Development of Contextual-Based Physics Learning Modules Inquiry and LMS to Improve Students' Self-Regulation and Digital Literacy

Quratul Uyun Fadilasari[1*], Lovy Herayanti[1], Irham Azmi[1], & Muhammad Fuaddunnazmi[1]
[1]Physics Education Study Program, Uniersitas Pendidikan Mandalika, Indonesia
*Corresponding Author: quratuluyunfadilasari.physics@gmail.com

Received: 13th July 2026; **Accepted**: 12th August 2026; **Published**: 19th October 2026
DOI: https://dx.doi.org/10.29303/jpft.v12i2.12639

Abstract *- This study aims to develop and validate a physics learning module based on a contextual inquiry approach and supported by a Learning Management System (LMS) that is valid, practical, and effective in improving high school students' self-regulation skills and digital literacy. The study employed a Research and Development (R&D) method using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model. The module was tested on 25 Grade XI students from Science Class 2 at SMAN 1 Dompu, focusing on hydrostatic pressure and incorporating the Ruangguru LMS and PhET simulations. Validation by three experts yielded an average score of 87.50%, placing the module in the highly valid category. The module's practicality was reflected in student and teacher response scores of 88.10% and 85.00%, respectively, both of which fell into the very practical category. The self-regulation and digital literacy questionnaires yielded scores of 90.00% and 95.00%, respectively, both classified as very good. The effectiveness test, measured using the normalized gain (N-gain), yielded an average score of 0.79, categorized as high, with minimum and maximum values of 0.36 and 0.98, respectively. These findings indicate that the developed module is valid, practical, and effective as an innovative, technology-based instructional resource that supports the development of students' self-regulation skills and digital literacy.*

Keywords: *Physics Learning Module; Contextual Inquiry; LMS; self-regulation; Digital Literacy*

INTRODUCTION

The development of education in the digital era requires changes in learning strategies that are able to face the challenges of 21st century competencies, such as critical thinking, creativity, collaborative, digital literacy, and self-regulated learning (SRL) skills. Physics learning as one of the science subjects not only focuses on understanding theoretical concepts, but also emphasizes students' active participation in mastering concepts through an inquiry approach and effective use of learning technology.

Physics learning in the field still often faces problems in the form of a teacher-centered approach, lack of student involvement in the inquiry process, and the lack of optimal use of the Learning Management System (LMS) as a learning medium. This condition has an impact on students' low self-regulation skills in managing their learning process independently, as well as their limited digital literacy skills (Syefrinando et al., 2022). In fact, these two skills are essential competencies needed in 21st century learning.

Physics learning modules with a contextual approach have been shown to be effective in increasing student engagement and understanding. Arifah and Azis (t.t.) showed that the QR Code-integrated contextual-based physics module is able to improve students' digital literacy. Meanwhile, the inquiry approach in the physics module has been proven to improve students' science process skills and critical thinking skills (Kurniawan & Bintialiumar, 2021; Damayanti & Panggabean, 2025).

LMS integrations such as Google Classroom and Ruang Guru provide flexibility for students to access materials, work on assignments, discuss, and reflect on independent learning (Aziz & Widianto, 2024; Herayanti et al., 2025).

Research by Elmabaredy and Gencel (2024) shows that incorporating the features of a self-regulated learning strategy into a digital LMS system has a positive impact on student learning outcomes and performance. Meanwhile, Syefrinando et al. (2022) found a significant relationship between digital literacy and self-regulation skills in online physics learning. However, there is still a gap in research that simultaneously integrates contextual inquiry modules with LMS to improve students' self-regulation and digital literacy together.

Based on these conditions, this study aims to: (1) develop an LMS-assisted inquiry-based contextual physics learning module that meets valid criteria; (2) describe the level of practicality of the module based on the responses of students and teachers; and (3) analyze the effectiveness of the module on learning outcomes and describe the profile of self-regulation and digital literacy of students after the implementation of the module.

RESEARCH METHODS

This research uses a Research and Development (R&D) approach with the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model. The mixed methods approach is applied with a primary quantitative focus to test the validity, practicality, and effectiveness of the product, as well as a qualitative approach to describe the results of expert assessments and user responses.

