

Development, Feasibility, and Student Feedback on CAI-Based Learning Media: A Case Study in Web Programming Courses

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Abstract— We evaluated the feasibility of Computer-Assisted Instruction (CAI) based learning media and measured student responses in the Informatics Study Program. We conducted an experiment involving 21 students who had various academic abilities. Our assessment is based on three criteria: method of use, material content, media appearance, and ease of use. The research results show that CAI media is suitable for use. In the method of use, we get a percentage of 72.6%, which is quite significant. CAI media received a score of 76.5% in the material content aspect, which is included in the outstanding category. Media views obtained 76.6% and were also included in the exceptional category. Meanwhile, the ease-of-use aspect received the highest score, 79.9%, in the outstanding category. Overall, we conclude that CAI-based learning media is effective and suitable for use as a tool in the learning process in the Informatics Study Program.

Keywords: *Assessment indicators, Computer-Assisted Instruction, Learning evaluation, Media feasibility, Student response*

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1. Introduction

The Recently, universities have been aggressively adapting teaching methods from Teacher-Centered Learning (TCL) to Student-Centered Learning (SCL). This shift aims to improve the quality of education. The reason is that the quality of education is essential in countries like Indonesia. TCL prioritizes educators as the principal source of knowledge. SCL promotes student engagement and active participation.

SCL stresses active student engagement. SCL differs sharply from traditional teacher-centered approaches. This methodology fosters intrinsic motivation and academic achievement by allowing students to take charge of their learning experiences [1][2]. SCL is a modern educational philosophy that focuses on the student's personality, enhancing the quality of higher education. It promotes the development of competitive specialists with flexible thinking, responsible learning, and increased social and professional mobility through individualized educational trajectories [3].

The following sections outline key aspects of student-centered learning. The shift from TCL to SCL may utilize technologies by integrating e-learning and computer-assisted instruction (CAI). These two technologies aim to enhance an interactive and engaging educational experience [4].

However, implementing SCL through e-learning and CAI, especially in Indonesia, faces challenges. Even though e-learning tools are available, many institutions still need help switching from TCL to SCL. This problem arises partly because the learning model that integrates e-learning with SCL principles is not yet effective. As a result, traditional face-to-face methods continue to dominate [5]. This eliminates the potential of technologies such as e-learning and CAI. We developed an interactive CAI to encourage

teachers to gradually transition to SCL. We can use artificial intelligence (AI) to enhance pedagogical practices [6]. But before wider implementation, we want to know the impact on learning. This research aims to evaluate the feasibility of CAI-based learning media in the Informatics Study Program. Evaluation is carried out by assessing CAI using eight main indicators, namely method, use, material content, appearance, media, and ease of use. We also aim to explore how these learning tools can enhance student learning and facilitate the TCL to SCL transition. This transition needs a strategy [7].

The main problems to be addressed through this research are:

- a) How does the development of the CAI learning method meet the requirements of the Web Programming course?
- b) How do students respond to CAI-based learning media in terms of effectiveness, content, appearance, and ease of use?

2. Method

2.1 Model and Steps

The study defines R&D as a systematic activity combining basic and applied research to discover solutions or create new goods, services, and knowledge, emphasizing its role in enhancing innovation and competitiveness for sustainable developmental outcomes [8]. We refer to the Research and Development (R&D) model in this study. We refer to this model to produce specific products and test their effectiveness. We can use R&D model to generate better educational practices, allowing researchers to produce specific educational products and assess their effectiveness through systematic research processes. Since the development of CAI in this study is a technological development, it is appropriate to use an R&D approach.

To create CAI, we use requirements analysis, realize it, and then check the quality of CAI. At this initial stage, it is helpful to ensure that CAI can be used in the next stage, namely experimentation.

To answer the two questions in the introduction, more than the R&D approach is needed. So, in this research, we also refer to the ADDIE (Analysis, Design, Develop, Implement Evaluation) model. R&D and ADDIE in educational technology research integrate systematic design, development, and evaluation processes. R&D creates innovative educational products, while ADDIE's structured phases—Analysis, Design, Development, Implementation, and Evaluation—ensure effective learning solutions tailored to specific educational needs [9].

