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Development of Learning Tools Based on the Outdoor Learning Mathematics Project Model on Social Arithmetic Topics to Improve Students' Numeracy Skills

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ABTRACT: Numeracy is one of the essential competencies that students need to solve mathematical problems in real-life situations. However, many junior high school students still experience difficulties in applying mathematical concepts to contextual problems because classroom instruction is predominantly teacher-centered and less connected to authentic learning experiences. Therefore, innovative learning devices integrating the Outdoor Learning Mathematics Project (OLMP) model are needed to promote meaningful learning and improve students' numeracy skills. This study aimed to develop OLMP-based learning devices on Social Arithmetic material that are valid, practical, and effective in improving junior high school students' numeracy skills. This research employed a Research and Development (R&D) approach using the modified Four-D (4D) model consisting of the Define, Design, Develop, and Disseminate stages. The developed products included teaching modules, student worksheets (LKPD), numeracy test instruments, and a teacher guidebook. The subjects consisted of Grade VII students of SMP Argopuro Panti, Jember. Data were collected through expert validation, classroom observations, questionnaires, interviews, and pretest–posttest numeracy tests. Data analysis included validity, practicality, effectiveness, N-Gain, normality, and independent sample t-test analyses. The developed learning devices achieved a validity score above 3.75 (very valid), a practicality level of 96.5%, and positive responses from students (97%). Students' learning activities reached 92%, while classical numeracy mastery achieved 86%. Furthermore, the independent sample t-test revealed a significant difference between the experimental and control groups ($p < 0.05$), indicating that the OLMP model significantly improved students' numeracy skills. The OLMP-based learning devices are valid, practical, and effective for mathematics instruction on Social Arithmetic and significantly enhance junior high school students' numeracy skills through authentic outdoor learning experiences.

KEYWORDS: Outdoor Learning Mathematics Project, Learning Devices, Social Arithmetic, Numeracy Skills, Mathematics Education.

INTRODUCTION

Numeracy has become one of the essential competencies required in the twenty-first century to enable individuals to interpret quantitative information, make logical decisions, and solve problems encountered in everyday life. Beyond performing mathematical calculations, numeracy involves the ability to apply mathematical concepts, procedures, and reasoning in various real-world contexts, including economic, social, and environmental situations. Consequently, strengthening students' numeracy skills has become a major concern in mathematics education worldwide because numeracy is closely related to critical thinking, problem-solving, and lifelong learning.

Recent studies have emphasized that mathematics learning should no longer focus solely on procedural knowledge but should provide authentic experiences that enable students to construct mathematical concepts through direct interaction with their surrounding environment. Outdoor mathematics learning encourages students to investigate real phenomena, collect empirical data, discuss mathematical ideas collaboratively, and develop meaningful conceptual understanding. Such learning environments also contribute to increasing students' motivation, engagement, and mathematical achievement.

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In Indonesia, improving students' numeracy skills has become one of the national priorities following the implementation of the *Merdeka Curriculum* and the National Assessment (*Asesmen Nasional*). The curriculum emphasizes contextual learning that enables students to construct mathematical understanding through authentic experiences rather than memorizing formulas.

Nevertheless, many junior high school students still encounter difficulties when solving contextual mathematical problems, particularly those requiring interpretation, reasoning, and decision-making. This condition indicates that classroom mathematics instruction has not yet fully facilitated the development of students' numeracy competencies.

One mathematical topic closely related to numeracy is Social Arithmetic. The concepts of profit and loss, discounts, taxes, simple interest, gross weight, net weight, and tare are directly connected with students' daily experiences. Therefore, Social Arithmetic provides an ideal context for developing numeracy skills because students can learn mathematics through authentic situations encountered in markets, shops, schools, and surrounding communities. However, classroom observations and preliminary interviews conducted with mathematics teachers revealed that Social Arithmetic instruction remains predominantly teacher-centered. Learning activities are generally limited to textbook exercises and procedural calculations, while contextual exploration and direct interaction with real-life situations receive little attention. As a result, students often understand mathematical formulas but experience difficulties applying them in authentic situations.

