necessary to master information and communication technologies and tackle future globalization challenges. The teaching framework for the twenty-first century proposed by Zurweni, et.al. (2017) explains that the skills required for success in this era of globalization are future-oriented, which is increasingly difficult but can be accomplished through the use of the 4C Standards: critical thinking and problem solving, communication, collaboration, creativity, and innovation (Ahonen & Harding 2018). Internet technology advancements have created new opportunities to develop and apply software education methods for computer-supported collaborative learning (Nguyen, et.al., 2016).

The online collaboration model is a learning model that is built and implemented based on workflows and standards developed in conjunction with the STAD type collaborative learning model. Collaboration not only involves students in a team or study group, but lecturers are also involved in the group members as learning facilitators.

An online collaborative model is defined as a procedure or step that researchers need to take to help students learn in groups, participate, interact, and jointly complete a task in algorithms and programming courses (Harun, et.al., 2021). The online collaboration model provides students with opportunities to develop critical thinking skills, create frameworks, and work together to complete assignments (Sankaranarayanan, et.al., 2020). Algorithm and Programming learning outcomes produce cognitive, psychomotor, and affective competencies. The behavior of the cognitive domain of students is behavior that is the result of thinking. Psychomotor behavior related to learning output includes skillful engineering involving muscles and physical strength. Affective behavior integrates feelings, attitudes, interests, emotions, and values (Bennedsen &Caspersen, 2019).

Algorithm and Programming is the first subject that students take in programming. This course explores solving existing issues by developing programming algorithms and their implementation in programming languages. One of the course's competencies is logical, critical, systematic, and inventive thinking in the context of creating or implementing science and technology that respects and incorporates humanistic values. As a result, students must possess the computer programming abilities required of all computer science students (Susanti, et.al., 2020). This course necessitates the development of a set of cognitive processes via practice and the authoring of algorithmic solutions (Francisco & Ambrosio, 2015). Program

learning is required to enhance students' problem-solving abilities and provide them with fundamental computer science skills (Pirinen, 2017).

Students struggle to comprehend fundamental programming ideas, are proficient at problem-solving, namely identification, algorithms created into program code, and have poor student learning outcomes due to lack of motivation and ineffective learning (Ortiz-Rojas, et.al., 2017; Susanti, et.al., 2021; Khaleel, et.al., 2017). The research found that the pass rate for programming after 12 years grew by just 5%, which is unsurprising given the program's difficulty until programming schools' failure rate phase is almost the same (Susanti, et.al., 2020). This is because their problem-solving skills are unsuccessful (Febrian & Lawanto, 2018). Meanwhile, pupils must possess cognitive abilities, the ability to handle complicated issues, and attitudes and drive to compete (Brennan & Resnick, 2018). They blend mastery of knowledge and technology into solutions in response to century trends, according to Yee-King, et.al. (2017).

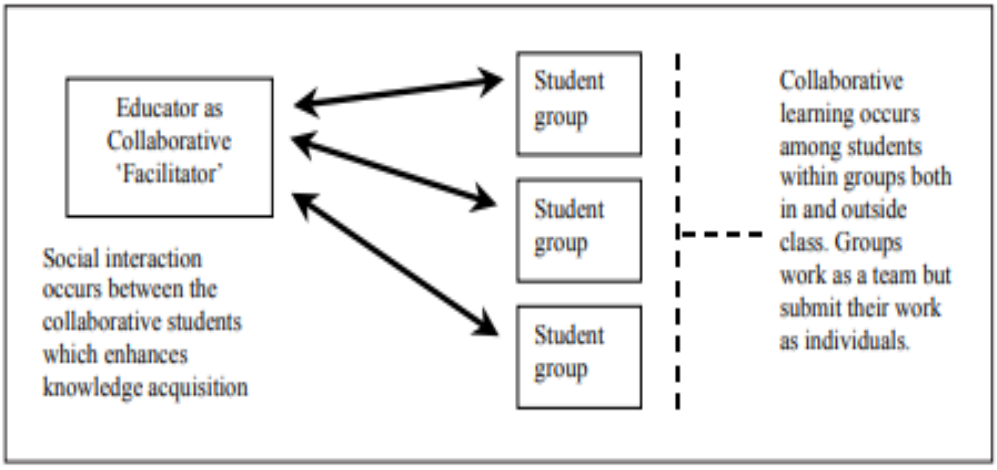
An online collaborative learning environment with inquiry-based practice strategies is proposed to increase social interaction among students to find concepts and understand complex problems (Yee-King, et.al., 2017). Programming training in algorithms and programming courses must be learned through an observation process. Observations or experiments must be carried out to explain or test the truth of the concept so that students can feel the idea in context (Orion, 2017). Previously it was suggested to study outside the classroom to provide direct experience of the learning process; therefore, the curriculum developed should teach students to identify and classify phenomena, techniques, skills, and concepts learned in a certain way.

