Development of Differentiate Student Worksheets: an Efforts to Improve Student Argumentation Ability

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ABSTRACT

Online learning experiences have been associated with reduced learning outcomes and limited student engagement in argumentation. To address this issue, the focus on teaching materials becomes crucial, especially in promoting differentiated learning to accommodate pandemic-induced learning losses. A prime candidate for enhancing argumentation skills is the study of quadrilaterals within mathematics. Mastering the quadrilateral concept and its argumentative structure is pivotal for students. Hence, the creation of student worksheets employing differentiated learning principles is imperative. This research aims to develop valid, practical, and effective quadrilateral worksheets with a focus on adversity quotient differentiation. The ADDIE model guides the development process through Analysis, Design, Development, Implementation, and Evaluation stages. Rigorous evaluation, including expert validation (83.8% very valid), field trials (91% very practical), and N-Gain score analysis (0.73, indicating effectiveness), underscores the quality of the developed worksheets. In conclusion, the adversity quotient differentiated quadrilateral worksheets has been successfully crafted to enhance students' argumentation skills. It is deemed valid, practical, and effective in improving learning outcomes. This initiative holds potential for addressing the challenges posed by online learning and contributes to students' academic development.

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A. INTRODUCTION

Learning in the pandemic era took longer than expected. Meanwhile, the school learning process involves teachers and students in teaching and learning (Hewi & Asnawati, 2020). The existence of a high risk of transmission encourages learning to be carried out online, namely using the Internet for access, flexibility, and connectivity (Firman & Rahayu, 2020). However, online learning tends to be direct, focusing on material, assignments, and questions (Nurpratiwi & Setianingsih, 2021). The online learning experience during the pandemic limited students' ability to argue directly. The ability to argue is important for students. In learning mathematics, students need to not only master problem-solving methods but also have experience in giving arguments against the solutions found (Wulandari et al., 2016). Argumentative ability reflects a person's ability to provide logical statements supported by adequate data and theory, both in oral and written form (Soekisno, 2015).

Argumentation is very important in mathematics because of its role in discourse, which requires logical thinking. Logical thinking is seen when constructing proofs in mathematics.

Mathematicians are reluctant to accept statements without supporting evidence because the evidence confirms the truth of mathematical statements (Sadieda, 2019). The development of evidence and argumentation aims to convince oneself and others about the statement's truth. According to Zhen et al. (2016), providing evidence is also a form of explanation to facilitate other people's understanding of the truth of a statement. Therefore, strong argumentation skills have an important impact on the preparation of mathematical proof (Sadieda, 2019).

Geometry, especially in the context of proof, is a complex area of mathematics. Research shows low results in understanding geometry, as revealed by Sunardi & Yudianto (2016), where 61 out of 82 students scored below 60 in geometry material. Students also experience difficulties constructing proofs in geometry, as (Maarif et al., 2020) stated. Focusing on quadrilaterals as an example, theorems such as Varignon's theorem, "If the midpoints of each side of a quadrilateral are connected, a parallelogram is formed," is one of the theorems that require proof (Grigorieva, 2013). Observations were made when the school implemented 100% face-to-face in grade 7 students who had studied quadrilateral material in elementary school. In the preminary studies, students are asked to solve problems about Varignon's theorem then students only identified shapes visually and had difficulty distinguishing shapes such as kites and parallelograms. Students also need help giving solid arguments.

Much research on quadrilateral concepts has been carried out, but research on student arguments still needs to be completed. Minister of Education and Culture No. 53 of 2014 and NCTM that support the communication of reasoning and the construction of mathematical proofs by students. However, the accommodation of students' argumentation abilities in learning still needs to be improved, as is the result of a study by Songsil et al. (2019) which shows students need help in giving scientific arguments. Students' argumentative ability is influenced by several factors, including the ability to solve problems. The study by Khumairoh et al. (2020) and Sukmaningrum & Kurniasari (2022) show that problem-solving affects a person's reasoning ability in giving arguments. Stoltz in Safi'i et al. (2021) explains that Adversity Quotient (AQ) is key to overcoming problems and success. AQ is a person's ability to survive and solve problems when faced with difficulties. If the highest aq level is owned by students, the better the learning outcomes (Putra & Oktaviane, 2022). Thus, AQ has the potential to help students increase their resilience and ability to solve the problems they face.