Recent educational studies have consistently demonstrated that contextual and project-based learning environments significantly improve students' mathematical understanding and numeracy. Learning experiences that actively involve students in solving authentic problems encourage them to connect mathematical concepts with everyday life while promoting higher-order thinking skills. Likewise, outdoor learning has attracted increasing attention because it enables students to investigate mathematical phenomena directly through observation, measurement, data collection, and collaborative problem-solving in natural environments. Such experiences provide meaningful learning opportunities that cannot always be achieved through conventional classroom instruction.

The Outdoor Learning Mathematics Project (OLMP) model represents one of the innovative instructional approaches integrating outdoor learning with project-based mathematics activities. The model encourages students to identify real problems, conduct investigations outside the classroom, collaborate in groups, analyze collected information, and communicate their findings systematically. Through these activities, students are expected to construct mathematical knowledge independently while simultaneously improving their creativity, communication, collaboration, and critical thinking skills. Furthermore, OLMP promotes meaningful learning because mathematical concepts are learned within authentic contexts rather than through abstract explanations alone. Mathematics learning should provide authentic experiences that enable students to construct mathematical concepts through direct interaction with their environment. Outdoor Learning Mathematics (OLM) facilitates meaningful learning by connecting mathematical concepts with real-life situations, thereby improving students' motivation and learning achievement (Pambudi, 2022).

Several previous studies have confirmed the positive contribution of outdoor mathematics learning. Earlier research reported that the OLMP model effectively increased students' participation, creativity, and learning achievement in mathematics. Other studies also demonstrated that learning devices integrating Outdoor Learning Mathematics successfully fulfilled the criteria of validity, practicality, and effectiveness while improving students' creative thinking skills. In addition, research concerning numeracy-oriented learning devices based on realistic mathematics education and local cultural contexts has shown positive impacts on students' numeracy performance. These findings indicate that contextual mathematics instruction has substantial potential to improve learning quality.

Didik Sugeng Pambudi and colleagues have extensively investigated Outdoor Learning Mathematics (OLM) and Outdoor Learning Mathematics Project (OLMP) in various educational contexts. Their studies demonstrated that outdoor mathematics instruction significantly improves students' learning motivation, mathematical achievement, mathematical connection ability, and active participation by allowing learners to experience mathematics in authentic situations rather than merely studying abstract concepts inside the classroom

Furthermore, recent development studies conducted by Pambudi, Dian Kurniati, and collaborators revealed that learning devices integrating outdoor learning and contextual activities fulfilled the criteria of validity, practicality, and effectiveness while successfully improving students' numeracy and mathematical connection skills. These findings indicate that contextual learning devices have considerable potential to strengthen numeracy-oriented mathematics instruction under the *Merdeka Curriculum*. Previous studies have demonstrated that Outdoor Learning Mathematics is effective in improving students' mathematical

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achievement, motivation, and mathematical connection ability. Students become more active physically, socially, and cognitively when mathematical learning is integrated with contextual outdoor activities (Pambudi et al., 2022).

Despite these promising findings, several research gaps remain. First, previous studies primarily focused on improving mathematical achievement, creativity, or general problem-solving abilities, whereas relatively few studies specifically examined students' numeracy skills within the framework of the National Assessment. Second, existing OLMP studies were generally implemented in different mathematical topics, while research investigating Social Arithmetic remains limited despite its close relationship with everyday numeracy practices. Third, previous investigations mostly evaluated the effectiveness of learning models without comprehensively developing complete learning devices consisting of teaching modules, student worksheets, numeracy assessment instruments, and implementation guidelines. Therefore, comprehensive development research integrating OLMP with numeracy-oriented learning devices is still necessary.

Addressing these gaps is important because mathematics learning should not merely improve students' computational abilities but also prepare them to solve practical problems encountered in daily life. Developing learning devices that systematically integrate contextual outdoor activities into mathematics instruction is expected to provide teachers with practical guidance while simultaneously enhancing students' engagement and numeracy competence. Moreover, learning devices developed through a systematic research and development process can ensure instructional quality by meeting the criteria of validity, practicality, and effectiveness before classroom implementation. Although previous studies have confirmed the effectiveness of Outdoor Learning Mathematics, most research has focused on geometry and mathematical connection ability. Research concerning the development of comprehensive Outdoor Learning Mathematics Project (OLMP)-based learning devices specifically designed to improve junior high school students' numeracy skills in Social Arithmetic remains limited.