Investigating the effectiveness of the proposed approach during the learning activities, team members identified problems from the assignments given by the lecturer. They started posing problems collaboratively to design new programming assignments. They then collaborate to complete the task. Students in the team carry out a search process to find a solution to the problem in a flowchart. Lecturers check the results and provide feedback. After that, the task is implemented with a programming language to prove the concepts obtained. Each team tries to complete the task proposed by the lecturer. The final result of learning is given an evaluation to see students' cognitive in learning.

Collaborative Learning

Collaboration is an adjective that refers to the interaction of multiple individuals who join a group to accomplish a shared objective while acknowledging each individual's contribution (Nason & Woodruff, 2004). Collaborative learning Figure 1 is a kind of social interaction when people work together to gain information.

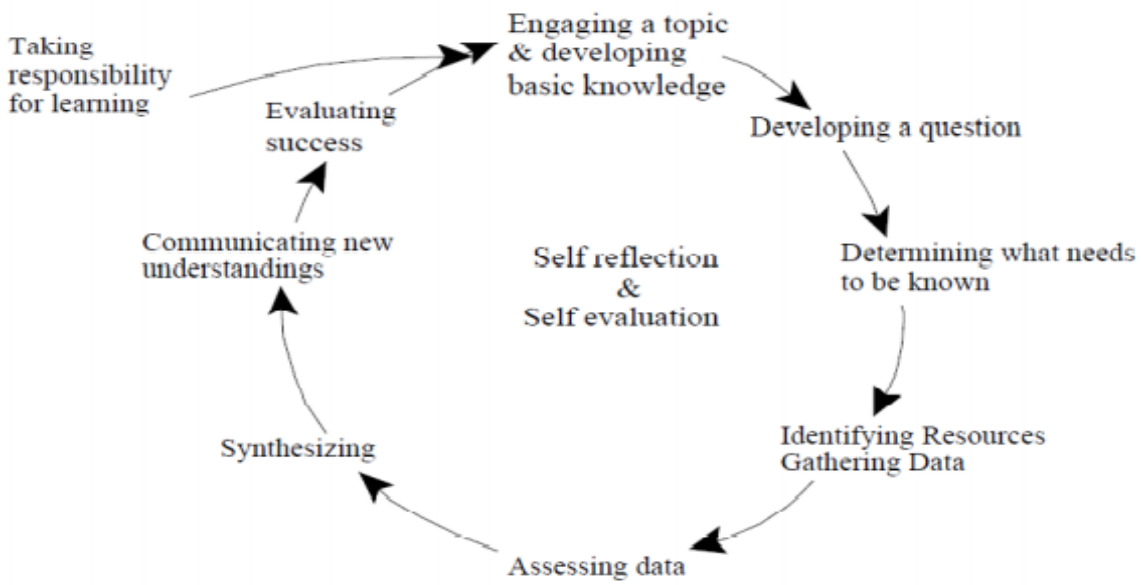
FIGURE 1
COLLABORATIVE LEARNING



Collaborative learning using an inquiry-based approach encourages students to actively share their thoughts, views, recommendations, and creative ideas about a particular issue (Sipayung, et.al., 2018). Lecturers may develop students' creative ability to create more time-efficient solutions. Additionally, the collaborative learning paradigm has the potential to close the gap between pupils with advanced academic talents and those with limited intellectual capacities. Collaborative learning may help students develop their ability to solve issues, reason, and collaborate on projects. This is evident when students collaborate in groups, submit hypotheses, interview lecturers, and communicate their thoughts or what they learn in the process—learning (Kasimatis, et al., 2010; Brailas, et al., 2017).

Figure 2 depicts the inquiry-based learning environment, emphasizing active responsibility for learning and comprehension while collaboratively developing knowledge. Developing new expertise via data collection and reflection (Eppes, et.al., 2020).

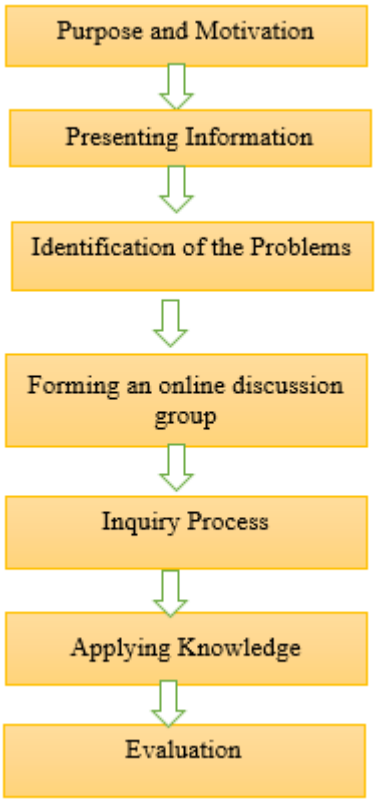
FIGURE 2
INQUIRY PROCESS



METHODOLOGY

This is an experimental study. The experimental design utilized in this study is a conventional experimental design. The population in this research were 31 students of the Informatics Engineering Study Program who took the Algorithm and Programming course during the 2020/2021 academic year. Two groups of students were formed. The experimental group consisted of fifteen individuals. The control group consisted of sixteen individuals. As seen in Figure 3, the Inquiry-Based Collaborative Model is a development model that combines seven processes with the STAD Type Collaborative by (Slavin, 2015).

