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ICARE: Development of Mathematics Student Worksheets on Sequences and Series Material

Nur Halimah, Arnida Sari*

Program Studi Pendidikan Matematika, Universitas Islam Negeri Sultan Syarif Kasim Riau, Riau, Indonesia
e-mail: arnidasari@uin-suska.ac.id

ABSTRACT. This study aims to develop and produce learning media, using ICARE-based Student Worksheets (LKS) on sequence and series material, that meet the criteria of validity, practicality, and effectiveness. This type of research is development research with the ADDIE model. The subjects of this study were grade XI students, educational technology experts, and learning material experts. The object of the study was Learning Media using ICARE-based Student Worksheets on sequence and series material. Data collection techniques used questionnaires and test techniques. The research instruments were validation sheets for research technology experts, validation sheets for learning materials, student response questionnaires, and post-test questions. The types of data were quantitative and qualitative. The data were analyzed using both qualitative and quantitative descriptive analysis techniques. The results of this study indicate that the Learning Media, using ICARE-based Student Worksheets on Sequence and Series Material, developed, is classified as very valid and very practical for small, limited groups. The results of the effectiveness test showed that the learning media using ICARE-based Student Worksheets on sequence and series material are effective. In addition, the average value of the experimental class is higher than the average value of the control class.

Keywords: development; ICARE; sequences and series; worksheets

ABSTRAK. Penelitian ini bertujuan untuk mengembangkan dan menghasilkan media pembelajaran menggunakan LKS berbasis ICARE pada materi barisan dan deret yang memenuhi kriteria valid, praktis, dan efektif. Jenis penelitian ini merupakan penelitian pengembangan dengan model ADDIE. Subjek penelitian ini adalah siswa kelas XI, ahli teknologi Pendidikan dan ahli materi pembelajaran. Objek penelitian adalah Media Pembelajaran menggunakan LKS berbasis ICARE pada materi barisan dan deret. Teknik pengumpulan data menggunakan teknik angket dan tes. Instrumen penelitian berupa lembar validasi untuk ahli teknologi penelitian, lembar validasi untuk materi pembelajaran, angket respon siswa, dan soal posttest. Jenis data berupa data kuantitatif dan data kualitatif. Data dianalisis menggunakan Teknik analisis deskriptif kualitatif dan Teknik analisis deskriptif kuantitatif. Hasil penelitian ini menunjukkan bahwa Media Pembelajaran menggunakan LKS berbasis ICARE pada Materi Barisan dan Deret yang dikembangkan tergolong dalam kategori sangat valid dan sangat praktis untuk kelompok kecil dan kelompok terbatas. Hasil uji efektifitas, diperoleh bahwa media pembelajaran menggunakan LKS berbasis ICARE pada materi barisan dan deret efektif untuk digunakan. selain itu, nilai rata-rata kelas eksperimen lebih tinggi dari pada nilai rata-rata kelas kontrol.

Kata kunci: barisan dan deret; ICARE; LKS; pengembangan

INTRODUCTION

Mathematics is still considered a difficult subject by most students, leading to low interest in learning it. This situation has long been a concern in the education world. Nevertheless, mathematics plays a strategic role in the education system because it is taught in a tiered and continuous manner. The goal of mathematics learning is to develop logical, systematic, and critical

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thinking skills, as well as foster creativity and innovation in solving everyday life problems (Rohmah, 2021).

The 2013 Curriculum-based learning aimed to drive active student involvement through a scientific approach, student engagement remains disappointingly low due to persistent teacher-centered methods. This ongoing reliance on traditional lectures demands urgent action: teachers must implement a more structured, student-centered model immediately. The ICARE model, encompassing Introduction, Connection, Application, Reflection, and Extension, offers a promising and necessary alternative. Swift adoption of this model is critical to boost student engagement and motivation. Therefore, teachers are strongly encouraged to adopt the ICARE learning model in their classrooms to foster greater student participation and enthusiasm (Antari et al., 2022; Hasyim, 2023).