Argument-based learning can use Student Worksheets as a tool. Worksheets is a collection of papers that contain questions, material information, instructions, and work steps in solving problems according to competence (Sembiring & Napitupulu, 2022). Student Worksheets triggers student involvement in learning, making discussions more active (Rahayu & Budiyono, 2018). Student worksheets is flexible and can be developed according to students' abilities, supporting differentiation learning. Differentiated learning accommodates students' readiness, learning profiles, interests, and talents (Aprima & Sari, 2022). This aligns with the independent curriculum, which emphasizes learning based on Permendikbudristek No. 56 2022. Thus, differentiated learning is an effort to meet students' learning needs and achieve competence according to their learning profile (Herwina, 2021).

The other result of observations show that learning is still conventional and needs to implement differentiated learning. Whereas differentiated learning is one of the characteristics of the independent curriculum (Putra, Pratama, et al., 2023). In interviews with mathematics

teachers, teachers acknowledged difficulties in designing differentiated learning, especially in determining the appropriate form for teaching and learning activities in the classroom. One form of differentiated learning can be done through content differentiation using student worksheets, taking into account the level of Adversity Quotient owned by students.

Research on developing student worksheets based on Adversity Quotient to improve students' argumentation skills still needs to be completed. Even though students' argumentation abilities are related to the level of Adversity Quotient they have (Putra, Rahardi, et al., 2023). Much research has been conducted on other subjects with developed learning models and methods, such as the flip-based argumentation learning model; the project-based learning model; and guided inquiry learning model (Agustiningsih et al., 2021; Tama et al., 2016; Yanti et al., 2023), as well as the technique of asking and professional development's teachers; argument mapping strategy; and content issues strategy (Indrawatiningsih et al., 2020; Kristianti et al., 2018; Siska et al., 2022; Wilkinson et al., 2023). So, based on that previous research, it shows that no research specifically pays attention to treatment to improve students' arguments as a form of differentiated learning, especially through the development of learning media. Therefore, the aim of the research is to develop student Adversity Quotient differentiation-based worksheets with a focus on quadrilateral material that can improve students' argumentation skills.

B. METHODS

This study uses research and development (R&D) methods, which focus on manufacturing and testing a product. The R&D method tests the products' effectiveness (Sugiyono, 2014). This research applies the ADDIE development model, which includes the stages: Analysis, Design, Development, Implementation, and Evaluation (Putra & Wintarti, 2020). The selection of the ADDIE model is based on its flexibility in developing various learning products (Mulyatiningsih, 2014). This model allows continuous feedback in product development (Sharifah & Faaizah, 2015), and the phases in this model interact and influence each other (Rizal et al., 2022). This makes the ADDIE model synergistic and systematic in its implementation. The description of the ADDIE model is carried out in a linear sequence in the hope of achieving the goal in a coherent manner. Aldoobie (2015) describes the stages of the ADDIE model which can be seen in the Figure 1.

Figure 1. ADDIE's steps model

This research was conducted at one of the Lamongan's junior high schools with 28 students of grade 7 as the test subjects. At the same time, the data collection instruments used included validation sheets, questionnaires, and evaluation tests. The validation sheet is used to collect data about the accuracy of the content and functionality of the student worksheets, it contains 17 questions that assess aspects of the format, content, language and appearance of the

worksheet. In contrast, the questionnaire is used to find out the user's response after using the student worksheets that contains 9 question. The validation sheet and questionnaire use a Likert scale for assessment. Then, evaluation tests to get the results of students' arguments which are then processed to obtain how effective the product has been developed. It contains two open questions which have indicators that students can analyze types of quadrilaterals based on their characteristics and student s can prove that a quadrilaterals is formed.