By referring R&D and ADDIE model, we add five sub-stages of CAI software development. (1) Analysis: At this stage, we carry out a preliminary study to determine the learning needs at the experimental location; (2) Design: In this step, we select a learning model and design what form of CAI is appropriate; (3) Development: At this stage, we use the collaborative constructivism learning model. Then, we developed a CAI tool to support the implementation of this learning model. We apply an R&D approach at this stage. The essence of choosing a learning model and using CAI is encouraging students to learn more together to solve problems. In this situation, lecturers are encouraged to play a more significant role in assisting and monitoring learning and practical activities; (4) Implementation: At this stage, a product trial is carried out through learning experiments; (5) Evaluation: Assessment of the use of the CAI-based collaborative constructivism model using eight criteria. Figure 1 shows the research model.

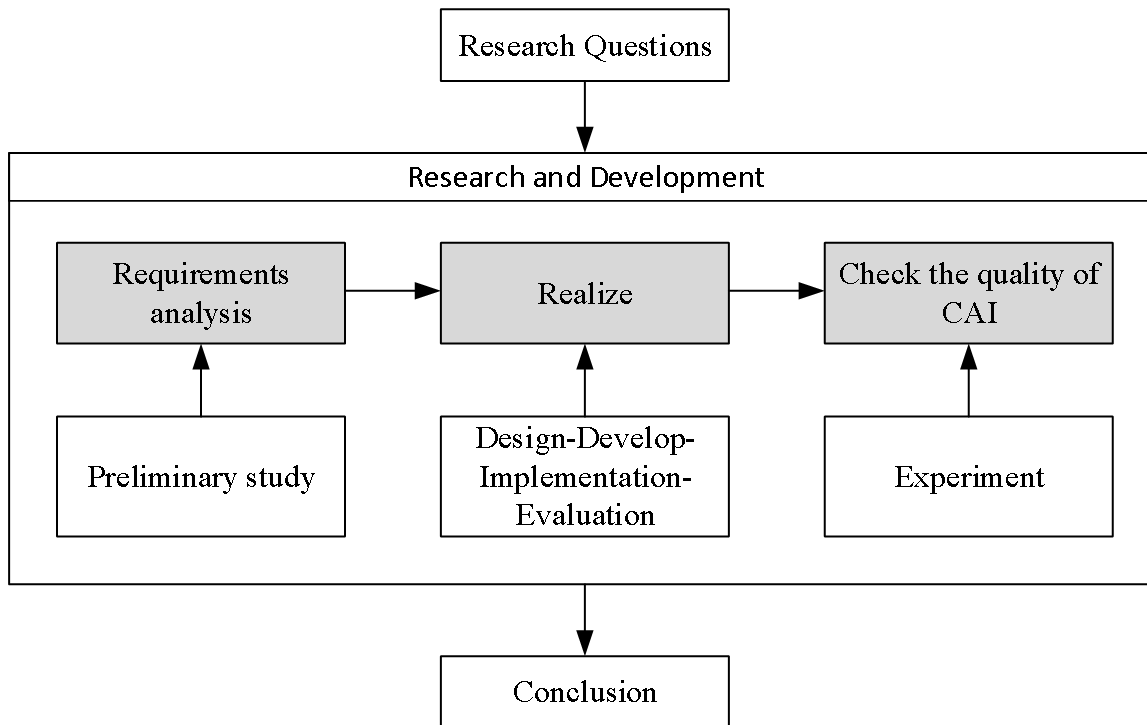


Figure 1. Research model

2.2 Location and Sample

In conducting experiments, we had to choose the right location and time. We must implement the model in authentic learning and current batch, so we experimented to select a location that meets several criteria. This experiment involved students and lecturers, so it included field experiment research. This research requires changes in learning methods from conventional methods to techniques that use information technology according to collaborative constructivism rules. There are changes in the function of lecturers in learning activities, from the beginning as a teacher to being a companion following the regulations of SCL. Thus, the research location was chosen at the university, which had the following conditions:

- a) Has a study program that organizes a course suitable for applying methods and e-learning?
- b) The environment is quite conducive to research activities, including the willingness of lecturers to be involved in Student experiments.
- c) We already used to use computers and internet facilities; we need this to reduce technical barriers during research.
- d) LMS facilities are available and sufficient for research

We chose an institution in east Indonesia region as the research location. We arrangement with the Informatics Study Program because it is considered to meet the above requirements. The Informatics Study Program held Web Programming courses. This course is rolling in the fourth semester. Learning methods include theory and practice in the laboratory. The obstacle is that there is no low activity on campus and at home. This condition causes many students to be unable to show their abilities. This condition is suitable for monitoring the collaborative constructivism approach.

In this study, we use two sets of samples: the development sample and the experimental sample. The development sample comprised students who had previously taken programming courses at the research site. These students were tasked with testing the modules developed and providing feedback through completing questionnaires. The feedback from the students was then compared with evaluations from subject matter experts. Once both sets of assessments showed consistent results, the module was deemed ready for use in the experimental phase.

