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IoT Integration in E-Modules: Digital Innovation to Improve Students' CPS and Communication Skills

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A B S T R A C T

The industrial revolution 4.0 requires the world of education to carry out digital transformation, including in Indonesian learning in universities. Currently, students are required not only to master language materials, but also to have 21st century skills such as Creative Problem Solving (CPS) and effective communication skills. However, conventional learning methods still dominate, not accommodating the needs of these skill development. Therefore, this study raises the urgency of integrating Internet of Things (IoT) technology in the Indonesian module as an innovative strategy to answer these challenges. The main objective of this research is to design and implement an IoT-based Indonesian e-module that is able to encourage active student involvement in communication activities and collaborative problem solving. This E-Module is expected to be an interactive, contextual, and relevant learning alternative to the needs of the times. The method used is Research and Development (R&D) with a modified Borg & Gall model covering the stages of needs analysis, design, development, validation, testing, and evaluation. The research will involve lecturers and students from the Indonesian Language and Literature Education, Mathematics and non-education study programs at Graha Nusantara Padangsidimpuan University as test subjects to ensure the flexibility and acceptability of the modules. This research is expected to make a real contribution to the development of digital learning models in universities.

Keywords: *Iot, E-Modul, Digital, CPS, Komunikasi, Book Antiques, 9, Single Spacing (No More Than Two Lines)*

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INTRODUCTION

The development of digital technology has had a significant impact in various fields, including education. In the era of the Industrial Revolution 4.0 and Society 5.0, the integration of technology into the learning process is an absolute necessity to produce adaptive, creative, and communicative human resources. One of the technologies that has great potential to be used in the world of education is the Internet of Things (IoT). Although its implementation has grown rapidly in the fields of engineering and science, the use of IoT in Indonesian learning is still relatively minimal. Indonesian learning in higher education today still tends to be conventional and focuses on theoretical aspects. In fact, language learning is supposed to train creative thinking, problem-solving, and effective communication skills (Fayzullina & Saglam, 2015; Adila et al., 2020; Yustina et al., 2022; Ndiung & Squirt, 2024; Baso Stuttgart Sappaile et al., 2024; Julio et al., n.d.; Fidai et al., 2019).

The problem that occurs in the field, particularly among students of the Indonesian Language and Literature Education study program at Graha Nusantara University, is the lack of Creative Problem Solving (CPS) and communication skills in the Productive Language course. Based on interviews and observations, several factors contribute to the low CPS and communication abilities, including unattractive learning models that cause students to lose motivation, as well as a lack of engaging learning media and teaching materials.

Given these problems, the researcher formulates the hypothesis that the urgency of this study lies in the need for digital innovations capable of bridging learning needs with the demands of 21st-century competencies, especially CPS and communication skills. The integration of IoT into the Indonesian E-Module is seen as an innovative solution that can provide real, interactive, and applicative context-based learning experiences. Such an E-Module is expected not only to increase students' interest and participation, but also to develop their thinking and language skills holistically (Wieth et al., 2019; Rahmawaty et al., 2023; Rahmawaty et al., 2023; Oktarina et al., 2018).

Problem Formulation

> *What is the practicality, feasibility, and effectiveness of the IoT-integrated Indonesian E-Module to improve CPS and Student Communication Skills?*
> *How to improve students' CPS and communication skills by using the IoT-integrated Indonesian E-Module?*

To answer the formulation of the problem, the following problem-solving approach was prepared:

> *The researcher will conduct a needs analysis through observation and interviews with students and lecturers. Based on the results of the analysis, the researcher will design an IoT-based Indonesian E-Module by integrating IoT devices or simulations into the learning scenario. The E-Module will be validated by material experts, media experts, and technologists to ensure the feasibility of content, display, and usability. The validation results are used for revision before the trial.*
> *The study will use a pretest-posttest design in a group of students to measure the improvement of CPS and communication skills after the use of the E-Module. The activities in the E-Module are designed with an IoT-context-based problem-based learning (PBL) approach that requires students to formulate problems, analyze situations, and find creative solutions. The data from the CPS test results will be statistically analyzed to determine the level of effectiveness of the E-Module.*

Research on the integration of technology in Indonesian learning has developed quite rapidly, especially in the context of digital and multimedia-based learning. Several previous studies have examined the use of e-learning, interactive media, and Android-based applications in language learning to improve literacy skills, writing skills, and reading comprehension. In addition, 21st century learning approaches such as (Martinez, 2022) *problem-based learning* and *project-based learning* have also been applied to improve higher-level thinking skills (HOTS) (Wangge , 2023) (Miri et al., 2007).