In this study using qualitative descriptive analysis techniques and quantitative descriptive data analysis techniques. Data processing of the assessment results by experts and field practitioners uses descriptive qualitative analysis techniques. Qualitative data in the form of criticisms, suggestions, and general opinions in the questionnaire are grouped according to aspects of the assessment using data analysis techniques. The results of this analysis are used as a basis and consideration in revising and perfecting the developed student worksheets products. While the percentages obtained from product validity, practicality, and effectiveness tests are processed using quantitative descriptive analysis techniques. In the validity and practicality tests, obtained from processing the value of the questionnaire results from the validator for validity and practitioners (teachers and students) for practicality. The value of the questionnaire results is obtained using the percentage formula as follows.

$$N = \frac{TSe}{TSm} \times 100\% \tag{1}$$

TSe is expresses the total empirical score; TSm is expresses the maximal score. The data that has been collected produces a percentage value which is then analyzed with practical criteria arranged based on the characteristics of the instrument. The instrument's characteristics consist of four categories of choices, as shown in the Table 1.

Table 1. Worksheet's Assessment Criteria

Score (N)	Criteria	Explanation
85,01%- 100%	Very Valid / Very Practical	Can used without revision
70,01%-85,00%	Valid / Practical	Can used with little revision
50,01%- 70%	Less Valid / Less Practical	Recomended not used, need major revision
1,00% -50,00%	Not Valid / Not Practical	Can't used

(Akbar, 2013)

A product effectiveness test is done by measuring its effect on learning outcomes through an evaluation test of argumentation ability. Student Worksheets effectiveness is achieved if students' argumentation abilities increase. Improvement was evaluated through a comparison of pre-test and post-test results. The pre-test was carried out before students used the student worksheets, while the post-test was carried out after using the student worksheets. Students' argumentation abilities are assessed in evaluation tests using an assessment rubric based on the Toulmin argumentation structure, including claims, data, warrants, backing, qualifiers, and rebuttals. Indicators and assessments of student arguments are listed in Table 2. Analyzing increasing learning outcomes using the normalized N-gain method to assess students' learning changes statistically.

Table 2. Rubric's Assessment of Student Arguments

Argumentation Component	Score	Indicator
Claim	0	Students don't give conclusions from their statement.
	1	Students give conclusions from their statement.
Data	0	Students don't provide inaccurate data from their statement.
	1	Students provide right data from their statement.
Warrant	0	Students dont show the relationship between data and conclusions
	1	Students show inaccurate relationship between data and conclusions
	2	Students show right relationship between data and conclusions
Backing	0	Students dont make conjectures between data and conclusions
	1	Students make imprecise conjectures between data and conclusions
	2	Students make conjectures between data and conclusions
Qualifier	0	Students don't show the quality of their conclusion
	1	Students show the quality of their conclusion
Rebuttal	0	Students can't provide opposite conditions from conclusion given
	1	Students can provide opposite conditions from conclusion given
Total	...	$Value = \dfrac{Score\ obtained}{9} \times 100$

The normalized gain of this word is used to express the increase in the quality of students' arguments after using the developed worksheet, through the following categorization shown at Table 3.

Table 3. N-Gain Criteria

Interval	Criteria
$0{,}00 < gain < 0{,}30$	Low
$0{,}30 \leq gain < 0{,}70$	Medium
$0{,}70 \leq gain \leq 1{,}00$	High

(Hake at Amalia et al., 2022)

C. RESULT AND DISCUSSION
1. Result
   a. Analysis Phase

   The initial phase identifies the reasons for developing Differentiated Student Worksheets, drawing on preliminary research, initial observations, and teacher interviews. Challenges in learning include insufficient student explanations, gaps in prerequisite knowledge, and traditional teaching methods in classes that should employ an independent curriculum. The gathered information and observations resulted in an initial hypothesis, stressing the need for tools to improve students' explanation and argumentation skills, strengthen prerequisite knowledge, and implement differentiated learning.