For the experimental phase, the sample was drawn from students currently enrolled in web programming courses at the exact research location. These students acted as users in testing the module's effectiveness in an authentic learning environment.

2.3 Instrument

Table 1 shows the key indicators for evaluating the CAI module. This study evaluates the CAI module as an e-learning SCORM model for Web Programming courses. These indicators serve as benchmarks for assessing various aspects of the CAI module, such as content quality, user interaction, and overall effectiveness. This evaluation tool was designed to ensure the CAI's alignment with learning objectives, practical usability, and motivational and educational impact on students.

The questionnaire employs 10 key indicators, grounded in the Learning Object Review Instrument (LORI), to assess the feasibility of the CAI from various perspectives. LORI is a widely cited evaluation tool that uses nine criteria to assess learning objects' quality, including Content Quality, Learning Goal Alignment, and Usability, aiming to enhance the effectiveness of educational materials. In the context of our research, LORI is adapted to evaluate CAI (Computer-Assisted Instruction), so that the existing indicators are adjusted to assess the quality of computer-based learning media. LORI has undergone several modifications to enhance its effectiveness in evaluating learning objects [10]

Table 1. Indicators for Evaluating CAI Learning Media

Indicator	Description
Content Quality	Measures the accuracy, relevance, and quality of content in CAI, ensuring alignment with learning objectives and student needs.
Learning Goal Alignment	Assesses how well CAI supports the achievement of learning goals and maintains consistency between content and objectives.
Feedback and Adaptation	Evaluates the quality of feedback provided to help students understand material and improve their performance.
Motivational Effectiveness	Measures how well CAI engages and motivates students through interactive and stimulating features.
Presentation Design	Assesses the visual quality, including layout, colour, typography, and navigation, to support learning and interaction.
Interaction Usability	Evaluates the ease of use and intuitiveness of the CAI interface for students.
Accessibility	Measures whether CAI is accessible to all learners, including those with disabilities, through features like

	alternative text.
Reusability	Assesses the potential for CAI to be reused across different contexts without major modifications.
Standards Compliance	Evaluates whether CAI follows relevant technical and pedagogical standards, such as SCORM or curriculum guidelines.
Engagement	Measures how effectively CAI fosters active student participation and engagement in learning activities.

In addition to software development, a feasibility questionnaire was created to evaluate the usefulness of the CAI learning media (see Table 2). The CAI module encompasses evaluations from media and material experts alongside senior students' responses.

Table 2. Indicators for Evaluating the Feasibility of CAI Media in Terms of Content

Indicator	Description
Curriculum Alignment	Ensures that the CAI material aligns with the Web Programming course syllabus and learning objectives.
Scientific Accuracy	Assesses whether the content is factually correct and free from conceptual errors.
Clarity of Presentation	Evaluates how well the material is structured and whether it is easy to understand.
Relevance to Students' Needs	Determines if the content meets students' learning levels and expectations.
Interactivity	Measures the extent to which the CAI provides interactive features such as simulations, exercises, or quizzes.
Content Completeness	Examines whether all essential topics are covered without missing key information.
Language and Grammar Quality	Ensures that the text is clear, communicative, and follows proper academic language rules.
Appeal of Presentation	Assesses engaging multimedia elements such as text, images, animations, or videos to enhance comprehension.

3. Result and Discussion

The quality of learning plays an essential role in determining the quality of a university's education system [11], including in Indonesia. The quality of learning is influenced by effective teaching and leadership. The quality of learning in higher education is pivotal for enhancing the effectiveness of university education systems.

Information technology's rapid progress has changed how people communicate, work, and learn. The applications of information technology that have been proven to impact education are e-learning and CAI. Currently, e-learning has been integrated into modern educational practices. The level of knowledge and application of technology greatly influences the development of a country's civilization. In developing this civilization, the education sector has played an important role.

Universities with quality human resources can develop knowledge that contributes to scientific progress and national development. Lecturers have a fundamental role in the human development process. They are responsible for transforming, developing, and disseminating knowledge, including technology and art, through education, research, and community service. Lecturers are the key to the success of the educational process because they directly carry out the learning process. A Lecturer also acts as motivators and facilitate students in acquiring and processing knowledge.