The ICARE learning model allows teachers to manage learning more effectively by emphasizing each stage (Rahmi et al., 2023; Rihandoko et al., 2024; Shofiyati, 2022). In addition to affecting academic achievement, learning shapes student attitudes and behavior. Studies by Yumiati & Wahyuningrum (2015), Rahmadhani & Wahyuni, (2020), Sasna Junaidi et al. (2024), and Putu (2020) the results showed that the use of ICARE-based learning modules improved student learning outcomes. Therefore, it can be concluded that the ICARE learning model affects the development of students' thinking skills.

In 11th grade, several high school mathematics topics remain difficult for some students, including sequences and series. Research by Zuwandi et al. (2023), Musa et al. (2024) and Saragih et al. (2024) indicates that students' conceptual understanding of sequences and series remains low. In line with these results, other research also confirms that students experience difficulty in solving problems related to sequences and series (Hartati, 2021; Simanjuntak et al., 2025; Wulandari & Setiawan, 2021).

Based on results from working on six problems, the lowest percentage of students' abilities was in the indicator of solving arithmetic sequences, at around 25%, while the indicator for calculating arithmetic sequence patterns reached 78%. These findings indicate that students still experience difficulties in understanding and solving sequence problems, and that their understanding of the concepts of sequences and series needs further study.

METHOD

This research applies research and development (R&D) methods to develop and validate learning products. The products developed are not only physical products but also learning methods (Sugiyono, 2023). Research and development aim to produce a viable product through needs analysis and effectiveness testing. However, testing in this study was limited to the product's validity, effectiveness, and practicality. The development of Student Worksheets (LKS) used the ADDIE model, chosen because it has long been used in development research. This aligns with Mulyatiningsih (2015) view that the ADDIE model is a general and systematic framework for developing teaching materials. The ADDIE model has simple, structured, and easy-to-learn development stages.

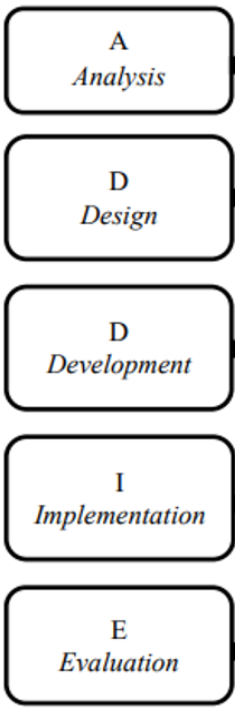

Figure 1. ADDIE Model

This research uses the ADDIE development model, which includes analysis, design, development, implementation, and evaluation (Pribadi, 2009). In the analysis phase, learning needs and problems are identified. In design, learning objectives are set, and scenarios, tools, materials, and evaluation instruments are created. The development phase produces a ready-to-use product. The implementation phase introduces the product in the classroom for feedback. The evaluation phase, conducted formatively and summatively, assesses the product's validity, practicality, and effectiveness for improvement.

This research was conducted in the even semester of the 2023/2024 academic year at SMAN 12 Pekanbaru. Validity tests involved educational technology and learning material experts, while practicality and effectiveness were tested with eleventh-grade students. The research object was an ICARE-based worksheet (LKS) on sequences and series. Data collected included both qualitative and quantitative inputs from expert reviews, questionnaires, and student learning outcome tests.

RESULTS AND DISCUSSION

Results

In the analysis stage, the results of observations and interviews showed that mathematics learning remains teacher-centered, so students tend to memorize concepts and experience difficulties with solving various problems, especially story problems. The use of textbooks is also ineffective because they are less engaging and difficult to understand, which affects student interest and learning outcomes. Although the 2013 Curriculum has been implemented at SMAN 12 Pekanbaru, student learning outcomes remain suboptimal. Therefore, learning materials are needed that are appropriate to students' needs, interesting, and contextual.

In the design stage, researchers designed learning media using the inquiry-based Google platform, utilizing various supporting elements. The learning media, in the form of ICARE-based Student Worksheets (LKS) on sequences and series, were edited and developed in Microsoft Word and Canva Pro to ensure alignment with the learning objectives.