However, most of these studies have not touched much on the use of the Internet of Things (IoT) as part of learning innovations in the field of language. IoT is more commonly studied in engineering, science, and vocational fields, and is rarely associated with the context of language learning. On the other hand, the need to develop *soft skills* such as *creative problem solving* (CPS) and students' communication skills demands a more contextual and real-world-oriented approach to learning is something that IoT technology is very likely to facilitate (Jamro, 2021) .

METHOD

This research uses a Research and Development (R&D) approach with a modified development model from Borg & Gall, covering the stages of needs analysis, design, development, validation, testing, and evaluation. The research was carried out for one academic year by involving lecturers, media experts, material experts, and first-semester students as trial subjects. (Sugiyono, 2019) (Düsseldorf, 2005) (Sari et al., 2019) (Hilda et al., 2020a) (Hilda et al., 2020b) (Suharyat, 2022)

Research Process

Phase 1: Preliminary Study and Needs Analysis (Months 1–2), Conducting observations and interviews with lecturers and students to identify Indonesian learning needs

relevant to CPS and communication development, reviewing curriculum, learning outcomes, and literature related to IoT, as well as language learning media. Stage 2: Designing E-Modules (Months 3–4), Designing IoT-based Indonesian E-Modules with *a Problem Based Learning (PBL) approach,* Designing learning content, IoT-based project activities (e.g., environmental monitoring tools, temperature/motion sensors, etc.) associated with language tasks (writing reports, oral presentations, discussions, and others), Designing CPS assessment rubrics and communication. Stage 3: Initial Product Development (Month 5). The E-Module is composed in a complete and interactive format in digital format, Integration of the use of simple IoT devices (e.g. through IoT simulations or practical tools based on Arduino/sensors), the E-Module is ready for expert validation. Stage 4: Expert Validation (Month 6). Involving three validators: Indonesian material experts, learning media experts, and IoT technology experts, The validation process includes content feasibility, display design, technological suitability, and usefulness for CPS and communication development, E-Module revision is carried out based on expert input. Phase 5: Limited trial (months 7–8). Phase 6: Extensive Trial (Months 9–10) Stage 7: Dissemination and Publication Output (Months 11–12).

The research instruments used were questionnaires and tests to collect data on the validity, practicality, and effectiveness of the E-Module. Data analysis was carried out using qualitative descriptive analysis techniques to group inputs from qualitative data and quantitative descriptive analysis to compile data in the form of numbers and percentages. Analysis of the results of the validity, practicality, and effectiveness tests was carried out to determine the success rate of the E-Modules developed in supporting an effective learning process.

Analysis of Validity Test Results

The analysis of the results of the PBL-based E-Module validity test was carried out in several steps, namely:

Provide an answer score with the following criteria:SB = Excellent (5)
Assign a percentage value by:
Interpret the data based on the following table:

Completion Percentage	Category
K > 80	Highly Valid
60 < K ≤ 80	Valid
40 < K ≤ 60	Quite Valid
20 < K ≤ 40	Less Valid
K ≤ 20	Invalid

Analysis of Practicality Test Results

The analysis of the results of the PBL-based E-Module practicality test was carried out with several steps that are almost the same as the validity analysis, only different in interpreting them, namely:

Interval	Criterion
K > 80	Highly Valid
60 < K ≤ 80	Valid
40 < K ≤ 60	Quite Valid
20 < K ≤ 40	Less Valid
K ≤ 20	Invalid