FIGURE 3
STEPS FOR DEVELOPING AN INQUIRY-BASED ONLINE COLLABORATIVE LEARNING MODEL



The steps of the Inquiry-based Online Collaborative model can be described as follows.

Phase 1

Introductory activities and fundamental questions. Activities carried out by lecturers are: Lecturers motivate students in carrying out learning activities so that students are interested in participating in learning. Implementing learning in the preliminary activities (fundamental questions) is greeting and checking student attendance. Asking algorithm students in everyday life to see students' basic logic This real question is to see students' initial abilities in logical thinking skills. Determine the learning objectives according to the learning outcomes of the course. Guides Access to E-Learning. Explain the characteristics of the course and the importance of the concept of algorithms in solving problems. Prepare and organize learning resources as a means for students to collaborate.

Phase 2

Explain the basic concepts of algorithms and programming. Explain the programming language used to prove the student's line of thinking. Provide case examples and case studies to see students' thinking flow.

Phase 3

Perform problem identification. At this stage, the lecturer asks each student to identify and formulate problems in everyday life. Ask students to complete the title of the problem.

Phase 4

Dividing heterogeneous study groups provides online discussions Grow awareness of social interaction through online applications. Provide opportunities for students to participate in the learning process actively. Observe each discussion in groups.

Phase 5

Emphasizes student activities maximally to seek and find knowledge—lecturers as facilitators and motivators.

Phase 6

Lecturers provide opportunities to prove new knowledge by testing programming languages.

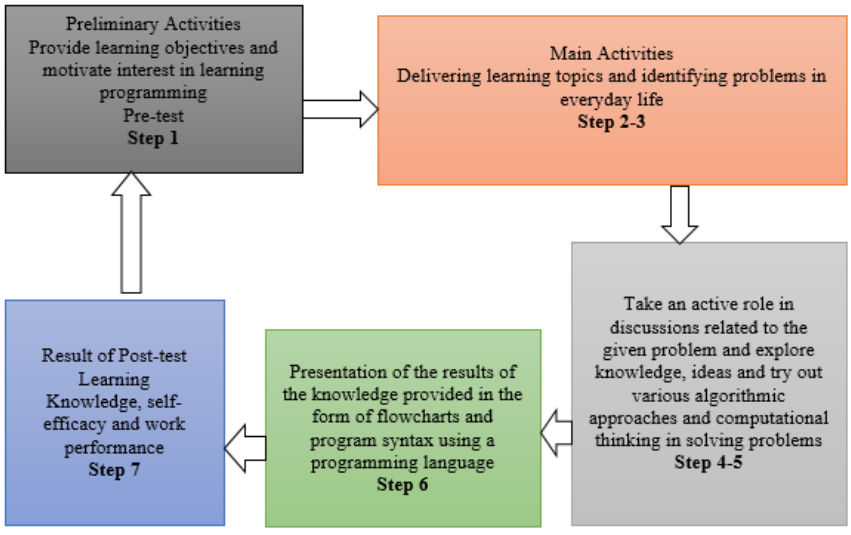
Phase 7

Evaluation, Measuring the final ability of students to gain knowledge and skills of students.

RESULT AND DISCUSSION

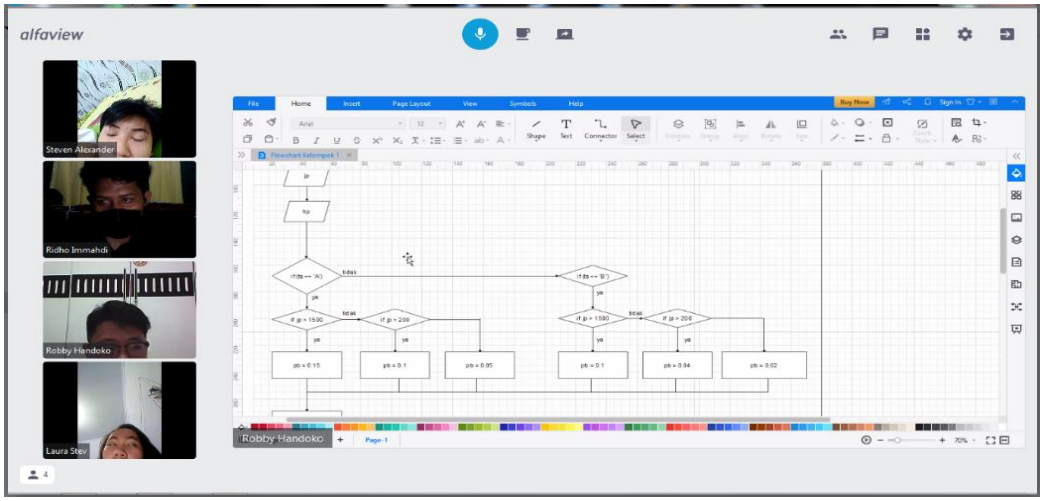
The preliminary student learning activity is the initial stage of the lecture. The lecturer provides learning objectives and motivation to attract students' interest in learning and self-reflection. Provide information related to lecture material and ask students to identify problems related to the given case. Lecturers guide them to discuss in online groups to discuss solving problems. Furthermore, students explore knowledge by looking for sources from outside or in the e-learning that has been provided. Students' final results are asked to make presentations and test programs using the C++ programming language. After the learning activities, pre-test and post-test were carried out. Figure 4 shows the activities carried out during the learning process.