Development Procedure (ADDIE Model)

The Analysis stage was carried out through observation of physics learning, teacher interviews, and analysis of student characteristics at SMAN 1 Dompu. The results of the analysis showed that learning is still teacher-centered, self-regulation skills are low, and LMS has not been utilized optimally. The Design stage includes the preparation of the module framework, the concept map of the Hydrostatic Pressure material, the contextual scenario of the inquiry, and the evaluation instrument. The Development stage is the core of the research in the form of making an integrated physics module for the Teacher's Room LMS and PhET simulation, equipped with two LKPDs, followed by validation by three experts. The Implementation stage applies modules to the experimental class with pretest-posttest data collection, self-regulation questionnaires, digital literacy questionnaires, and observations. The Evaluation stage assesses the quality of the module as a whole based on all the data obtained.

Research Subject and Location

The subjects of the study were 25 students of grade XI Science 2 SMAN 1 Dompu, Dompu Regency, West Nusa Tenggara. The sampling technique uses saturated sampling where all members of the population are sampled. The research will be carried out in May 2026 with the subject matter of Hydrostatic Pressure.

Data Analysis Instruments and Techniques

The instruments used include: (1) material, media, and learning expert validation sheets with a Likert scale of 1–5; (2) questionnaires of student and teacher responses; (3) Zimmerman's (2000) three-phase self-regulation questionnaire; (4)

digital literacy questionnaire; (5) questionnaire on the implementation of learning; and (6) pretest-posttest questions. The validity of the product was analyzed by the formula of feasibility percentage (P = Σx/Σxi × 100%), with the criteria: 81–100% = Very Valid; 61–80% = Valid; 41–60% = Valid Enough. Effectiveness was analyzed using Normalized Gain (N-Gain = (posttest score − pretest score)/(maximum score − pretest score)), with the category: ≥0.70 = High; 0.30–0.69 = Moderate; <0.30 = Low.

Table 1. Product Validity Criteria

Percentage (%)	Category: Validitas
81–100	Highly Valid
61–80	Valid
41–60	Quite Valid
21–40	Less Valid
0–20	Invalid

RESULTS AND DISCUSSION

Characteristics of Developed Modules

The product produced in this study is a physics learning module on Hydrostatic Pressure material for grade XI high school/MA students. The module is systematically designed by integrating a contextual approach to bridge abstract physics concepts with real phenomena around students, such as diving activities in the sea, dam construction structures, and water tank working mechanisms. The contextual approach is then combined with the syntax of inquiry learning which requires students to be actively involved in scientific activities, including observing, formulating problems, proposing hypotheses, collecting and analyzing data, and drawing conclusions. All of these instructional activities are digitally integrated in the Learning Management System (LMS) of the Teacher's Room and supported by a virtual simulation of PhET as an interactive visualization medium.

The structure of the use of this module is strengthened by two types of Student Activity Sheets (LKPD) which have a continuous function. LKPD 1 is focused on the initial exploration stage to build conceptual understanding through direct observation on PhET simulations. Meanwhile, LKPD 2 directs students to advanced data analysis activities and drawing scientific conclusions. In addition to being oriented towards mastering physics concepts, this module is specifically designed to stimulate self-regulation skills through the provision of learning planning activities, progress monitoring, time allocation management, and scheduled self-reflection activities in the LMS. On the other hand, students' digital literacy skills are developed simultaneously through structured tasks involving information search, critical evaluation of digital sources, operation of online interactive media, and virtual communication and collaboration activities.

Expert Validation Results

Product validation is carried out by three validators who are competent in their fields, including material experts (Validator I), media experts (Validator II), and education practitioners or field teachers (Validator III). The assessment comprehensively includes 25 indicators that represent aspects of material suitability, presentation aesthetics, linguistic aspects, graphics, effectiveness of LMS integration, feasibility of LKPD components, as well as the content of self-regulation and digital literacy. The data from the experts' assessment in detail is presented in Table 2 and the visualization can be observed in Figure 1. Based on the results of the analysis, the overall average percentage of validation

reached 87.50%, which placed this module in the Very Valid category. Nevertheless, there are interesting assessment dynamics if observed from the scores of each validator. Validator I gave a score of 88.50% and Validator II gave the highest score of 94.00%, while Validator III gave the lowest score of 80.00%. The difference in scores given by Validator III as an education practitioner provides a strong indication of the gap between conceptual readiness on paper and the reality of practical needs in the classroom. Teachers in the field tend to give more critical assessments because they consider real variables, such as the management of limited physics learning time allocation and the technical readiness of the gadgets owned by students.