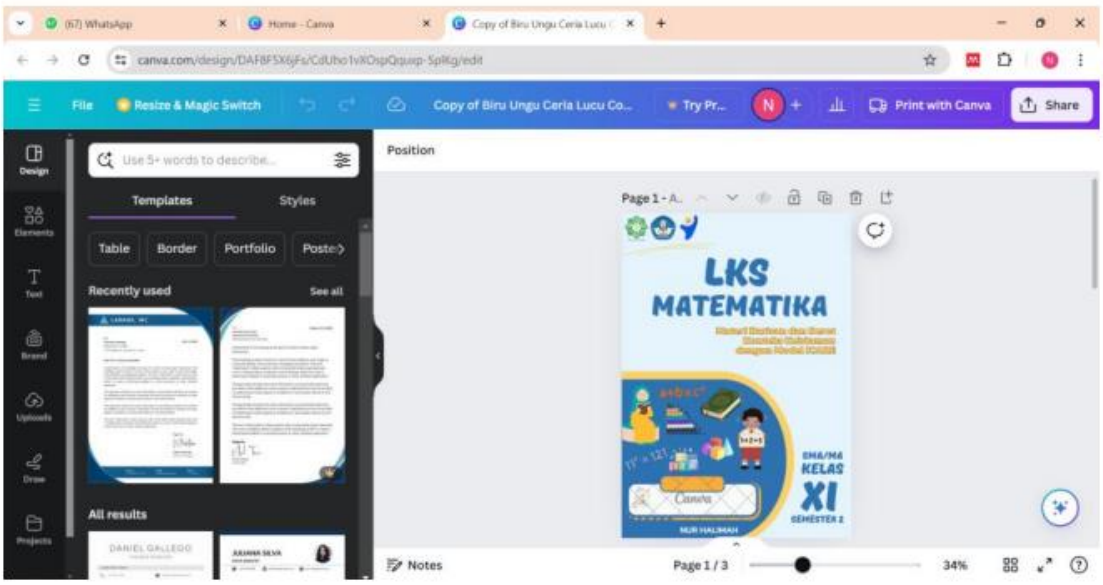

Figure 2. Ms. Word or Canva Pro web

The worksheets are equipped with a front and back cover. The back cover contains a brief description of the mathematical beauty of series, while the front cover lists the topic title, student identification, grade level, learning materials, and illustrations of mathematical symbols. The cover design is colorful and harmonious, enhancing student appeal.

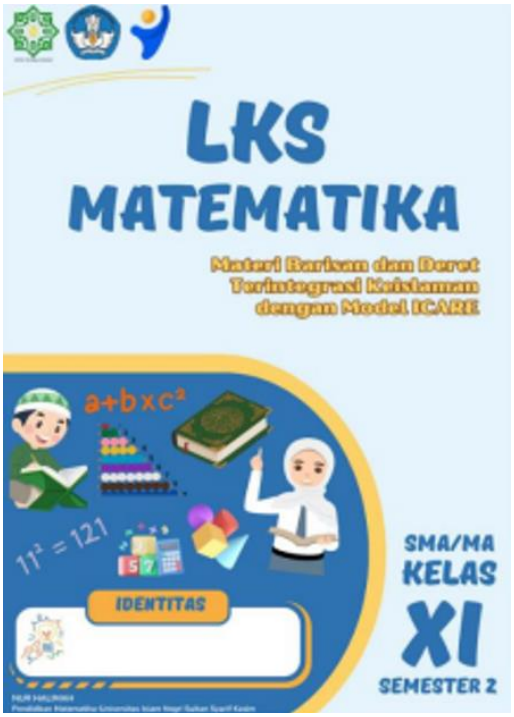

Figure 3. Front Cover

Figure 4. Back Cover

The foreword expresses gratitude to Allah Subḥānahu wa Ta ʻālā, offers prayers and greetings to the Prophet Muhammad SAW, and expresses the author's hopes for the use and development of ICARE-based LKS.