Despite these encouraging findings, several important research gaps remain. Previous studies by Pambudi and colleagues primarily investigated Outdoor Learning Mathematics in Geometry, Similar Triangles, and mathematical connection ability, while relatively limited attention has been devoted to the development of Outdoor Learning Mathematics Project (OLMP)-based learning devices specifically designed for Social Arithmetic to improve junior high school students' numeracy skills. Moreover, most previous investigations focused on evaluating instructional effectiveness rather than comprehensively developing and validating complete learning devices consisting of teaching modules, student worksheets, teacher guides, and numeracy assessment instruments. This study extends previous research conducted by Pambudi and colleagues by developing a comprehensive set of Outdoor Learning Mathematics Project (OLMP)-based learning devices for Social Arithmetic. Unlike previous studies that primarily examined learning effectiveness or mathematical connection ability, this research integrates outdoor project-based learning with numeracy-oriented assessment aligned with the Indonesian National Assessment and the *Merdeka Curriculum*.

The novelty of this study lies in several aspects. First, this research develops a complete set of learning devices integrating the Outdoor Learning Mathematics Project (OLMP) model specifically for Social Arithmetic learning in junior high schools. Second, the developed devices are explicitly designed to improve students' numeracy skills according to the indicators emphasized in the Indonesian National Assessment, including the ability to use mathematical symbols and numbers, analyze information presented in various representations, and utilize analytical results to make predictions and decisions. Third, unlike previous studies that mainly evaluated learning models, this research develops and validates comprehensive instructional products consisting of teaching modules, student worksheets (LKPD), numeracy assessment instruments, and teacher guidelines using the modified Four-D (4D) development model. Finally, the effectiveness of the developed learning devices is evaluated through expert validation, practicality assessment, and statistical analyses, including N-Gain and independent sample *t*-tests, to provide comprehensive empirical evidence regarding their educational effectiveness. The novelty of this study extends previous research conducted by Pambudi and colleagues by developing a comprehensive set of OLMP-based learning devices specifically designed for Social Arithmetic to improve junior high school students' numeracy skills. Unlike previous studies that primarily examined outdoor mathematics instruction or mathematical connection ability, this research integrates project-based outdoor learning with numeracy-oriented assessment aligned with the Indonesian National Assessment and *Merdeka Curriculum*. In addition, the developed products were comprehensively evaluated in terms of validity, practicality, and effectiveness using expert validation, classroom implementation, N-Gain analysis, and effect size measurement.

Based on these considerations, this study aims to develop Outdoor Learning Mathematics Project (OLMP)-based learning devices for Social Arithmetic that are valid, practical, and effective in improving junior high school students' numeracy skills. The

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findings are expected to contribute theoretically to the advancement of contextual mathematics education and practically to provide mathematics teachers with innovative learning devices that support meaningful learning and strengthen students' numeracy competencies in accordance with the objectives of the *Merdeka Curriculum*.

RESEARCH METHODS

This study employed Research and Development (R&D) using the modified Four-D (4D) development model proposed by Thiagarajan, Semmel, and Semmel. The model consisted of four sequential stages**:** Define, Design, Develop, and Disseminate. The developed learning devices included teaching modules, student worksheets (LKPD), numeracy test instruments, and a teacher guidebook designed to facilitate the implementation of the Outdoor Learning Mathematics Project (OLMP) model in Social Arithmetic learning. The development process emphasized three quality criteria: validity, practicality, and effectiveness.

The research was conducted at SMP Argopuro Panti, Jember, East Java, Indonesia**,** during the 2025/2026 academic year. The school was selected because it has implemented the *Merdeka Curriculum* and supports innovative mathematics instruction emphasizing numeracy development. The research involved three Grade VII classes. One class was used for limited field testing during the development stage, one class served as the experimental class implementing the developed OLMP learning devices, and one class served as the control class receiving conventional mathematics instruction.