Lecturers play a key role in encouraging student growth, not just as educators but also as facilitators who motivate and lead students through the learning and application process. This critical function is particularly visible when addressing the issues of modern education, such as adjusting to varied learning styles and providing enough learning resources. We discovered some cases when researching the Web Programming course in the Informatics Engineering Study Program at a private university in east Indonesia. Our findings revealed a lack of interactive learning content and a reliance on standard text editors. To address these issues, we created CAI media, which combines a learning management system with SCORM (Shareable Object Reference Model) module. Our research goal is to provide students with a more engaging and self-directed learning environment.

We conducted this research through field observations and literature studies in the Informatics Engineering Study Program in the Web Programming course. From observations, we found problems such as limited in student practicing media, which still uses text editors and differences in student learning styles. Based on needs analysis, students need more engaging and interactive learning media. We developed CAI media as a solution by integrating Moodle 3 and Course Lab 3. This media is designed to increase student motivation and learning independence. We use three stages of development, namely: module development, validation by user, and experimentation.

3.1 CAI Module development

The development of CAI learning media started from the learning analysis and design stage used by the Informatics Study Program at a private university in Indonesia. The initial observation stage was carried out by analysing student needs. From the interview results, we know that many students still have not received the ease of doing assignments during the practical process. In practice, students use text editors only. Besides that, the supporting equipment is limited. The learning activity is not yet equipped with adequate laboratory space, so students are still constrained in practicing on campus. Students need new, exciting, diverse media that is used as alternative learning so that students do not feel bored. To solve these problems, we design a CAI as a practicing tool anywhere and anytime. We integrated CAI in an e-learning environment as a development approach. Through this integration, we enhance interactivity, personalize learning, and improve efficiency through engaging content as real-time coding. Figure 2 shows the CAI development approach. We also support learners in learning independently and flexibly as needed without relying on instructors. One of the advantages of this integration is that lecturers can search for activities and program code written by students. Combining CAI and LMS enriches the e-learning experience through interactive exercises, broad accessibility, and effectiveness in problem-based exercises or assessments.

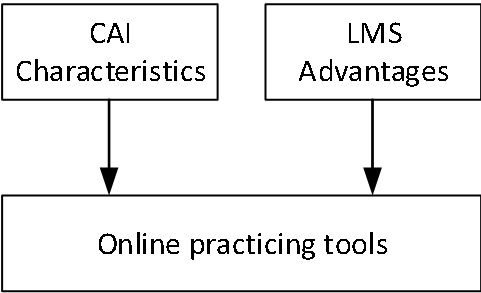


Figure 2. CAI development approach

We assess from the elements of the use procedure, issues of material content, appearance aspects and practical aspects of use. Then we developed the CAI learning media using CourseLab Authoring Tools 3 starting from the media flowchart, media display to the simulation process stage. Figure 3 shows the CAI module interface in e-learning as teaching web programming practicing tools.