Figure 5. Foreword

The table of contents lists the sections in the Student Worksheet (LKS), complete with page numbers, helping students browse and find the desired learning section more efficiently.

Figure 6. Table of Contents

In the development stage, the researcher continued the process by validating the research instrument and the mathematics learning media in the form of ICARE-based LKS. Before the media were validated, the research instrument was first tested using a validation sheet compiled from the previously designed instrument grid. Instrument validation was carried out by one validator, namely a lecturer in Mathematics Education at Sultan Syarif Kasim State Islamic University, Riau, Mrs. Rena Revita, M.Pd. Input and suggestions from the validator served as a basis for improvements, enabling the developed instrument to be declared suitable for use. The validated research instruments included a validity questionnaire from educational technology experts, a validity questionnaire from learning materials experts, a practicality test questionnaire, and a questionnaire to assess student learning outcomes.

During the LKS validation stage, the research instrument expert validated the questionnaire, which was then used by each expert validator. An educational technology expert and a learning materials expert reviewed the LKS to assess its feasibility before student trials. Their validation led to assessments and recommendations for improving the ICARE-based LKS. Two validators-a Mathematics Education lecturer from Sultan Syarif Kasim State Islamic University, Riau, and a mathematics teacher from SMAN 12 Pekanbaru-conducted the validation of educational technology. As shown in Table 1, the results indicated that the LKS required several improvements before use in trials.

Table 1. Suggestions for Improvement from Educational Technology Expert Validators

Validator	Suggestion	Status Correction	Description
Educational Technology Expert	Clarify the image	Already repaired	One time repair
Educational Technology Expert	Fix questions that use True/False	Already repaired	One time repair

The validity test of the learning material was conducted by two validators: a Mathematics Education lecturer at UIN Sultan Syarif Kasim Riau and a mathematics teacher at SMAN 12 Pekanbaru, to assess the suitability of the material and the completeness of the LKS elements. The test results indicated several recommendations for improvements to the developed LKS, as shown in Table 2.

Table 2. Suggestions for Improvement from Learning Material Expert Validators

Validator	Suggestion	Status Correction	Description
Learning Materials Expert	Improve the question sentence, so that it is easier to understand	Already repaired	One time repair
Learning Materials Expert	Do not use the time points of the formula discovery	Already repaired	One time repair

The posttest questions were validated prior to pilot testing to ensure their suitability for the learning material. Validation was conducted by three validators: a mathematics teacher from SMAN 12 Pekanbaru and two Mathematics Education lecturers from UIN Sultan Syarif Kasim Riau, who provided several suggestions for improvement.

Table 3. Posttest Validator's Suggestions and Improvements

Validator	Suggestion	Status Correction	Description
Posttest Question Expert 1	No Improvement Suggestions	No improvement	No improvement
Posttest Question Expert 2	No Improvement Suggestions	No improvement	No improvement
Posttest Question Expert 3	Improve the question indicator	Already repaired	One time repair

In the implementation stage, the revised ICARE-based worksheets, validated by educational technology and learning material experts, were tested with grade XI students at SMA Negeri 12 Pekanbaru. The trial was conducted in two stages: a small-group test and a limited-group test. The small-group test involved 10 students, with the aim of assessing the practicality of the worksheets by completing a questionnaire. The results showed a practicality percentage of 87.80% in the very practical category. Furthermore, a limited-group test was conducted on 33 grade XI students, with a practicality percentage of 87.40%, which was also in the very practical category, indicating that the worksheets were suitable for learning. In addition, the effectiveness of the worksheets was tested by administering a posttest to the experimental and control classes to determine differences in learning outcomes. Data analysis through normality tests, homogeneity tests, and t-tests showed that the use of ICARE-based worksheets on sequences and series material was effective in improving student learning outcomes.

In the evaluation phase, researchers revised and refined the learning media based on recommendations from validators and student feedback. This evaluation included results obtained during the development and implementation phases. In the development phase, the evaluation focused on analyzing data from media validation by educational technology experts, which was presented comprehensively in tabular form to illustrate the level of validity and feasibility of the developed learning media.