   Preliminary studies unveiled insights into students' argumentation abilities and adversity quotient. Analysis indicated difficulties in providing comprehensive explanations and constructing solid arguments. Traditional teaching methods needed

more interactivity, engagement, and student involvement. The researcher focused on conventional teaching in seventh-grade classes, which were meant to adopt an independent curriculum. Differentiated learning entails applying an independent curriculum with content, process, and product variations aligned with students' competencies. Considering these findings, the researcher plans to design Differentiated Worksheets that integrate the adversity quotient to enhance students' argumentation skills' quality.

b. Design Phase

The design phase aims to plan the development of student worksheets. The previous analysis forms the basis for designing activity. Some of the steps taken at this stage are as follows: Material Assessment; The material used for student worksheets is the subject matter of quadrilaterals for seventh grade. Student worksheets is prepared with the concept of differentiated learning based on students' learning difficulties, especially argumentation structures, by arranging steps based on the level of adversity quotient. Preliminary Design; Student worksheets is designed with A4 paper size and uses various fonts and sizes. It starts with a cover design and page template. Learning begins with problem orientation, essential questions, material exploration, and treatment according to the students' adversity quotient. Followed by practice questions and reflection. Tools; Tool for making student worksheets involves software such as Microsoft Word 2016 and Canva and hardware such as printers. Instrument Planning; The evaluation instrument consists of a questionnaire adapted to validators and practitioners. This questionnaire is used to measure the feasibility of student worksheets. After the product is considered feasible, a questionnaire is given to students to measure their response to the student worksheets. Test Instruments; The instrument used is the argumentation evaluation test to measure the effectiveness of student worksheets in improving students' argumentation skills. The aim is to assess the understanding and development of students' argumentation abilities.

c. Development Phase

At this stage, the researcher carried out two steps: the production of and the validation process. Production aims to produce prototypes that follow the initial design with components such as cover, content, and cover. On the cover are titles, researchers' identities, and illustrations of 3 students that reflect differentiation. The content section of the student worksheets consists of an introduction, learning activities, and differentiation based on students' adversity quotient. The introduction contains subject titles, learning objectives, student identities, tools and materials, and general instructions. The learning activity consists of two pages. The first page briefly describes the lesson's purpose and duration then apperceptions about quadrilaterals and argumentation. The second page contains problem orientation and material exploration with references that can be accessed via a QR code. Differentiation is done by giving treatment based on students' adversity quotient level. There is a strategy to improve the quality of students' arguments. This section includes study instructions, core activities, practice questions, and conclusions. Qu, Ca, and Cl codes identify groups of students with

different adversity quotient levels. Figure 2 show us one of the differentation treatment, for quitter's categorize student.
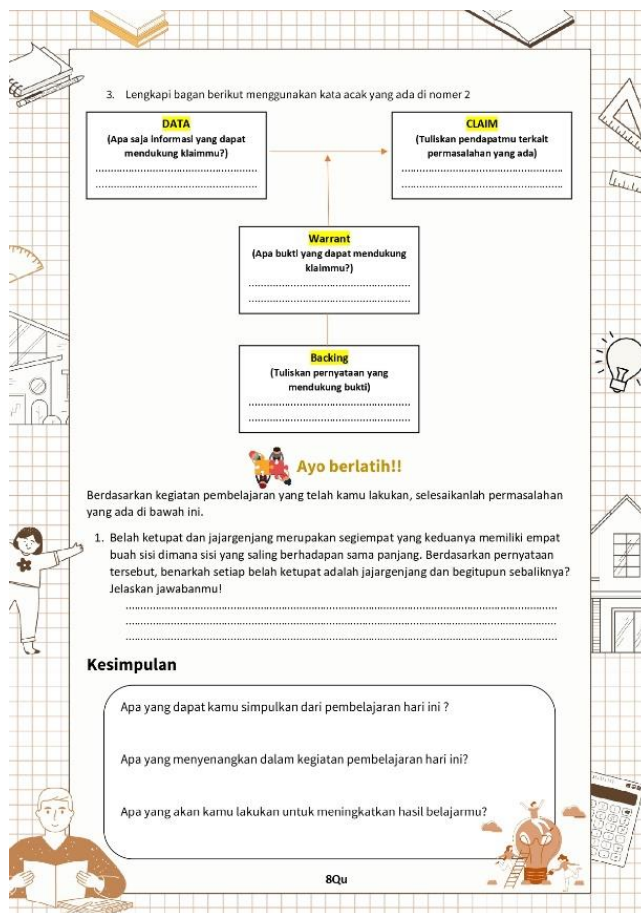