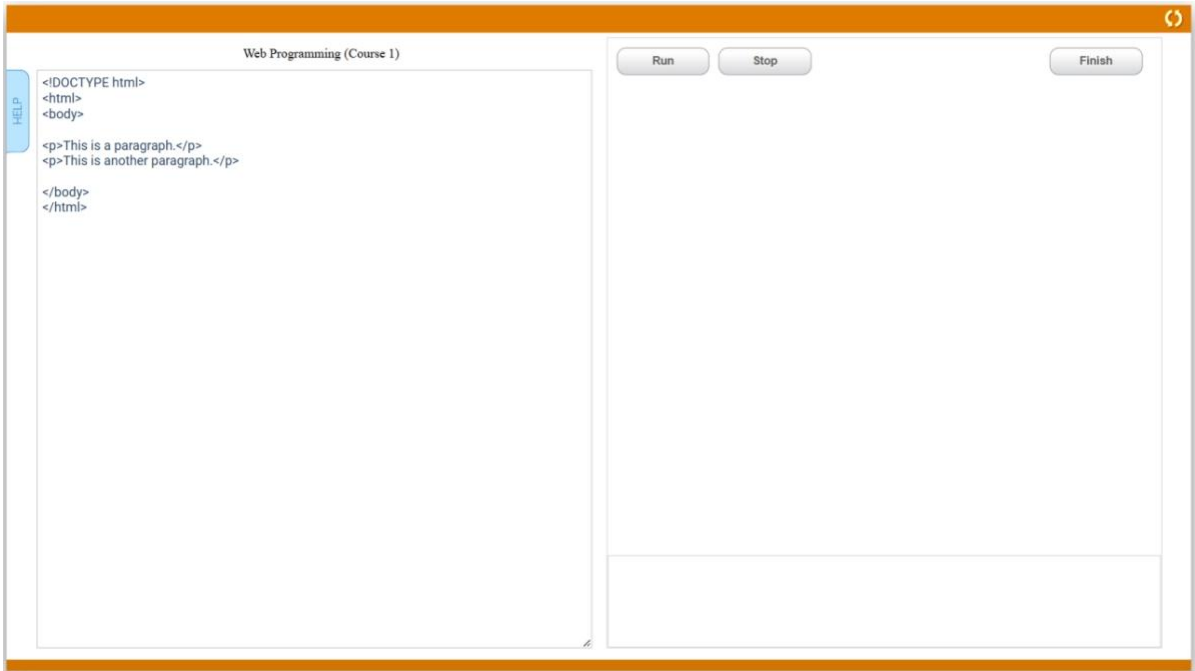


Figure 3. CAI Interface

We find out the feasibility of the media after validated by experts. The validators are senior lecturer who expert in multimedia. The researcher revised the learning media using CAI so that appropriate to the research subject.

As the research location, we chose a private informatics-focused university in Indonesia, which meets the required conditions. The evaluation phase of the development of learning media using CAI is to compare the results of all trials and recapitulate the assessment by the feasibility of material experts, media experts, and students.

3.2 CAI learning media feasibility

The feasibility of learning media is known through the expert validation stage by media experts. The selected validator consists of media experts, material experts, and students. There are three people who provide assessments and evaluations on the media and material aspects. Then we involved 26

students who tried and provided assessments and evaluations. The instrument of data collection uses a media feasibility questionnaire with a scale of 1-4. The full explanation is as follows.

a) Learning content expert

The results of the material expert's validation provide an assessment of the feasibility regarding the material presented. Based on the results of the validation seen in the appendix, we assessed the media from aspects of material relevance and aspects of learning.

- i) The feasibility of CAI media on the content aspects of the material with the number of 10 indicators with assessment obtained an average of 3.7 included in the excellent category obtained a percentage of 87.5% so that it is included in the criteria eligible.
- ii) The feasibility of CAI media in the learning aspect with the number of 10 indicators with assessment obtained an average of 3.5 by getting a good category and a percentage of 87.5% so that we included in the criteria of eligibility.
- iii) The feasibility of CAI media on the aspects of material relevance with the number of 8 indicators obtained by the average score of 3.7 by capturing good categories and the percentage of 93.75% included in the criteria eligible.

b) Multimedia expert Media experts provide an assessment of the media developed for students. Validation results to determine the feasibility concerning the material presented. Based on the results of the validation seen in the appendix, we assessed the media in the aspect of display and practical use of the program.

- i) We evaluated the feasibility of CAI learning media from the perspective of appearance, obtained an average of 3.5 including in the excellent category and a percentage of 87.5% so that it was included in the criteria eligible.
- ii) The feasibility of CAI media in the practical aspects of the use of the program obtained an average of 3, included in the excellent category and got a percentage of 70.6% so that it is included in the criteria eligible.

3.3 Experiment

We conducted an experiment using software in a real-world learning environment to assess its effectiveness in enhancing the learning experience. We tested the media on 21 students from the Informatics Study Program, who had varying academic abilities. The assessment was conducted through a survey, where students provided responses based on questionnaires to evaluate their feedback. Based on the survey results, we then measured the feasibility of using CAI media across various aspects:

- a) We measure the feasibility of using CAI media based on eight indicators. The percentage aspects of the method for using media steps were 72.6%. It is categorized as a significant category.
- b) The feasibility of CAI media in the content aspect of the material consists of 8 assessments points or indicators. Based on the evaluation of student responses to the material elements obtained a percentage of 76.5%, thus included in the excellent category.
- c) The results of the percentage of aspects of the appearance of the media obtained 76.6%, thus included in the excellent category.
- d) The results of the percentage of practical aspects of media use were obtained at 79.9%, and thus included in the excellent category.

4. Conclusion

Based on the research questions and analysis results, developing the Web Programming course's CAI learning method has met the validity, practicality, and usefulness requirements. The validation results by experts show that the material in CAI is classified as valid in terms of content, learning structure, and relevance to the needs of the Web Programming course. Validation of media aspects shows that appearance, ease of use, and suitability to learning needs are also valid. Data shows that students responded positively to CAI regarding effectiveness, content, appearance, and ease of use. From the results of interviews and data analysis, CAI media is considered practical for use in learning, has an attractive appearance, and supports a more interactive understanding of concepts.

The results of this research can be a basis for further development in applying CAI to other courses in the field of Informatics. In addition, educational institutions are advised to provide infrastructure that supports implementing CAI-based learning to improve the quality of Web Programming learning.

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