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| RESEARCH ARTICLE

Developing Differentiated Learning Devices to Heighten Student Learning Outcome on Light Concepts at SMP Negeri 1 Kwandang

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| ABSTRACT
Research development aims to produce differentiated learning tools that are valid, practical, and effective on the sub-theme of Light. The research model uses the ADDIE model. The research was carried out in one of the North Gorontalo Regency Middle Schools in the 2021/2022 academic year. The results of the research show that the differentiated learning tools developed meet the valid, practical, and effective requirements. The average percentage of expert validation results on RPP, LKPD, teaching materials, and learning achievement test instruments with respective categories is around 94%, 94%, 90%, and 90%. The results of the analysis of the implementation of learning and learning activities of students on good criteria were around 96% and 94%, respectively, and the percentage of students' responses in the trial was around 93%. The mean final test score of learning outcomes for each differentiated group has increased, namely for students with high learning readiness (79.43), moderate learning readiness (81.06), and low learning readiness (80.68) with an average percentage of student learning completeness about 94%. Furthermore, the mean N-Gain results of the three differentiated groups were in the high category, above 0.7. with the respective results for groups with high learning readiness at 0.74, groups with moderate learning readiness at 0.77, and groups with low learning readiness at 0.77.

| KEYWORDS

Differentiated Learning Devices, ADDIE, Learning Outcomes

| ARTICLE INFORMATION

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1. Introduction

Knowledge and technology thriving results in changes in human life, including education, with a relatively high change rate. Accordingly, learning transformation is expected to equip and prepare graduates to be preeminent generation responsive and prepared to face present and future challenges.

Through learning transformation, students are expected to carry out qualitative changes, yielding better behaviors. Hence, learning must be conducted in an interactive, inspirative, fun, and challenging atmosphere. It will motivate students to participate actively and affords adequate space to develop creativity and independence in accordance with their skills, interest, and physical development within a convenient and fun atmosphere to achieve their well-being.

21st Century education is claimed to be the development of three key competencies, i.e., thinking competency, acting competency, and living in the world competency (Greenstein, 2012). 21st Century education is claimed to be the development of three key competencies, i.e., thinking competency, acting competency, and living in the world competency (Greenstein, 2012). To meet the competencies, we call for learning approaches with an adjustment to student characters. As such, learning has to prioritize student needs and differences and be based on the learning identification results, covering readiness, interest, and learning profile.

Learning centered on students as individuals is learning with an open class system or flexible structured class system (Munandar, 1999). The learning breeds no pressure on student performance and emphasizes more individual attention. In so doing, differentiated learning is a critical approach to attain learning with a new paradigm focusing on student learning needs. Differentiated learning customizes classroom learning to meet students' individual learning needs (Tomlinson, 2000). Additionally, it is a series of common-sense decisions made by teachers oriented to student needs (Ministry of Education, Culture, Research, and Technology, 2020). The decisions made are associated with a) how teachers create a learning environment inviting students to learn and work hard to realize a higher learning objective, b) the curriculum with a learning objective clearly defined, c) sustainable assessment, d) how teachers respond to student learning needs, and e) effective class management. In short, differentiated learning is a learning approach in which teachers are demanded to adjust learning to student learning needs, bringing about learning that can accommodate student diversity and distinctiveness.

In holding differentiated learning, teachers should map student learning needs (Bayumi et al., 2021). Teachers have to understand student preparedness before beginning a learning activity.

Student learning needs can be classified into three aspects, namely learning readiness, interest, and profile (Tomlinson, 2001). To host differentiated learning, teachers can apply differentiated approaches: content approach, process approach, and product approach. In practice, teachers can implement one or more differentiated approaches to optimize services that fulfill student learning needs. Using differentiated approaches, students can deliver learning in accordance with their competency levels (teaching at the right level).

Our type of differentiated learning approach focuses on process differentiation. And yet, we do not sideline content and product differentiation. Meanwhile, student learning needs to focus on learning readiness. The reason for focusing on it is that the light concept delivered is an essential material that comes at the material depth and broadness level hard to understand.

The observation of science teachers at a junior high school in Gorontalo Utara demonstrated that most of the teachers hold poor learning. The learning was teacher-centred, conventional, and did not accommodate student learning needs. It brought on disparities, e.g., students' low learning motivation, difficulties in understanding learning materials, higher-competency students dominating learning activities, and poorly implemented peer tutoring. The issue caused a gap between students with higher competencies and those with low ones. It is regretted as all students have the right to equal and just educational services. The data were followed up using the ADDIE development analysis.