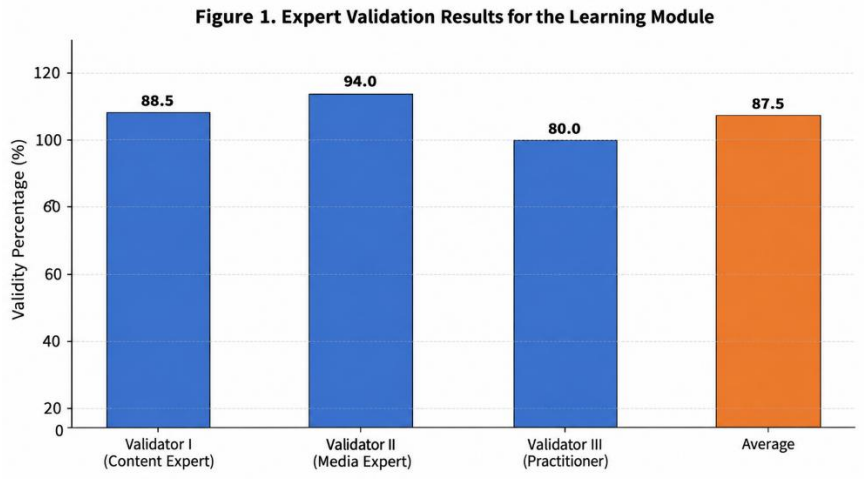


Figure 1. Percentage of Validation Results by Three Expert Validators

Table 2. Results of Expert Validation of Learning Modules

No.	Assessment Aspects	V-I	V-II	V-III	Average
1	Suitability of Materials & Curriculum	88,50%	94,00%	80,00%	87,50%
2	Presentation & Clarity of Modules	88,50%	94,00%	80,00%	87,50%
3	Language	88,50%	94,00%	80,00%	87,50%
4	Graphics & Display	88,50%	94,00%	80,00%	87,50%
5	LMS & PhET Integration	88,50%	94,00%	80,00%	87,50%
Average Percentage		**88,50%**	**94,00%**	**80,00%**	**87,50%**
Category		**Highly Valid**	**Highly Valid**	**Valid**	**Highly Valid**

In response to critical feedback from validators, a number of concrete revision steps have been implemented before the product is tested to students. Improvements are made by increasing the depth of theoretical studies, increasing examples of local phenomena that are closer to students' daily lives, and optimizing visual illustrations in the LKPD so as not to be confusing. Through this reconstruction process, the quality of the material and the readability of the modules were successfully improved so as to minimize the potential for misconceptions during learning. This

finding is linear with the research results of Bunga et al. (2025) which affirm that valid contextual-based teaching materials are able to trigger students' interest in learning. In addition, these results are strengthened by Damayanti and Panggabean (2025) who state that a strict multi-aspect validation process is a mandatory instrument to ensure the feasibility of materials and media before they are widely distributed.

Practicality of Modules

The level of practicality of using the module was measured using a response questionnaire instrument involving 25 students in grade XI Science 2 SMAN 1 Dompu and a physics teacher. This practical evaluation is also supported by complementary data in the form of self-regulation questionnaires, digital literacy questionnaires, assessments of test question instruments, and observation sheets on learning implementation. The recapitulation of the data from the results of the practicality measurement is systematically summarized in Table 3, with the achievement trends depicted in Figure 2 and Figure 3.

Table 3. Recapitulation of Module Practicality Questionnaire Results

No.	Instruments	Shoes	Percentage	Category	Remarks
1	Student Response (average)	—	88,10%	Very Practical	25 students
2	Teacher Response	34/40	85,00%	Very Practical	1 teacher
3	Self-Regulation Questionnaire	36/40	90,00%	Excellent	Post-module
4	Digital Literacy Questionnaire	38/40	95,00%	Excellent	Post-module
5	Test Question Instruments	37/40	92,50%	Excellent	Student assessment
6	Implementation of Learning	38/40	95,00%	Excellent	Observations