FIGURE 4
INQUIRY-BASED ONLINE COLLABORATIVE LEARNING ACTIVITIES



The display of online student discussions can be seen in Figure 5.

FIGURE 5
ONLINE COLLABORATIVE ACTIVITIES



Display of program implementation in e-learning.

FIGURE 6
PROGRAM IMPLEMENTATION

The needs analysis questionnaire was analysed using descriptive techniques. The purpose of this questionnaire is to see if there are gaps that have occurred so far in learning before the new model is implemented. The needs analysis will see how much they need new learning models in Algorithm and Programming courses.

The needs analysis instrument aims to fix problems in learning in the Algorithm and Programming course by knowing the causes so that what is expected from the learning objectives in this course can be achieved. This instrument is distributed to students before the teaching activity takes place. The needs analysis instrument can be seen in Table 1.

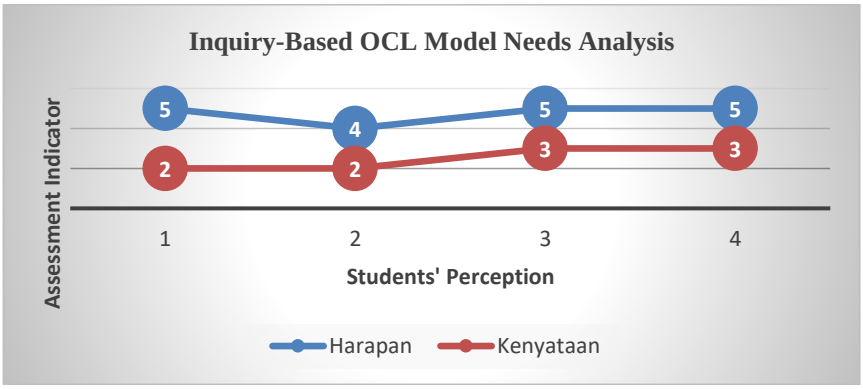
TABLE 1
NEEDS ANALYSIS INSTRUMENT

No	Indicator	Total
1	Student Perception	5
2	Learning Experience	10
3	Model Development Needs	8

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.

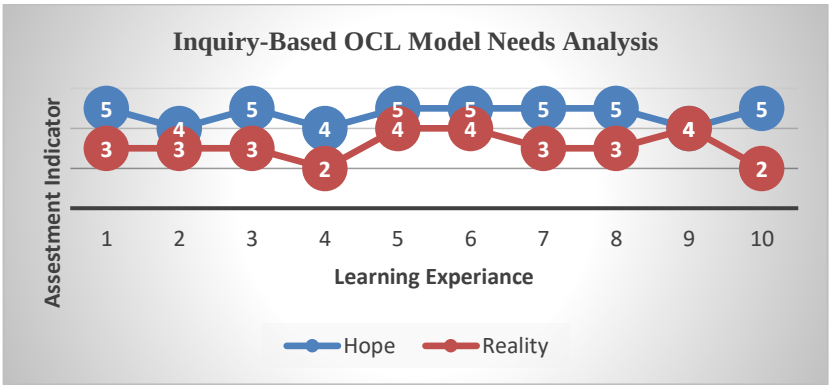
According to student perceptions during lectures, the needs analysis results with an inquiry-based online collaborative model such as motivation in learning, interest in learning, learning difficulties, and interest in the model to be developed. The results obtained can be seen in Figure 7 below:

FIGURE 7
STUDENTS' PERCEPTIONS OF THE NEED FOR AN INQUIRY-BASED ONLINE COLLABORATIVE LEARNING MODEL



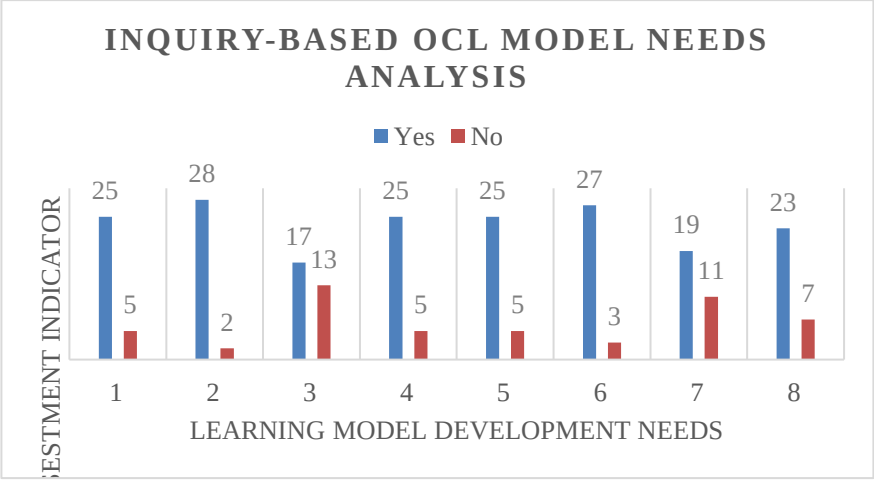
Needs analysis based on student experience with methods/models/media, learning facilities, and student experience with learning, with the following results:

FIGURE 8
RESULTS OF INQUIRY-BASED OCBL MODEL NEEDS ANALYSIS BASED ON STUDENT LEARNING EXPERIENCES



The results of the needs analysis based on the needs of developing an Inquiry-Based OCL model in the Algorithm and Programming course are presented in Figure 9 below:

FIGURE 9
RESULTS OF THE NEEDS ANALYSIS OF THE DEVELOPMENT OF AN INQUIRY-BASED ONLINE COLLABORATIVE MODEL BASED ON STUDENT NEEDS



Cognitive Aspects of Pre-Test and Post-Test Results

From a cognitive standpoint, the effectiveness metric assesses how well students do on examinations or activities, most notably while examining a solution algorithm in the Algorithm and Programming course and other practice problems.

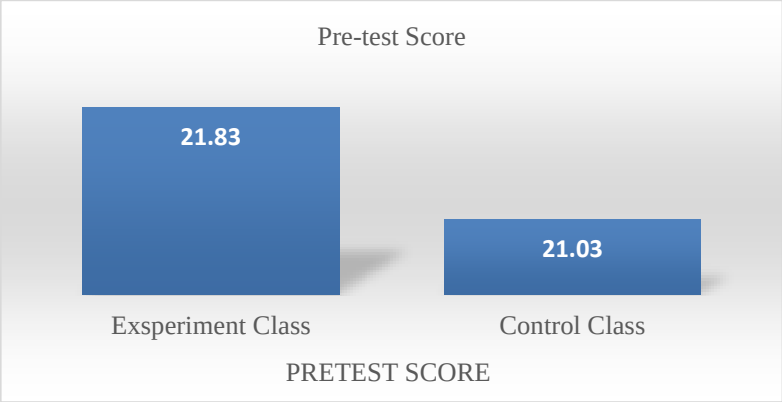
Before testing, the questions must be developed with their degree of difficulty in mind. The difficulty level of the questions indicates the degree of difficulty or ease with which the questions are to be tested. The degree of difficulty of the questions can be classified as follows:

TABLE 2
CATEGORY OF QUESTION DIFFICULTY DEGREE

Number	Interval	Category
1	0,00 < 0,30	Difficult
2	0,30 < 0,70	Medium
3	0,70 < 1,00	Essay

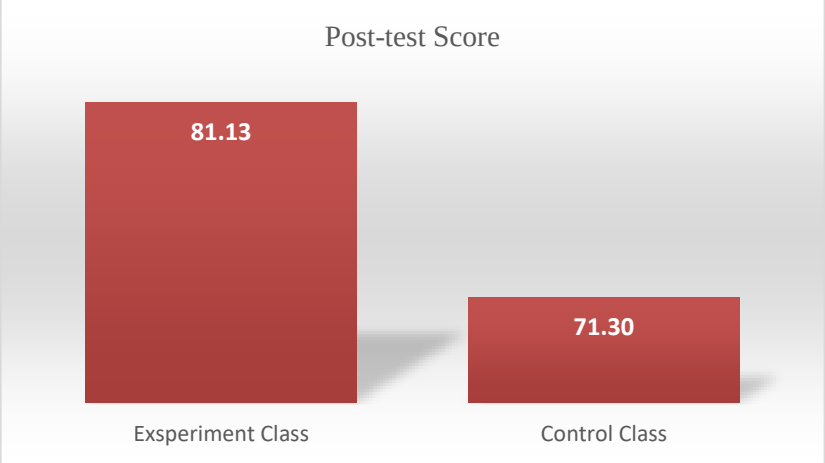
A pre-test is given before starting the learning material. Pre-test aims to determine the initial cognitive abilities of students whether the test subjects have the same skills and come from the same sample. The results of students' cognitive tests in both classes to assess students' initial abilities can be seen in Figure 10.