Table 4. Results of Validation by Educational Technology Experts

Aspect	Indicator	Validation Value	Criteria
Graphical Eligibility	Use of letters and writing	80,00	Valid
	Worksheet Design	77,50	Valid
	Use of images in LKS	73,33	Valid
	The appearance of the worksheet is attractive	80,00	Valid
Average Overall Ideal Percentage		**77,69%**	**Valid**

Based on the validation results, the worksheets were declared valid by educational technology experts, with a score of 77.69%, and required no substantial revisions. However, the validators'

suggestions were still used to refine the worksheets. The validation results by the learning materials experts are presented in Table 5.

Table 5. Results of Validation by Learning Material Experts

Aspect	Indicator	Validation Value	Criteria
Didactic Terms	Material according to learning indicators	90,00	Very Valid
	Encourage students' curiosity	80,00	Valid
Didactic Terms	Use language appropriate to the students' developmental level	80,00	Valid
	Provide enough space on the worksheet so that students can write or describe something on the worksheet.	90,00	Very Valid
	Have clear and useful learning goals	85,00	Very Valid
	Presenting the title of the material and making details of the main material and presenting it simply and clearly	86,67%	Very Valid
	LKS has complete content	100,00	Very Valid
Average Overall Ideal Percentage		**85,71%**	**Very Valid**

The validation results from learning material experts indicated that the worksheets were highly valid, with a score of 85.71%, and thus required no significant revisions. However, the validator's suggestions were still used to improve the worksheets. The following are the overall validation results from educational technology and learning materials experts for the ICARE-based worksheets.

Table 6. Overall Validation Results

Indicator	Validation Value	Criteria
Educational Technology Expert	77,69%	Valid
Learning Materials Expert	85,71%	Very Valid
Average	**81,70%**	**Very Valid**

Based on the validation results, the ICARE-based worksheet met the criteria for high validity (average 81.70%) and was deemed suitable for student testing. Recommendations from educational technology and learning materials experts served as the basis for refining the worksheet.

Evaluation during the implementation phase examined the outcomes of the revised learning media from the previous phase, particularly the practicality of the worksheets. This evaluation aimed to ensure that the developed media was easy to use and did not hinder students' understanding of the material. A practicality test was conducted in small groups of 10 students to identify potential deficiencies or errors in the worksheets. After the trial, students were asked to complete a practicality questionnaire as an assessment instrument. The results of the practicality test showed that respondents provided assessments only through the questionnaire, without adding additional comments or suggestions. The data from the small group practicality test are presented in Table 7.

Table 7. Results of the Small Group Practicality Test

Practicality Variable	Indicator	Practicality Value	Criteria
Student interest and appearance of worksheets	The appearance of PBL-based LKS attracts students' interest in using it.	89,43	Very Practical
	Students' interest in learning mathematics using the developed LKS	88,00	Very Practical
Process of Use	PBL-based LKS are more practical and their use can be adjusted to the student's learning speed.	84,00	Very Practical
	The use of PBL-based LKS increases student learning activities.	80,00	Very Practical
Material	PBL-based LKS allows students to connect the material they learn with real contexts in everyday life.	85,00	Very Practical
	PBL-based LKS can improve students' mathematical thinking skills, memory, and stimulate their thinking power.	92,00	Very Practical
	PBL-based LKS helps students understand the material	88,00	Very Practical
Time	The use of PBL-based LKS saves time	92,00	Very Practical
Evaluation	Practice questions in LKS help students hone their mathematical skills	88,00	Very Practical
Overall Ideal Percentage (%)		**87,80%**	Very Practical

A practicality test in a limited group was conducted after the media was piloted in a small group. This trial involved 31 students, and the assessment results indicated that the learning media were categorized as very practical. The results of the practicality test in the limited group are presented in Table 8.