The research sample consisted of 30 students in the experimental class and 30 students in the control class, while five additional students participated in the readability test of the developed learning devices. Sample selection employed cluster random sampling, in which intact classes were randomly assigned as experimental and control groups because class organization could not be rearranged individually.

The study adopted a quasi-experimental pretest–posttest control group design during the effectiveness evaluation stage. Both groups completed a numeracy pretest before instruction and a posttest after the learning intervention. The experimental group learned Social Arithmetic using the Outdoor Learning Mathematics Project (OLMP)-based learning devices, whereas the control group received conventional teacher-centered instruction.

Several research instruments were employed to collect quantitative and qualitative data. The instruments included (1) expert validation sheets for evaluating the quality of the teaching module, student worksheets, teacher guidebook, and numeracy test; (2) classroom implementation observation sheets to assess practicality; (3) teacher and student response questionnaires; (4) interview guidelines for collecting qualitative feedback from teachers; and (5) essay-type numeracy tests administered as pretests and posttests to measure students' numeracy skills.

Instrument validity was evaluated through expert judgment involving two mathematics education lecturers and one experienced junior high school mathematics teacher. Each validator assessed the developed learning devices based on content suitability, language clarity, instructional design, presentation, and practicality. The average validation score (Va) was calculated using:

$$V_a = \frac{\sum_{i=1}^{n} V_i}{n}$$

where *Vi* represents each validator's score and *n* represents the number of validators. The learning devices were considered valid when the average score satisfied $3.00 \leq Va < 4.00$ on a four-point rating scale.

The practicality of the developed learning devices was determined through classroom implementation observations, teacher response questionnaires, student response questionnaires, and interview results. Observation scores were averaged across all indicators to determine the implementation level. Teacher and student responses were analyzed using percentage scores calculated as:

$$P = \frac{\sum X}{N} \times 100\%$$

Learning devices were categorized as practical when implementation scores reached at least 75% and teacher as well as student responses indicated positive perceptions toward the learning process.

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Students' responses were analyzed descriptively by calculating the percentage of positive responses for each questionnaire indicator, including learning motivation, ease of using the worksheets, clarity of instructions, collaboration experiences, and overall satisfaction with outdoor mathematics learning. Positive responses of 75% or higher indicated that the developed learning devices were well accepted by students.

The effectiveness of the developed learning devices was evaluated using students' numeracy test scores. Prior to hypothesis testing, data normality was examined using the Shapiro–Wilk test**,** considering its suitability for relatively small sample sizes. Data were considered normally distributed when the significance value exceeded 0.05**.**

Homogeneity of variance between the experimental and control groups was assessed using Levene's Test. Equal variances were assumed when the significance value was greater than **0.05**, allowing the use of parametric statistical analysis.

To determine whether significant differences existed between the experimental and control groups, an Independent Samples t-test was conducted at a significance level of $\alpha = 0.05$. If the obtained significance value (Sig. 2-tailed) was less than 0.05, the null hypothesis was rejected, indicating that the OLMP-based learning devices significantly improved students' numeracy skills compared with conventional instruction.

Students' improvement in numeracy skills was further evaluated using the Normalized Gain (N-Gain) index calculated by:

$$\text{N-Gain} = \frac{\text{Posttest Score} - \text{Pretest Score}}{\text{Maximum Score} - \text{Pretest Score}}$$

The resulting N-Gain values were interpreted according to the following categories: High (≥0.70), Moderate (0.30–0.69), and Low (<0.30)**.** The developed learning devices were considered effective when the average N-Gain reached at least the moderate category.

To determine the magnitude of the treatment effect, Cohen's Effect Size (d) was calculated using:

$$d = \frac{\bar{X}_{\text{post}} - \bar{X}_{\text{pre}}}{SD_{\text{pooled}}}$$

where (\bar{X}_E) represents the experimental group's mean score, (\bar{X}*C) represents the control group's mean score, and (SD*{pooled}) denotes the pooled standard deviation. Effect sizes were interpreted according to Cohen's criteria: 0.20 (small), 0.50 (medium), and 0.80 or above (large)**.**

The research hypotheses were formulated as follows:

H_0**:** There is no statistically significant difference in numeracy skills between students taught using the Outdoor Learning Mathematics Project (OLMP)-based learning devices and those taught using conventional learning.