Figure 2. Worksheet's quitter differentiation treatment

The closing section contains general reflections asking students to provide responses about the learning being carried out. This reflection includes providing self-assessment and learning objectives. These elements in the worksheets are designed to meet differentiation needs and improve students' argumentation skills. The following is the validation result, as shown in Figure 3.
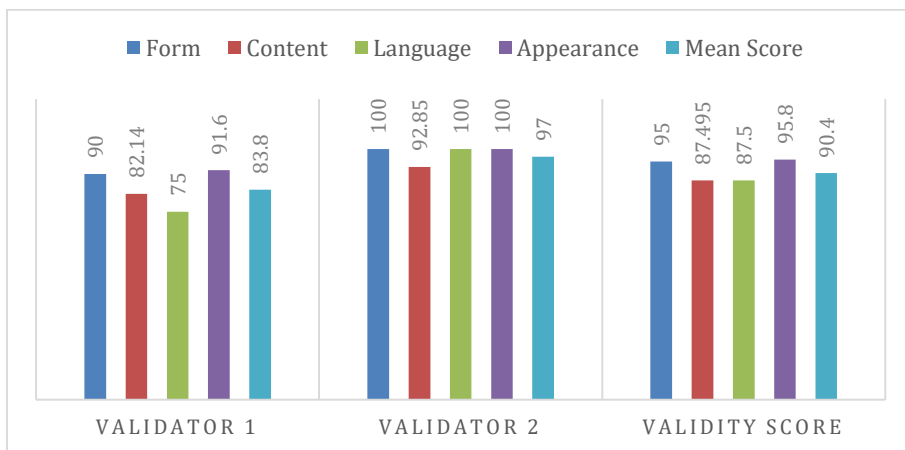

Figure 3. Validation Result

The validation process aims to get input from experts regarding the developed product. This input is used to improve the worksheets to be more suitable. A university lecturer and a junior high school teacher validated the research instrument. The validation score from the expert validator reached 83.8%, with input to adjust the duration of worksheets work according to real treatment estimates. The practical validator gives a validation score of 97%, with suggestions to provide differences in practice questions between the camper and quitter student categories. Based on the results of these two validations, it can developed is in a very valid category. Input from experts becomes the basis for improving worksheets before further trials are carried out.

d. Implementation Phase

After validation, the worksheets was tried out in a class of 28 students with various types of adversity quotients. This trial also involved a teacher as an observer. Trials were conducted to measure the practicality and effectiveness of worksheets. The test results show that the developed product gets a practicality score of 91%, indicating that the worksheets is very practical to use in learning, as shown in Figure 4.

Figure 4. Worksheet's implementation activity

Next, an effectiveness test is conducted to evaluate the effectiveness of the worksheets. The analysis technique uses an argumentation evaluation test, namely the pretest before using the worksheets and the post-test after using the worksheets. The effectiveness test of worksheets was analyzed using the N-Gain value obtained from the pretest and post-test comparisons. The results of the N-Gain analysis show that the average score is 0.73, which is in the high category. This shows that worksheets has adversity quotient differentiation effectively improve the quality of students' arguments.

e. Evaluation Phase

Based on the validation results that expert and practitioner validators have carried out, the practicality and effectiveness tests obtained the following percentage results. (1) The validity is 90.4%; (2) Practical validity is 91%; and (3) Effectiveness Validity is 0.73 So that quadrilateral worksheets have adversity quotient differentiation are declared valid, practical and effective, and suitable for use in learning.