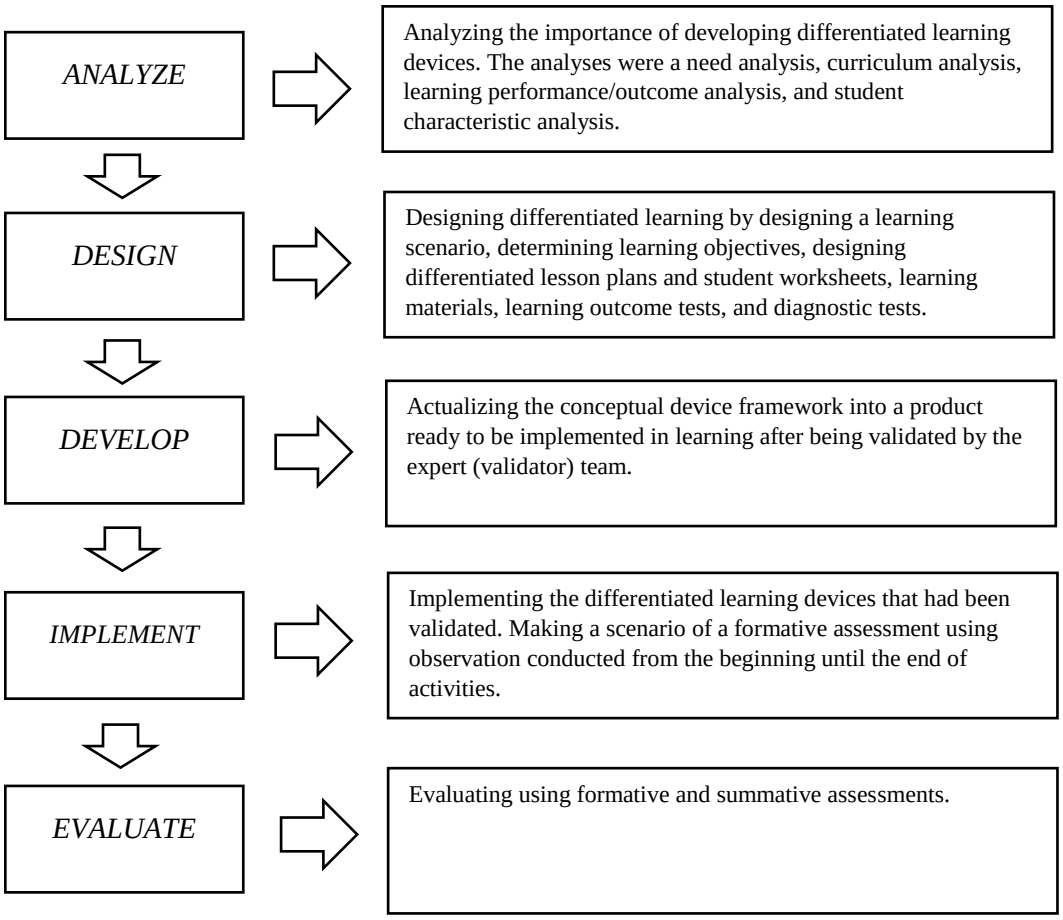
We designed our differentiated learning using the following stages: a) mapping student learning needs at the learning readiness level using diagnostic assessments, b) designing differentiated lesson plans, student worksheets (content, process, and product), learning materials, and learning outcome tests, d) giving a formative assessment to analyze the process and reflect on learning, e) giving an assignment as the learning product, and f) giving a summative assessment.

2. Methodology

This research was research and development to engender differentiated learning devices to augment student learning outcomes. The device developed focused on lesson plans and student worksheets. However, we still considered teaching materials and learning outcome tests. This research was carried out in the odd semester 2021/2022, and the research subjects were eighth graders at the B class SMP Negeri 1 Kwandang Gorontalo Utara. The limited scale test was conducted on students from the replication class to acquire a more accurate interpretation and better results.

This research reference Borg and Gall's (2010) argument that research and development aim to develop and validate an educational product. The phases in the process were called the R & D cycle. The research phases complied with the ADDIE (Analysis, Design, Development or Production, Implementation or Delivery, and Evaluation) model by Dick & Carry (2001). Figure 1 delineates the model.