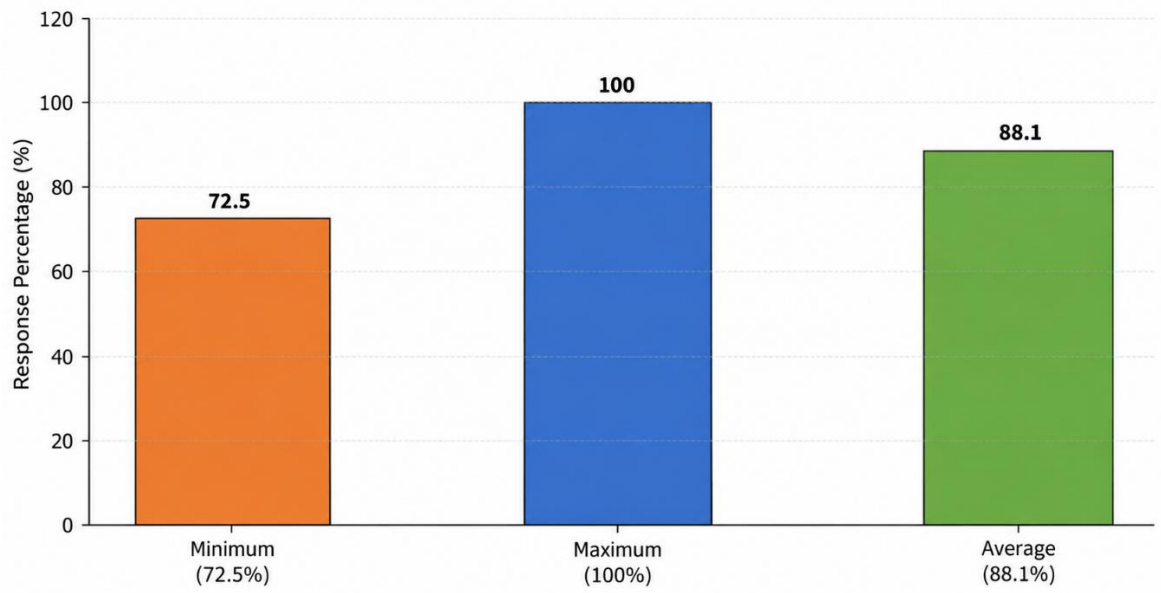


Figure 2. Percentage of Student Responses to Learning Modules

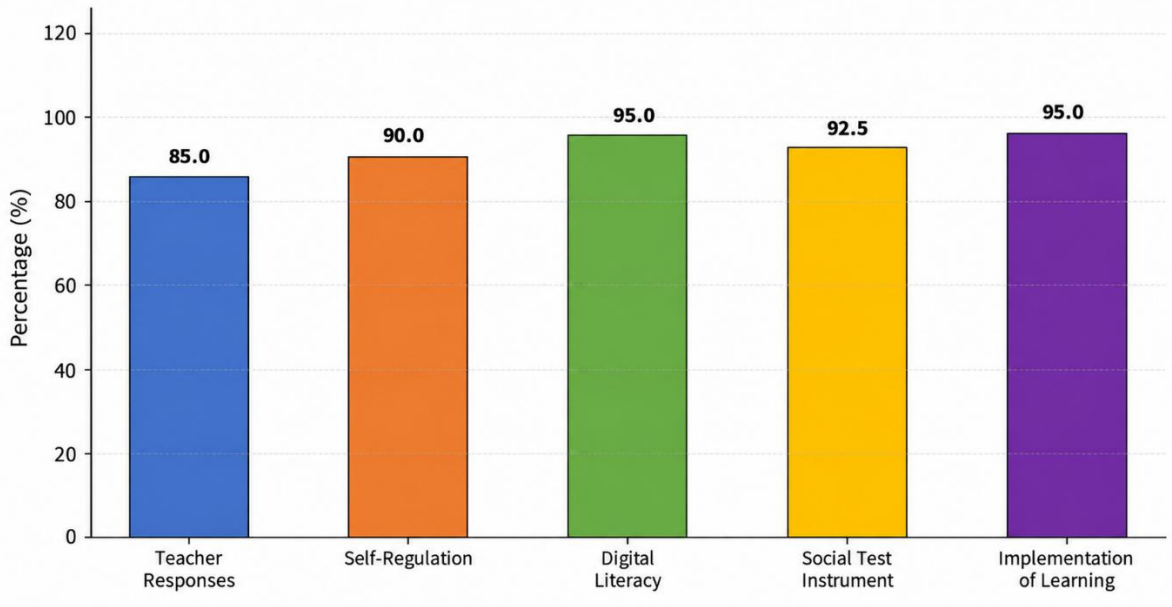


Figure 3. Recapitulation of All Instrument Practicality Module

The results of the questionnaire analysis showed that the students' responses were in the range of 72.50% to 100% with an average achievement of 88.10%, which was included in the Very Practical criteria. From the student's point of view, this practicality is triggered by the systematics of the structured presentation of the material and the integration of PhET simulations that are able to visualize the abstract properties of fluid pressure into easy-to-understand graphical forms. In line with student perception, the teacher's response questionnaire obtained a percentage score of 85.00% (Very Practical). Teachers consider that this module provides convenience in organizing classes, while the use of the Ruang Guru LMS is very helpful in monitoring digital track records and student learning progress in real-time.