Analysis of the Effectiveness Test Results

The effectiveness of the developed Indonesian E-Module is determined from the difference in the average posttest and *posttest of* the experimental and control classes. The type of *quasi-experimental* design used by the researcher is *the Nonequivalent Pretest-Posttes Control Group Design.* An overview of this design can be seen in the following table (Sudjana, 2006)

Pretest	**Treatment**	***Posttest***
O1	X	O2
O3	-	O4

Information:
X = Treatment of the experimental class
O1 ; O3 = *Experimental class pretest* and O2 control; O4 = *Posttest of* experimental and control classes

FINDINGS AND DISCUSSION

The focus of this research is the development of a product in the form of "IoT Integrated Indonesian E-Module with *a Problem Based Learning* (PBL) approach to Improve *Creative Problem Solving* (CPS) and Student Communication Skills". The development process in this study uses the Reasearch and Development (R&D) method with a modified Borg & Gall model in six stages: Needs Analysis, Design, Development, Validation, Trial, and Evaluation. The IoT integrated e-Module with the developed PBL approach, has been validated by validators and piloted. Data analysis is in accordance with the completion steps, so that valid, practical, and effective products are produced. The results of data analysis and description of the development carried out are described as follows.

Stages of development of IoT Integrated Indonesian Language E-Module with a *Problem Based Learning Approach*

The development of an IoT-integrated Indonesian E-Module with a Problem Based Learning approach uses the Reaserch and Development (R&D) method with the Borg & Gall model which is modified into six stages: Needs Analysis, Design, Development, Validation, Trial, and Evaluation. The following is a description of the results of each stage:

Needs Analysis

The needs analysis stage is a crucial first step in the development of technology-based e-modules and innovative learning approaches. This process begins with a study of the curriculum and learning outcomes in the Indonesian Language and Literature Education Study Program, in order to identify relevant courses to be integrated with Internet of Things (IoT) technology, such as Applied Indonesian, Digital Literacy, Productive Language or Speaking Skills. From the study, it was also determined the learning outcomes that can be achieved through the *Problem Based Learning* approach, which emphasizes collaborative real problem solving.

Furthermore, surveys and interviews were conducted with students to explore the level of digital literacy, interest in technology-based learning, and the challenges they face in understanding theoretical Indonesian materials. The results of this survey show that students have high enthusiasm for the use of technology, especially IoT Weather Monitoring, which is a weather monitoring system that utilizes internet-connected sensors to measure temperature, humidity, precipitation, and wind speed, then display the data in real-time. On the other hand, consultation with the lecturer in charge of the course is carried out to develop a contextual problem scenario that is in accordance with the local culture, as well as determine the relevant type of IoT data to support the learning process.

The feasibility study of the technology is also an important part of this stage, by identifying simple and economical IoT devices such as temperature, humidity, rainfall, and wind speed sensors that can be used to integrate data into the e-module dashboard. Evaluation of the readiness of campus infrastructure, such as the availability of computer laboratories and internet access, is also carried out to ensure the smooth implementation of technology. All data obtained from surveys, interviews, and feasibility studies are then analyzed to profile the needs of students, lecturers, and institutions. The results of this analysis are the basis for designing e-modules that are in accordance with the needs of content, technology, and pedagogical approaches based on PBL, so as to be able to increase the effectiveness and attractiveness of Indonesian learning in the digital era.

Planning

At this stage, it contains product design activities that will be made in the form of prototype I of the E-Module. This stage consists of selecting appropriate media, selecting formats, preparing tests and initial design of e-modules.

Development

At this stage, the E-Module development process is carried out through the abbreviation *Problem Based Learning* in Productive Language materials. Development is carried out guided by the initial design so that an initial product called prototype I is produced.