Figure 1. ADDIE Model-Based Research Phases



Source: Modification from Dick & Carry (2001)

This research employed descriptive quantitative data collected from the validation, observation sheet, and learning outcome test results. We used three techniques, i.e., observation, questionnaire, and learning outcome test. The observation was systematically observing and recording observable elements of a symptom of the research object (Widoyoko, 2014). A questionnaire was made for expert validators and students and adjusted to each party's functions and interests. The results of questionnaires responded to by students acted as data informing learning implementedness practicality using the developed learning devices. A learning outcome test was carried out to measure students' knowledge competencies, indicating the results of the learning process they participated in.

Descriptive data analysis was used to measure the quality of the developed differentiated learning devices. Validation was analyzed based on the validation scores given by expert validators to the learning devices using a Likert scale of 1-5. The practicality analysis was conducted building on the results of the observation of teaching implementedness, student learning activities, and student responses to differentiated learning implementedness using Guttman's scale. Effectiveness was analyzed using data on the results of learning outcome tests given in the form of pretest-posttest assessments through the following phases:

a. Quantifying student scores.
b. Quantifying student mean scores.
c. Converting mean scores into quantitative ones.
d. Finding the difference between pretest and posttest results using the normality gain test (N-Gain) using the following formula.

$$g = \frac{\text{Xposttest} - \text{Xpretest}}{\text{Xmax} - \text{Xpretest}} \times 100\%$$

Table 1. Normalized N-Gain Criteria

Normalized Gain	Interpretation
0.70 ≤ g ≤ 100	High
0.30 ≤ g ≤ 0.70	Medium
0.00 ≤ g ≤ 0.30	Low
g = 0.00	No increase
-1.00 ≤ g ≤ 0.00	Decrease

Source: Nirmalasari et al. (2016)

3. Results and Discussion

The analyses performed were a need analysis, curriculum analysis, learning performance/outcome analysis, and student characteristic analysis using interview, observation, and document study techniques. The subjects were science teachers teaching eighth graders and the vice school head of the curriculum division SMP Negeri 1 Kwandang Gorontalo Utara.

The data demonstrated that student motivation to learn science was low, students focused on learning in the initial learning stages only, students got easily bored in learning, students found difficulties in understanding the delivered materials, learning did not boost learning activities, learning was dominated by teachers (teacher-centered), learning did not accommodate student learning needs (learning readiness, interest, profiles), learning activities were dominated by high-competency students, and low-competency students could not keep up with the learning speed of high-competency ones. The curriculum analysis was performed on the learning devices teachers used by considering the characteristics of the curriculum applicable at SMP Negeri 1 Kwandang. The collected data exhibited that teachers' teaching devices, i.e., syllabi and lesson plans, did not adhere to the 2017 curriculum development guidelines 2017 revision; teachers did not make adequate student worksheets; formulated basic competencies, competency indicators, and learning objectives mentioned in lesson plans were poorly connected; formulated learning considered no audience, behavior, condition, and degree (ABCD) elements; student-centered learning principles were ignored on lesson plans; and learning strategies/approaches chosen were inappropriate.

Based on the learning performance/outcome analysis, the majority of students were scored under KKM and found difficulties in doing tasks delivered by teachers. In addition, teachers rarely gave formative assessments; question item indicators did not accord with learning objectives, and question items were not aligned with test writing principles. The student characteristic analysis was performed in a sample class containing 30 respondents with different characters and competency levels.

The data collected served as the base for designing valid, practical, and effective differentiated learning devices. Figure 2 presents the results of the validation analysis of learning devices (lesson plans, student worksheets, learning materials, and learning outcomes tests) by three expert validators.