FIGURE 10
PRE-TEST RESULTS BEFORE STUDENTS STUDY



After the learning material is finished, the post-test is given to see the effect on students' cognitive learning outcomes. The results of the post-test are shown in Figure 11.

FIGURE 11
STUDENT LEARNING POST-TEST RESULTS



The independent-sample t-test (T-test) aims to see the difference in learning outcomes between the control and experimental classes after conducting the pre-test and post-test. The hypotheses proposed in this test are:

Ho: *There is no difference in the average pre-test results of control and experimental class students.*

Ha: *There is a difference to the average student pre-test results control and experiment class.*

Decision-making basis:

1. If the significance value or sig. (2-tailed) > 0.05, then Ho is accepted, and Ha is rejected.
2. If the significance value or sig. (2-tailed) < 0.05, then Ho is rejected, and Ha is accepted.

The three tests above use IBM SPSS Statistics 24.

The test results obtained an independent sample t-test with sig .909 > 0.05, with the same variance. Then the value of t-count at equal variance assumed is 5,178 with a significant probability of 0.000 (two-tailed) and at t table = 1.703. Then t-count > t table or 5.178 > 1.703.

It was concluded that there were differences in student learning outcomes who were taught using a developed model from conventional learning

Affective Aspect

The affective aspect is students' attitude in learning seen from discipline, cooperation, group discussion, and responsibility. The students' affective scores/attitudes for the two groups can be seen in Figures 12 and 13.

FIGURE 12
AFFECTIVE ASPECTS OF INQUIRY-BASED OCL LEARNING IN THE CONTROL CLASS

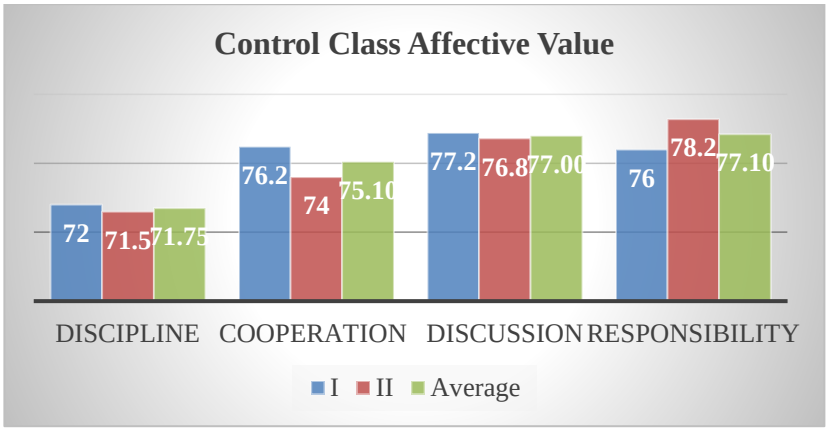
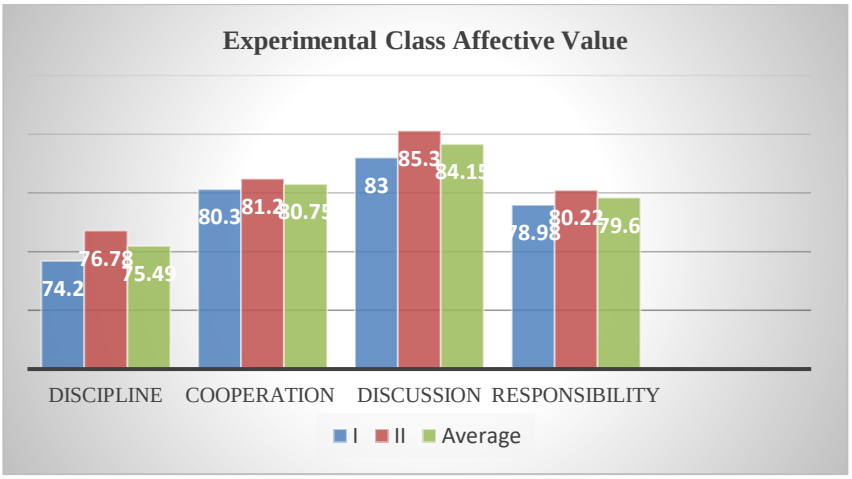