Table 8. Results of Limited Group Practicality Test

Practicality Variable	Indicator	Practicality Value	Criteria
Student interest and appearance of worksheets	The appearance of PBL-based LKS attracts students' interest in using it.	87,81	Very Practical
	Students' interest in learning mathematics using the developed LKS	89,33	Very Practical
Process of Use	PBL-based LKS are more practical and their use can be adjusted to the student's learning speed.	83,67	Very Practical
	The use of PBL-based LKS increases student learning activities.	88,67	Very Practical
Material	PBL-based LKS allows students to connect the material they learn with real contexts in everyday life.	84,67	Very Practical
	PBL-based LKS can improve students' mathematical thinking skills, memory, and stimulate their thinking power.	95,33	Very Practical
	PBL-based LKS helps students understand the material	87,67	Very Practical
Time	The use of PBL-based LKS saves time	86,67	Very Practical
Evaluation	Practice questions in LKS help students hone their mathematical skills	82,67	Very Practical
Overall Ideal Percentage (%)		**87,40%**	**Very Practical**

A posttest was conducted after the trial to determine the effectiveness of the learning media used. The posttest was administered to both the experimental and control classes to compare learning outcomes after the treatment. The average posttest scores for students after the treatment are presented below.

Table 9. Average Learning Outcomes of Experimental Class and Control Class

Class	Average Learning Outcomes After Treatment
Experiment	85,76
Control	68,74

These results indicate that the ICARE-based worksheets for Sequences and Series have been implemented effectively. Students in the experimental class demonstrated high levels of engagement and motivation during the learning process, resulting in higher average posttest scores.

Discussion

Analisis Validity Analysis

The study shows that ICARE-based worksheets (LKS) on Sequences and Series were implemented effectively. The experimental class outperformed the control class after treatment, proving that LKS supports learning objectives. Students in the experimental class were highly engaged and motivated. This led to higher posttest scores than in the control class, confirming that ICARE-based worksheets improve the quality of mathematics learning.

Practicality Analysis

The practicality analysis of ICARE-based worksheets in small groups aimed to determine students' ease of use with the learning media. A questionnaire was given to grade XI students at SMA Negeri 12 Pekanbaru. The analysis showed the worksheets scored 87.80%, meeting very practical criteria. These results show that the worksheets have an attractive appearance and increase student interest and engagement. They are easy to use at each student's pace, help with understanding the material, relate concepts to everyday contexts, and improve thinking skills, memory, and learning efficiency.

A similar practicality analysis with a limited group of eleventh-grade students at SMA Negeri 12 Pekanbaru showed consistent results. The ICARE-based worksheets were rated highly practical, with an 87.40% rating. Student assessments indicated the worksheets increased interest, encouraged active learning, and made the material easier to understand. Practice questions also improved mathematical skills. These findings confirm that the worksheets are suitable for broad use in mathematics instruction.

Effectiveness Analysis

The posttest results showed that the experimental class had an average of 85.76, including the very good category, while the control class had an average of 68.74, with a good category. The results of the t-test at a significance level of 0.05 with dk = 32 showed that t_count = 5.2203 was greater than t_table = 1.694, so Ha was accepted, and Ho was rejected. This indicates a significant difference in learning outcomes between the experimental and control classes, suggesting that the ICARE-based LKS on the Sequence and Series material was effective in improving student learning.

CONCLUSION

The mathematics learning media, in the form of ICARE-based Student Worksheets (LKS) on the Sequence and Series material, were deemed very suitable for learning. The validation results showed that the LKS obtained 77.69% from educational technology experts and 85.71% from learning material experts, with an overall average of 81.70%, which falls within the very valid category. The practicality test also showed very good results, with 87.80% in small groups and 87.40% in limited groups, indicating that the LKS is easy to use, attracts students' interest, and supports the learning process effectively. In addition, the effectiveness test showed that the average posttest score in the experimental class was 85.76 points higher than that in the control class (68.74). The results of the

t-test at a significance level of 0.05 with 32 degrees of freedom showed that the calculated t-value exceeded the t-table value, indicating a significant difference in learning outcomes between the two classes. Thus, the ICARE-based LKS based on sequences and series has been proven valid, practical, and effective in improving students' mathematics learning outcomes.

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