Figure 2. Learning Device Validation Results

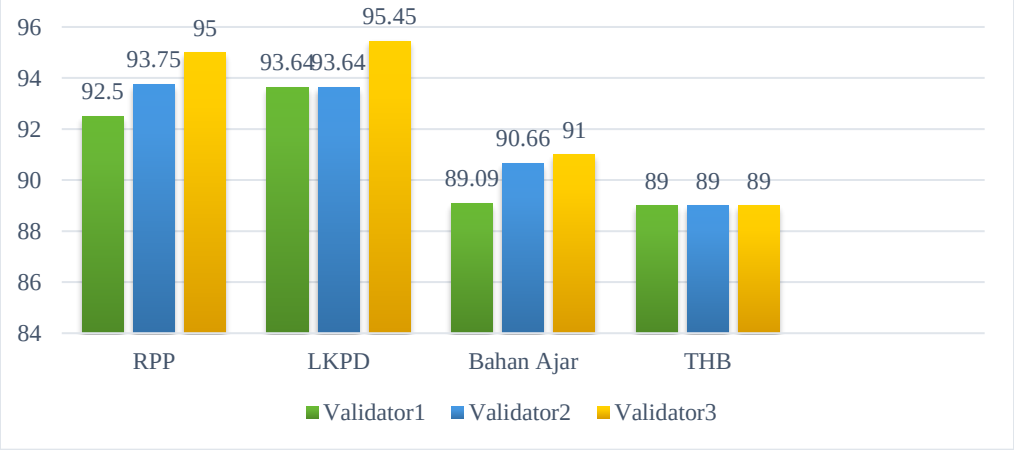
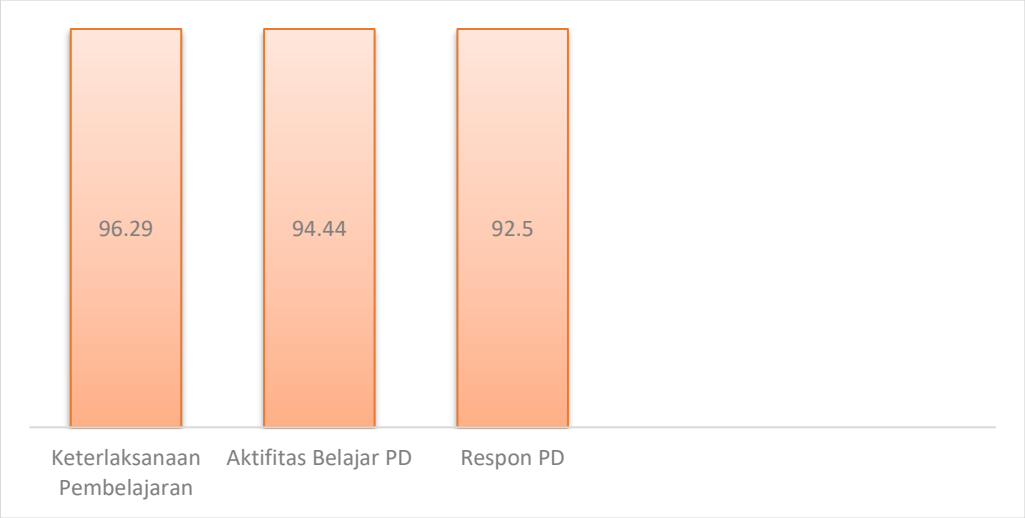


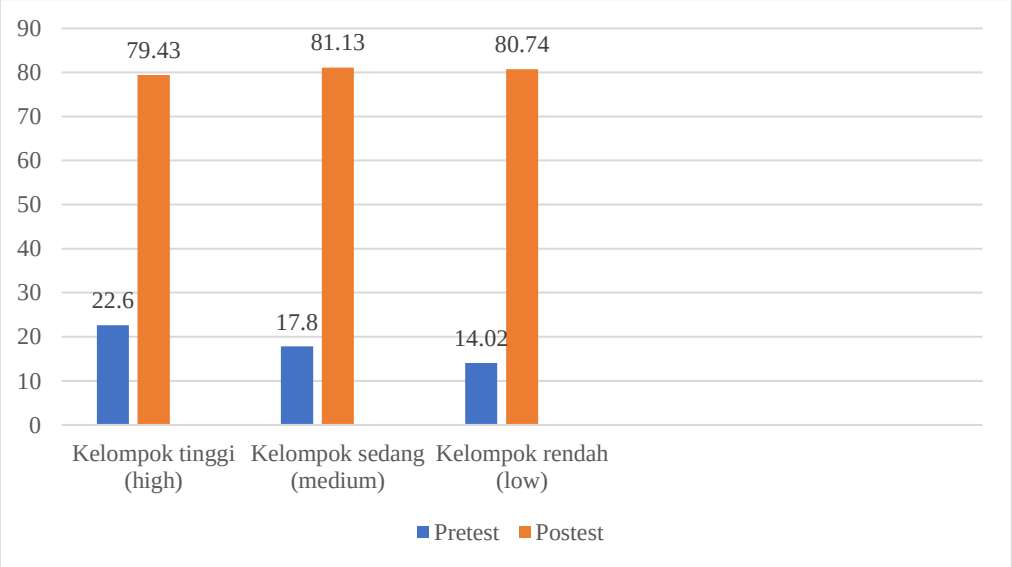
Figure 3 shows the analysis results of the practicality of the developed learning devices. The results were acquired through observing learning implementedness, student learning activities, and student responses to differentiated learning.