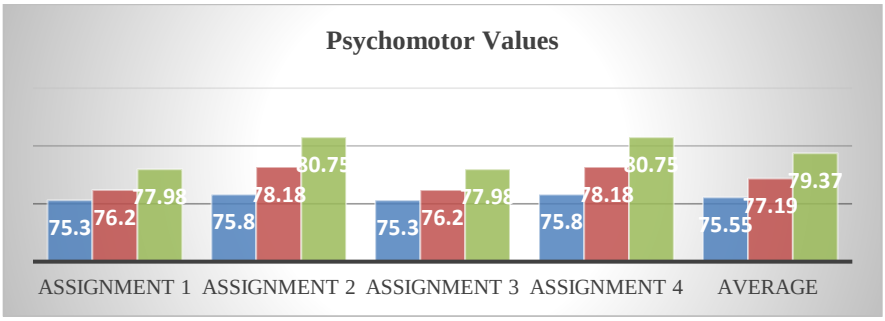
FIGURE 13
AFFECTIVE ASPECTS OF OCL LEARNING BASED ON EXPERIMENTAL CLASS INQUIRY



Psychomotor Aspect

The psychomotor aspect is the value of student skills in giving the final assignment in groups, as shown in Figure 14.

FIGURE 14
PSYCHOMOTOR RESULTS OF INQUIRY-BASED OCL LEARNING



CONCLUSION

The inquiry-based online collaborative learning model is learning that is done online. The inquiry-based online collaborative learning model here can create flexible learning and can be done at any time, and in various places, there are interaction and activity facilities. The syntax in the inquiry-based online collaborative learning model is sharing instructional content online. The proportion in online learning will explain its function as a supplement, complement in learning, make an appropriate schedule, and approach through synchronous, asynchronous methods. The learning syntax includes Goals and Motivation, where students are given goals and motivation to carry out learning activities to attend lectures. Then Presenting Information Students explain the basic concepts of algorithms and programming. As well as getting case examples and case studies to see the student's thinking flow, which is then Identification of Problems where students identify and formulate problems in everyday life and complete the identification of these problems, for Group Of Discussion syntax Growing awareness of social interaction through online applications. Providing opportunities for students to participate in the learning process actively, Process Inquiry syntax emphasizes student activities to seek and find knowledge. The Applying New Knowledge syntax offers the opportunity to prove new knowledge by testing programming languages.

REFERENCES

Abanyam, F.E., & Onimawo, J.A. (2020). Green Netnographic Marketing Strategy for Eliminating Contact Research Practices in Nigerian Universities: A Post-Corona Virus Paradox. *Journal of Technology and Humanities*, *1*(2), 30–41. https://doi.org/10.53797/jthkkss.v1i2.4.2020

Ahonen, A.K., & Harding, S.M. (2018). Assessing online collaborative problem solving among school children in Finland: A case study using ATC21S TM in a national context. *Int. J. Learn. Teach. Educ. Res.*, *17*(2), 138–158.

Bennedsen, J., & Caspersen, M.E. (2019). Failure rates in introductory programming - 12 years later. *ACM Inroads*, *10*(2), 30–35.

Brailas, A., Avani, S.M., Gkini, C., Deilogkou, M.A., Koskinas, K., & Alexias, G. (2017). Experiential learning in action: A collaborative inquiry. *The Qualitative Report*, *22*(1), 271.

Brennan, K., & Resnick, M. (2012, April). New frameworks for studying and assessing the development of computational thinking. In *Proceedings of the 2012 annual meeting of the American educational research association, Vancouver, Canada* (Vol. 1, p.25).

Eppes, T., Milanovic, I., & Wright, K. (2020). *Improving student readiness for inquiry-based learning: An engineering case study*.

Febrian, A., & Lawanto, O. (2018). Do Computer Science Students Understand Their Programming Task?—A Case Study of Solving the Josephus Variant Problem. *Int. Educ. Stud. 11*(12), 26.

Francisco, R.E., & Ambrosio, A.P. (2015, June). Mining an Online Judge System to Support Introductory Computer Programming Teaching. In *EDM (Workshops)*.

Harun, F., Suparman, Hairun, Y., Machmud, T., & Alhaddad, I. (2021). Improving Students' Mathematical Communication Skills through Interactive Online Learning Media Design. *Journal of Technology and Humanities*, *2*(2), 17–23. https://doi.org/10.53797/jthkkss.v2i2.3.2021

Hendriyani, Y., Ramadhani, D., Nasution, T., Susanti, W., & Verawardina, U. (2020). Examining career development of informatics engineering vocational education students in the industrial revolution 4.0. *Int. J. Innov. Creat. Chang.*, *11*(4), 275–298.

Kandakatla, R., Berger, E.J., Rhoads, J.F., & DeBoer, J. Student perspectives on the learning resources in an Active, Blended and Collaborative (ABC) pedagogical environment. *Int. J. Eng. Pedagog.*, *10*(2), 7–31.

Kasimatis, K., Gkantara, C., Psycharis, S., & Petropoulou, O. (2019). Promoting STEM content epistemology in Technology enhanced collaborative learning environments. *International Journal of Physics & Chemistry Education*, *11*(2), 55–65.