The high practicality of this module has a direct impact on strengthening students' metacognitive character, as evidenced by the acquisition of a self-regulation questionnaire of 90.00% (Very Good). If dissected based on the theory of self-learning governance from Zimmerman (2000), this module has proven to be effective in facilitating three phases of self-regulation in a continuous manner. First, in the planning phase (forethought), the learning target feature in the LMS encourages students to set their learning goals. Second, in the implementation phase (performance control), the interactive LKPD work combined with PhET trained students to monitor their understanding independently when exploring the variables of water depth and fluid density. Third, in the self-reflection phase, the self-evaluation column at the end of the module guides students to assess the extent of the essence of the material they have mastered.

In addition to self-regulation, the aspect of students' digital literacy also showed a very high achievement of 95.00% (Very Good). This success is driven by the habituation of digital activities inherent in the modules, where students are required to actively operate the Teacher's Room LMS, extract data from PhET simulations, and communicate their scientific findings in a digital platform. The learning implementation process that touched 95.00% proves that all contextual syntax of inquiry can be implemented in the classroom without significant obstacles. This empirical fact supports the argument of Elmabaredy

and Gencel (2024) that the integration of self-regulation features into digital platforms is significantly able to boost students' academic performance and learning independence.

Module Effectiveness (N-Gain Analysis)

The effectiveness test of the use of the module was carried out by analyzing the difference in pretest and posttest scores through the calculation of the Normalized Gain (N-Gain) score. This experiment was applied to a group of saturated samples of 25 students in grade XI Science 2 SMAN 1 Dompu on the subject matter of Hydrostatic Pressure. The summary of statistical data from the effectiveness test results is described in Table 4 and supported by the comparison graph of values in Figure 4.

Table 4. Results of N-Gain Module Effectiveness Analysis

Statistics	N-Gain Score	N-Gain Percentage (%)
Number of Students (N)	25	25
Minimum Score	0,36	35,71%
Maximum Value	0,98	97,56%
Track-Track (Mean)	0,79	78,44%
Standard Deviation	0,17	16,30%
Category	Height	Height