Figure 3. Learning Device Practicality



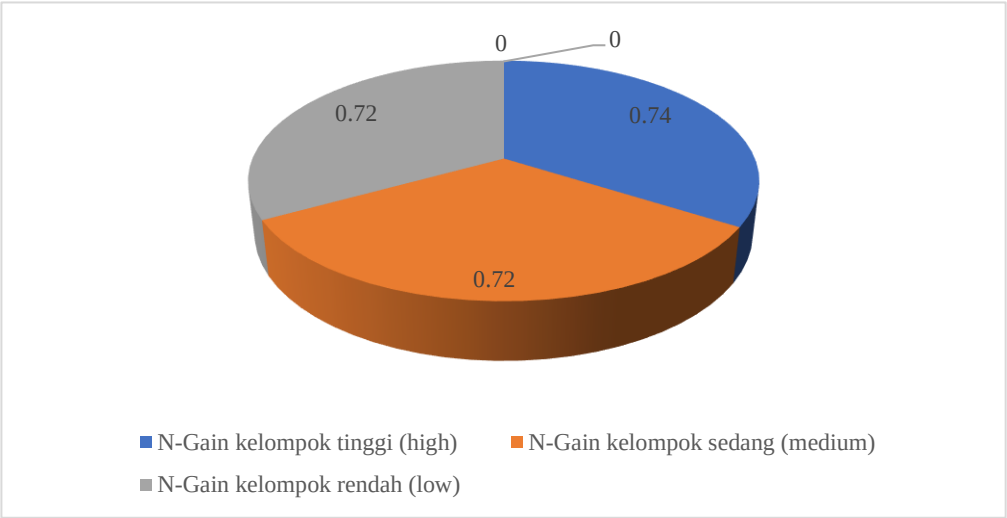
The effectiveness of the developed learning devices was identified from the analysis of learning outcome tests using the normality gain (N-Gain) test on pretest and posttest scores. The scores were also leveraged to interpret increases in student learning outcomes after differentiated learning implementation. The score analysis suggested an increase in student learning outcomes, as demonstrated in Figure 4.

Figure 4. Differentiated Group Learning Outcome Test



The results of the normality gain (N-gain) test attributed to the effectiveness of the developed learning devices in differentiated learning are demonstrated in Figure 5.

Figure 5. Differentiated Group Normality Gain (N-Gain) Test



According to the results of the validation carried out by the expert validation team comprising Physic Education lecturers Postgraduate Program UNG, the developed differentiated learning devices (lesson plans, student worksheets, learning materials, and learning outcome tests) were scored 81-100, and accordingly, considered very valid. The score range stated that the developed differentiated learning devices were valid to use. Based on the practicality analysis conducted through observing learning implementedness, student learning activities, and student questionnaire responses, the developed learning devices were also scored 81-100 and considered very practical. The score range suggested that the developed learning devices were practical for differentiated learning. Bearing on effectiveness observed through learning outcome tests, i.e., pretests-posttests given to the three differentiated groups and tested using the normality gain (N-Gain) test, the learning devices were scored $0.70 \leq g \leq 1.00$ and, hence, considered effective. It confirmed that the developed learning devices were effective in being used in differentiated learning. Additionally, pretests and posttests given to differentiated groups exhibited that students with high learning preparedness gained 79.43 with an initial mean score of 22.66, groups with medium learning preparedness gained 81.06 with an initial mean score of 17.80, groups with low learning preparedness gained 80.68 with an initial mean score of 14.02, and the mean learning completeness percentage was 94%. Building on the pretest and posttest scores of the three differentiated groups, the final mean scores of all differentiated groups increased.

4. Conclusion

Grounded on the results and discussion, the developed differentiated learning devices were valid, practical, and effective to be used in differentiated learning to improve student learning outcomes, especially concerning light concepts at SMP Negeri 1 Kwandang. The results of the analysis of the implementation of learning and learning activities of students on good criteria were around 96% and 94%, respectively, and the percentage of students' responses in the trial was around 93%. The mean final test score of learning outcomes for each differentiated group has increased, namely for students with high learning readiness (79.43), moderate learning readiness (81.06), and low learning readiness (80.68) with an average percentage of student learning completeness about 94%. Furthermore, the mean N-Gain results of the three differentiated groups were in the high category, above 0.7. with the respective results for groups with high learning readiness at 0.74, groups with moderate learning readiness at 0.77, and groups with low learning readiness at 0.77.

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