2. Discussion

Worksheet validity is assessed based on format, content, language, and appearance. In the format, the validity percentage reaches 92.5%, indicating the suitability of the format helps the direction of learning orientation. Concerning content, the validity percentage reaches 87.5%, indicating that constructing the right content supports learning objectives. The language aspect also achieves a validity percentage of 87.5%, indicating good and effective use of language. The sentence structure used in the worksheet must be standardized and effective to make it easy for users to understand (Dian Anggraeni & Kustijono, 2013).

The worksheet display is very valid, with a percentage of 95.8%, thanks to attractive media such as videos, animations, and illustrations, which encourage student interest and enthusiasm. In line with this, Leow & Neo (2014) stated that with the help of learning media, it can increase understanding in constructing students' knowledge through students' audio-visual senses. An evaluation was carried out through a response questionnaire from observers and students to measure the practicality of the worksheet. Some factors contributing to worksheets' practicality include Video integration as subject matter, which attracts students' interest in using student worksheet.

Even though the it is in the form of sheets of paper, videos can be accessed via the QR Code. Using video in worksheet has the advantage of involving students in learning and effectively delivering material, as Nurrita (2018) stated. In addition, the opinion of Sulistyani et al. (2013) stated that learning media with animation can visualize material that previously only existed in the form of images in textbooks, increasing understanding and meaning for students.

QR Code, short for Quick Response, allows quick access to information by utilizing the code provided (Farida et al., 2019). In worksheets, QR Code gives students special access to learning materials, especially videos. This QR Code can integrate various learning references for students. Adjustment of differentiation learning, in which students are grouped based on similar ability levels. Differentiation learning is supported by grouping students according to their ability level (Sally & Renzulli, 2018). The developed worksheets applies a process differentiation learning approach, with variations in the intensity of the guidance and attention given by the teacher to students according to their categories.

Different treatment is given to quitter-type students by using ISQ (Interactive Semi-open Question), modified from Albano & Iacono (2019), where students place random sentences according to the structure of the argument (shown at Figure 1). For camper-type students, an argumentation mapping strategy was used based on Indrawatiningsih et al. (2020), where students fill out a mapping of the argumentation structure for the given problem (shown at Figure 2). Meanwhile, climber-type students receive guided questions according to the structure of the argument (shown at Figure 3).

The effectiveness of student worksheets is evaluated by comparing the pre-test and post-test results. Effective worksheets are those that can train and improve student competence. This aligns with Umbaryati (2016) that worksheets help develop process skills. If there is an increase in competence, then the use of product in learning is considered effective, according to (Hilyana, 2017). Therefore, the worksheet developed has succeeded in achieving the desired learning objectives and provides a meaningful learning experience that is appropriate to the student's level of adversity and can improve the quality of the arguments they have.

D. CONCLUSION AND SUGGESTIONS

The results of the development of differentiated worksheets for enhance students' argumentation abilities are valid, practical, and effective in accommodating differentiated learning based on adversity quotient. The validity was tested by experts and practitioners with a validation score of 83.8%, which is very valid. The practicality test through field trials resulted in a score of 91%, indicating a very practical quality. The argumentation test's effectiveness test showed an N-Gain of 0.73, indicating a strong and effective increase. The developed worksheet has the following structure: (a) Cover page with title, author's name, student illustrations depicting differentiation, and the theme of mathematics; (b) The introductory section includes subject titles, learning objectives, student identities, tools and materials, and general instructions; (c) Learning activity one briefly describes the activity, apperception, problem orientation, material exploration, practice questions, and conclusions; (d) Learning activity two briefly describes activities, apperception, problem orientation, material exploration, and differentiation action; and (e) The closing section contains learning reflection activities. While suggestions that can be given from this study are the worksheets in this study only cover part of the material on quadrilaterals, non-cognitive student competencies (adversity quotient), and forms of process differentiation learning so that they can be developed for other aspects such as learning readiness and content differentiation. The worksheets being developed are still in hard file form, so it is necessary to develop worksheets in digital form to facilitate online learning.

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