H_1**:** Students taught using the Outdoor Learning Mathematics Project (OLMP)-based learning devices demonstrate significantly higher numeracy skills than students receiving conventional mathematics instruction.

All quantitative analyses were performed **using** IBM SPSS Statistics version 27, while qualitative data obtained from interviews and classroom observations were analyzed descriptively to support the quantitative findings. The developed learning devices were considered successful when they simultaneously fulfilled the criteria of validity, practicality, and effectiveness.

RESULTS AND DISCUSSION

Results

The effectiveness of the Outdoor Learning Mathematics Project (OLMP)-based learning devices was evaluated through descriptive and inferential statistical analyses. The descriptive statistics summarize students' numeracy scores before and after the implementation of the developed learning devices.

Table 1. Descriptive Statistics of Students' Numeracy Scores

Group	N	Pretest Mean	SD	Posttest Mean	SD
Experimental	30	48.73	7.82	82.67	6.91
Control	30	47.90	8.15	68.40	8.74

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Table 1 indicates that both groups had nearly identical initial numeracy abilities before the learning intervention. The experimental class obtained a mean pretest score of 48.73, while the control class achieved 47.90, suggesting comparable baseline performance. Following the implementation of the OLMP learning devices, the experimental class demonstrated a remarkable improvement, achieving a mean posttest score of 82.67, whereas the control class obtained 68.40**.** The increase observed in the experimental class indicates that learning activities integrating authentic outdoor mathematical projects effectively improved students' numeracy skills.

Learning Device Validity

The developed learning devices were validated by three experts consisting of two mathematics education lecturers and one experienced mathematics teacher.

Table 2. Expert Validation Results

Learning Device	Mean Score (Va)	Category
Teaching Module	3.81	Valid
Student Worksheet (LKPD)	3.78	Valid
Teacher Guidebook	3.84	Valid
Numeracy Test Instrument	3.82	Valid
Overall Mean	3.81	Valid

The average validation score reached 3.81 on a four-point scale, indicating that all developed learning devices fulfilled the validity criteria. Validators particularly appreciated the contextual activities embedded within the Outdoor Learning Mathematics Project model, the systematic learning procedures, and the alignment between learning objectives and numeracy indicators.

Practicality of Learning Devices

Practicality was measured through classroom implementation observations conducted during three learning meetings.

Table 3. Practicality of Learning Device Implementation

Indicator	Percentage (%)	Category
Introduction Activities	96.20	Practical
Core Learning Activities	97.30	Practical
Closing Activities	95.80	Practical
Classroom Management	96.70	Practical
Average	96.50	Practical

The classroom observations revealed that the developed learning devices were implemented consistently according to the lesson plan. Teachers experienced minimal difficulty in managing project-based outdoor learning activities, while students actively followed every stage of the learning process.

Students' Responses

Students completed a response questionnaire after participating in three learning sessions.

Table 4. Students' Responses toward OLMP Learning

Aspect	Percentage (%)
Learning Motivation	98
Learning Interest	96
Worksheet Design	97
Ease of Learning	96

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Collaboration Experience	98
Outdoor Activities	97
Average	97

The questionnaire results demonstrate that students showed highly positive responses toward the developed learning devices. Most students reported that outdoor mathematical investigations increased their interest in learning Social Arithmetic because they could directly apply mathematical concepts in authentic situations.

Observation of Students' Activities

Students' learning activities were observed throughout the implementation of the Outdoor Learning Mathematics Project.

Table 5. Observation of Students' Learning Activities

Activity Indicator	Percentage (%)
Problem Identification	91
Data Collection	94
Group Discussion	93
Mathematical Calculation	90
Presentation	92
Reflection	91
Average	92

The observation results indicate that students actively participated throughout the learning process. Their involvement exceeded the predetermined success criterion of 75%, demonstrating that the OLMP model successfully encouraged active participation and collaborative problem-solving.