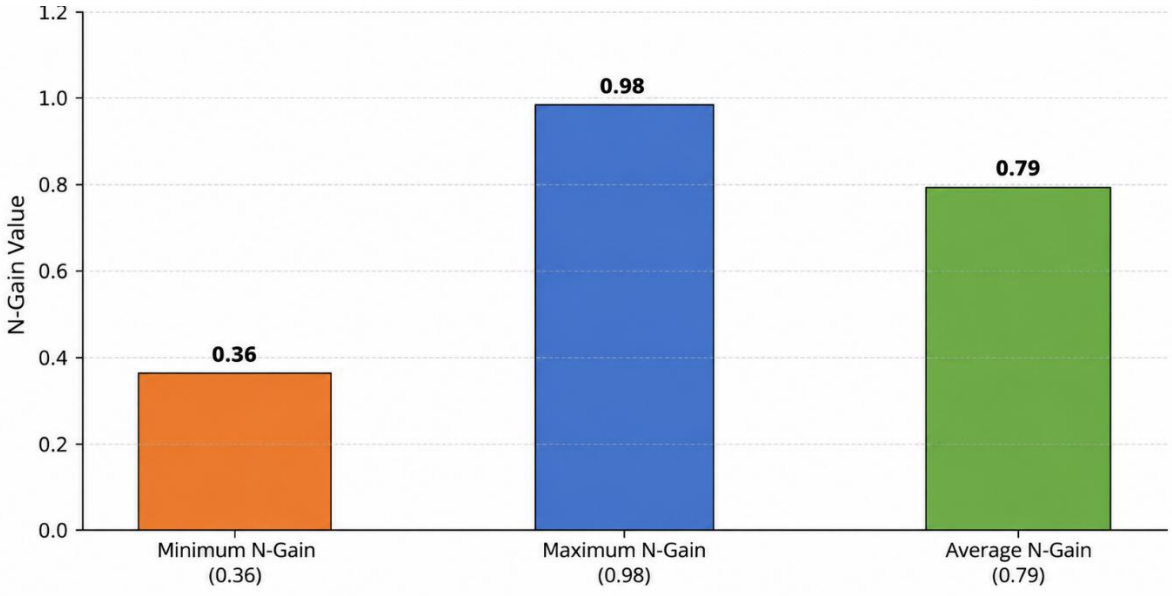


Figure 4. Results of N-Gain Analysis Improve Student Learning Outcomes

Data analysis showed that the average N-Gain value of students reached 0.79 (78.44%), which indicates the level of effectiveness in the High category. The minimum N-Gain value was recorded at 0.36 while the maximum value touched 0.98. This range of values proves that all students involved in learning experience an increase in their understanding of physics concepts that are positive. The relatively small standard deviation value (0.17) indicates that the distribution of improved learning outcomes among students is evenly distributed, thus minimizing the gap in understanding in the classroom.

Theoretically, this surge in effectiveness occurred because the module succeeded in shifting the learning paradigm from teacher-centered to student-centered. Through the contextual approach of inquiry,

students no longer simply memorize the mathematical formula of hydrostatic pressure $P = \rho \cdot g \cdot h$, but build this understanding themselves through scientific proof in a PhET virtual simulation. When students change the depth variable (h) or type of liquid (ρ) on the simulation and see the change in pressure directly, a profound cognitive reconstruction occurs. Independent activities in the Teacher's Room LMS also train students' learning resilience. These findings are in line with Al Mamun and Lawrie (2023) who stated that active interaction between students with structured inquiry-based digital content is able to train self-regulation and increase learning engagement essentially.

The improvement of students' digital literacy performance is driven by constant intensive interaction with technology during the learning process. Through this digital ecosystem, students transform from mere consumers of technology to productive and critical users in managing academic information. This confirms the opinion of Gunawan et al. (2024) that the active use of LMS is an effective medium to hone 21st century digital skills. In addition, Koilmo et al. (2025) also emphasized that virtual simulations not only increase digital literacy but also have a linear impact on strengthening students' cognitive learning outcomes.

Despite showing satisfactory results, the process of implementing the module in the field still encountered several operational obstacles. In the early phase of learning, some students experienced technological stutter when navigating the menu in the Ruang Guru LMS and had difficulty correlating the visual graph of PhET with the formulation of physics theory. This obstacle was successfully mitigated through the provision of interventions in the form of focused guidance (scaffolding) by teachers, technical demonstrations of the use of simulation features, and intensive assistance during group discussions. This field experience is in line with the assertion of Nasar et al. (2025) that the effectiveness of digital learning implementation is highly dependent on the students' initial technological readiness and the quality of support or feedback provided by teachers in the classroom, Although the N-Gain results indicate a high category, the interpretation of effectiveness needs to be done with caution as the study used a one-group pretest-posttest design without a control group. Therefore, the improvement in learning outcomes obtained cannot be fully attributed only to the use of modules. Further research is recommended using quasi-experimental design or experiments with control groups so that the effectiveness of the modules can be tested more robustly.

CONCLUSION

This research succeeded in developing a physics learning module based on an LMS-assisted inquiry contextual approach that meets the criteria of being very valid, very practical, and effective. The validation results showed an average of 87.50% (Very Valid), student responses of 88.10% and teachers 85.00% (Very Practical), self-regulation questionnaires of 90.00% and digital literacy of 95.00% (Excellent), and an average N-Gain effectiveness of 0.79 (High). The integration of the inquiry contextual approach with the Ruang Guru LMS and PhET simulation has been proven to be able to support a more active, independent, and meaningful learning process for grade XI students of SMAN 1 Dompu.

Further research is suggested to extend the subject to more schools, develop similar modules on other physics subjects, optimize

the use of LMS features for limited network conditions, as well as combine quantitative and qualitative methods for a more comprehensive picture of the student learning experience, The limitations of this study lie in the number of samples involving only one class (n = 25) and the use of a one-group pretest-posttest design without a group control. In addition, the measurement of self-regulation and digital literacy is only carried out after the implementation of the module so that it cannot show the changes in the two variables directly.

ACKNOWLEDGMENTS

The author would like to thank Dr. Lovy Herayanti, M.Pd. and Irham Azmi, M.Pd. as supervisors, Prof. Dr. Saiful Prayogi, M.Pd. as Deans of FSTT Mandalika Education University, and Syifaul Gummah, S.Pd., M.Pd. as the Head of the Physics Education Study Program. Appreciation was also conveyed to the expert validators, physics teachers, and all students of grade XI Science 2 SMAN 1 Dompu who had participated in this research.

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