Khaleel, F.L., Ashaari, N.S., Wook, T.S.M.T., & Ismail, A. (2017). Programming learning requirements based on multi perspectives," *Int. J. Electr. Comput. Eng.*, *7*(3), 1299–1307.

Nason, R., & Woodruff, E. (2004). Online collaborative learning in mathematics: Some necessary innovations. In *Online collaborative learning: Theory and practice* (pp. 103–131). IGI Global.

Nguyen, V., Dang, H.H., Do, N.K., & Tran, D.T. (2016). Enhancing team collaboration through integrating social interactions in a Web-based development environment. *Comput. Appl. Eng. Educ.*, *24*(4), 529–545.

Novaliendry, D., Huda, A., Cuhanazriansyah, M.R., Sani, H.K., Hendra, H., & Karnando, J. (2021). E-Learning Based Web Programming Course in the COVID 19 Pandemic Time. *International Journal of Interactive Mobile Technologies*, *16*(20).

Novaliendry, D., Huda, A., Sanita, D., Putra, D.A., Nasution, M.D.F., Putra, R.S., & Hidayati, R.N. (2021). Android-Based Network Services Application Learning Media for Vocational High Schools. *International Journal of Interactive Mobile Technologies*, *16*(20), 83–100.

Ortiz Rojas, M.E., Chiluiza, K., & Valcke, M. (2017). Gamification in computer programming: Effects on learning, engagement, self-efficacy and intrinsic motivation. In *11th European Conference on Game-Based Learning (ECGBL)* (pp. 507–514). ACAD CONFERENCES LTD.

Orion, N. (2007). A holistic approach for science education for all. *Eurasia J. Math. Sci. Technol. Educ.*, *3*(2), 111–118.

Pirinen, R.I. (2017). Resilient Learning: Towards Integration of Strategic Research Programmes, Higher Education Functions, and Regional-National Development. *Int. J. Eng. Pedagog.*, *7*(2), 94.

Pikhart, M., & Klímová, B. (2020). eLearning 4.0 as a Sustainability Strategy for Generation Z Language Learners: Applied Linguistics of Second Language Acquisition in Younger Adults. *Societies*, *10*(2), 38.

Pratama, H., Azman, M.N.A., Kassymova, G.K., & Duisenbayeva, S.S. (2020). The Trend in using online meeting applications for learning during the period of pandemic COVID-19: A literature review. *Journal of Innovation in Educational and Cultural Research*, *1*(2), 58–68.

Roth, R. (2015). Institutional strategies and practices for integrating learning technologies in the inner, outer and virtual spaces. *International Journal of Learning, Teaching and Educational Research*, *12*(3).

Sankaranarayanan, S., Kandimalla, S.R., Cao, M., Maronna, I., An, H., Bogart, C., . . . Rosé, C.P. (2020). Designing for learning during collaborative projects online: tools and takeaways. *Information and Learning Sciences*.

Sipayung, D.H., Sani, R.A., & Bunawan, H. (2018, December). Collaborative inquiry for 4C skills. In *3rd Annual International Seminar on Transformative Education and Educational Leadership* (Vol. 200, pp. 440–445).

Slavin, R.E. (2015). Cooperative learning in elementary schools. *Education 3–13*, *43*(1), 5–14.

Susanti, W., Jama, J., Krismadinata, Ramadhani, D., & Nasution, T. (2021). An overview of the teaching and learning process basic programming in algorithm and programming courses. *Turkish J. Comput. Math. Educ.*, *12*(2), 2934–2944.

Susanti, W., Sukrianto, D., & Ramadhani, D. (2020). Pengaruh Model Discovery Learning dalam Kemampuan Berpikir Kritis dan Cognitif Mahasiswa Program Studi Sistem Informasi. *INVOTEK: Jurnal Inovasi Vokasional dan Teknologi*, *20*(3), 53–62.

Verawardina, U. (2020). Reviewing online learning facing the Covid-19 outbreak. *Talent Dev. Excell.*, *12*(3), 385–392.

Verawardina, U., Ramadhani, D., Susanti, W., Lubis, A.L., Simeru, A., & Ambiyar. (2020, May). Studying technology-based XXI century learning using Mooc in education. *Int. J. Psychosoc. Rehabil.*, *24*(9), 2644–2649. https://doi.org.10.37200/IJPR/V24I9/PR290297

Yee-King, M.J., Grierson, M., & D'Inverno, M. (2017). Evidencing the Value of Inquiry Based, Constructionist Learning for Student Coders. *Int. J. Eng. Pedagog.*, *7*(3), 109.

Zurweni, Wibawa, B., & Erwin, T.N. (2017, August). Development of collaborative-creative learning model using virtual laboratory media for instrumental analytical chemistry lectures. In *AIP Conference Proceedings* (Vol. 1868, No. 1, p.030010). AIP Publishing LLC.