Normality Test

Prior to hypothesis testing, data normality was examined using the Shapiro–Wilk test.

Table 6. Shapiro–Wilk Normality Test

Variable	Sig.
Experimental Pretest	0.218
Experimental Posttest	0.176
Control Pretest	0.241
Control Posttest	0.195

Since all significance values exceeded 0.05, the data were normally distributed. Therefore, parametric statistical analyses could be applied.

Paired Samples t-Test

The paired samples t-test was conducted to determine whether significant improvement occurred within the experimental group.

Table 7. Paired Samples t-Test

Comparison	t	df	Sig. (2-tailed)
Pretest–Posttest	24.861	29	0.000

The significance value of 0.000 (<0.05) indicates a statistically significant improvement in students' numeracy skills after participating in OLMP-based mathematics learning.

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N-Gain Analysis

Students' learning improvement was further examined using the Normalized Gain index.

Table 8. N-Gain Results

Group	Mean N-Gain	Category
Experimental	0.66	Moderate
Control	0.39	Moderate

The experimental class achieved a higher N-Gain score than the control class, indicating that the Outdoor Learning Mathematics Project produced greater improvement in numeracy skills than conventional instruction.

Effect Size Analysis

The magnitude of the treatment effect was calculated using Cohen's d.

Table 9. Effect Size

Comparison	Cohen's d	Interpretation
Experimental vs Control	1.72	Large

The calculated effect size of 1.72 indicates a very large educational impact. According to Cohen's criteria, values greater than 0.80 represent large effects. Therefore, the Outdoor Learning Mathematics Project learning devices substantially improved students' numeracy skills.

Overall, the quantitative findings demonstrate that the developed learning devices satisfied all development criteria. The devices were valid according to expert judgment, practical based on implementation and user responses, and effective in significantly improving students' numeracy achievement.

CONCLUSION

This study successfully developed Outdoor Learning Mathematics Project (OLMP)-based learning devices for Social Arithmetic learning at the junior high school level using the Four-D (4D) development model. The developed products, consisting of a teaching module, student worksheets (LKPD), teacher guidebook, and numeracy assessment instrument, fulfilled the criteria of validity, practicality, and effectiveness. Expert validation results indicated that all learning devices were categorized as very valid. Furthermore, classroom implementation observations, teacher feedback, and student responses demonstrated that the developed learning devices were highly practical and feasible for classroom application. The effectiveness analysis revealed a significant improvement in students' numeracy skills, as evidenced by the results of the paired samples *t*-test, N-Gain analysis, and large effect size. Therefore, the Outdoor Learning Mathematics Project (OLMP) model can be considered an effective instructional approach for enhancing students' numeracy competencies in Social Arithmetic learning.

The findings of this study have important implications for mathematics education. Theoretically, the study supports constructivist learning theory by demonstrating that authentic learning experiences and direct interaction with real-world contexts facilitate deeper mathematical understanding and numeracy development. Practically, the developed learning devices provide mathematics teachers with an innovative and structured instructional alternative that integrates outdoor activities, project-based learning, and contextual problem-solving. Such an approach aligns with the objectives of the *Merdeka Curriculum*, which emphasizes meaningful learning experiences and the development of essential competencies for the twenty-first century.

Despite its positive findings, this study has several limitations. First, the implementation was conducted in only one junior high school, limiting the generalizability of the results to broader educational contexts. Second, the duration of the intervention was relatively short and focused exclusively on Social Arithmetic material. Third, the effectiveness evaluation primarily emphasized numeracy achievement, while other important outcomes such as critical thinking, creativity, mathematical communication, and long-term retention were not comprehensively examined.

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Future studies are recommended to implement the OLMP model in different schools and educational settings involving larger and more diverse student populations. Researchers may also extend the application of OLMP to other mathematics topics, such as Statistics, Geometry, Algebra, and Probability. Furthermore, future investigations should explore the impact of OLMP on other higher-order thinking skills, including critical thinking, problem-solving, creativity, mathematical literacy, and collaborative learning competencies. Longitudinal studies are also needed to examine the sustainability of students' numeracy improvement over extended periods of learning.

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