The results of the validation and input from the validators are then used as the basis by the researcher to revise the developed E-Module. The revised product of prototype I is

hereinafter referred to as prototype II. If prototype II has been declared valid by the validator, then the E-Module will be tested on a limited basis for students of the Indonesian Language and Literature Education Study Program, Graha Nusantara University. Data regarding the validity of the E-Module through the abbreviation *Problem Based Learning* can be seen in the appendix. The summary of the assessment results is presented as follows:

Average Validator Assessment Results

Assessment Aspects	Assessment Results	Category
Competency Compatibility	3,67	Highly Valid
Clarity of Material	3,33	Valid
Display Quality (Design)	3,33	Valid
Language and Readability	3,33	Valid
Compatibility with PBL	3,67	Highly Valid
Eligibility for Use	3,33	Valid
Average	**3,44**	**Valid**

Based on the table above, the average validator rating of the E-Module with *the Problem Based Learning* approach was 3.44, which is included in the valid category. This shows that the E-Module with *the Problem Based Learning approach* is feasible to use with a slight improvement.

The results of the validation of the research instrument were carried out through the use of validation sheets given to expert validators. The validated instruments included three types, namely student response questionnaires, lecturer response questionnaires, and CPS and Communication ability tests. The student response questionnaire is designed to obtain an overview of the responses, learning experiences, and level of student involvement in using the E-Module with *a Problem Based Learning* approach. Meanwhile, the lecturer response questionnaire was focused on assessing the ease of use, suitability of content, and usefulness of the product in supporting the learning process. The CPS and Communication ability tests are designed to measure the extent to which students are able to apply critical and creative thinking skills in solving real problems, as well as convey ideas or solutions effectively and in a structured academic and professional context in accordance with the indicators that have been set. This validation process aims to ensure that all instruments used in the research have an adequate level of clarity, relevance, and applicability so that they can produce valid and reliable data at the stage of testing and product implementation.

Description of Student Response Questionnaire Validation Results

Assessment Aspects	Assessment Results	Category
Aspects of Clues	3,5	Highly Valid
Response Coverage Aspect	4	Highly Valid
Language Aspects	3,5	Highly Valid
Average	**3,67**	**Highly Valid**

Description of the Results of the Validation of the Lecturer Response Questionnaire

Assessment Aspects	Assessment Results	Category
Aspects of Clues	3,5	Highly Valid
Response Coverage Aspect	3,5	Highly Valid
Language Aspects	4	Highly Valid
Average	**3,67**	**Highly Valid**

Based on the data in the table, the results of the validation of the student response questionnaire obtained an average score of 3.67 which is in the very valid category. This shows that the student response questionnaire is suitable for use in the research, although it still needs to be slightly improved according to the validator's input. Furthermore, the lecturer response questionnaire also received an average score of 3.67 with a very valid category. Thus, the lecturer's response questionnaire can be declared suitable for use by only requiring minor revisions so that the instrument becomes more optimal.

CONCLUSIONS

The results, practicality and effectiveness of IoT Integrated E-Modules with *a Problem Based Learning* approach to Improve CPS and Student Communication. The prototype of the IoT Integrated E-Module with *a Problem Based Learning* approach to Improve CPS and Student Communication for students of the Indonesian Language and Literature Education Study Program, Universitas Graha Nusantara Padangsidimpuan has been declared valid by three

experts, so it is considered very feasible to use. This E-Module has also gone through a trial stage limited to students and lecturers with only minor revisions required. In terms of practicality, learning tools in the form of IoT Integrated E-Module Prototypes with *a Problem Based Learning* approach have proven to be very easy to use in mathematics learning activities. Meanwhile, the effectiveness aspect was reviewed from the results of the learning implementation which included student activities, learning motivation, and UTS achievement results, showing that the E-Module was very effective in applying it to the Productive Speaking material. Thus, this E-Module can be categorized as very feasible, very practical, and very effective in supporting the improvement of CPS and student communication skills. In addition, this device also provides a more interactive and meaningful learning experience, where students act as facilitators who encourage active involvement and collaboration between students. Student response to mathematics learning with *the Problem Based Learning* approach after participating in learning using the IoT Integrated E-Module, the student response rate reached 92.07% with the very good category. The application of IoT Integrated E-Modules with *a Problem Based Learning* approach on Productive Speaking materials has proven to be very effective in learning Indonesian language in the Indonesian Language and Literature Study Program, Graha Nusantara University Padangsidimpuan. This e-Module is able to improve students' CPS and communication skills, so that it can be used as an alternative learning resource that is useful for both students and lecturers in the Indonesian learning process.

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