Designing Learning Materials Oriented Towards Project-based Learning on Statistics for 7th-grade Students

Ika Kurniasari [1] and Adinda Salshabilla[1]

[1] Mathematics Education, Faculty of Mathematics and Science, Universitas Negeri Surabaya, Indonesia
ikakurniasari@unesa.ac.id

Abstract. Mathematics plays a crucial role in facilitating students to develop various skills in the 21st century. It is important for teachers to adapt instructional models and tools based on the characteristics of the current generation. The objective of this research is to describe the process and outcomes of developing project-based learning materials on 7th-grade statistics that are valid, practical, and effective. This study utilized the Plomp development model, which consisted of preliminary research, prototyping phase, and assessment phase. The research subjects were divided into two schemes: the micro-evaluation test involves two teachers, each teaching six students in 7th-grade, while the try-out test involved one teacher teaching 32 students in 7th-grade at one of junior high schools in Surabaya. The research instruments used include validation sheets, questionnaires, implementation feasibility sheets, and learning outcome assessments. Data analysis techniques were employed to determine the criteria of validity, practicality, and effectiveness. Based on the conducted research, the project achieved high validity criteria, with 91.8%, 91.1%, and 97.78% for the instructional module and 95.2%, 93.6%, and 96% for the project worksheets through validation test. The project-based learning materials also met expected practicality criteria by walkthrough test and actual practicality, with 86.36% for micro-class 1 and 85.79% for micro-class 2. Furthermore, the effectiveness criteria were met as the try-out class achieved a classical mastery level of 87.5%.

Keywords: Learning, Project-based Learning Materials, Statistics

1 Introduction

The understanding of mathematics is crucial in the learning process as it involves solving complex problems, developing systematic and critical thinking, and fostering students' creativity when working in groups [1]. In 21st-century education, mathematics plays a role in facilitating students to digest new ideas, adapt to changes, handle uncertainty, discover patterns or regularities, and solve unconventional problems to compete with others [2]. Students also learn to apply mathematics to real-world problems by innovating, thinking creatively, and adapting to solve them [3]. Based on these explanations, it is necessary for students to learn mathematics, and Inganah et al. [4] support the idea that mathematics can develop the 6C abilities as 21st-century skills.

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Statistics is an important topic within mathematics that should be studied as it is useful for students in understanding data information in everyday life and has benefits across various fields [5,6]. This subject focuses on data collection, data organization, data presentation, data analysis, and data interpretation to draw conclusions [7]. Additionally, statistics has broad applications in various aspects, including modeling, formulating hypotheses, designing research studies, and analyzing data for decision-making purposes [8]. Based on these explanations, it can be concluded that statistics involves the skills required in the current 21st century.

However, students' understanding of statistical concepts remains low, as evidenced by their difficulties in applying statistical procedures, interpreting data processing, and lacking accuracy in data analysis and presentation [9]. Students still lack adequate skills in understanding basic concepts, creating mathematical models, performing statistical manipulations, and drawing conclusions in the field of statistics [5]. Mostly, students face difficulties in solving statistical problems, struggling to articulate solution steps and focusing only on the final results, as well as lacking proficiency in communicating their solutions both verbally and in writing simultaneously [10,11]. Students still exhibit low abilities in stating conclusions, overcoming irrelevance in statistics, providing reasoning for source selection, and explaining the deductions made in statistical topics [12].

One of the factors causing students' difficulties in statistics is the implementation of instructional models during classroom activities [6]. Most teachers utilize monotonous instructional models, leading to student boredom and lack of interest, which ultimately hinders the achievement of learning objectives [13]. Therefore, an appropriate instructional model is needed to facilitate the effective delivery of content in the classroom [14].

Teachers need to adapt strategies, models, and teaching methods that are suitable based on the characteristics of the current generation, incorporating innovative and engaging learning activities [15]. In line with 21st-century education, one applicable instructional model is project-based learning [16]. Project-Based Learning, also known as PBL, is a model that involves students in project-based activities to produce a final product. This approach focuses on student activities to find solutions by implementing various skills, such as researching, analyzing, designing, and demonstrating the developed product [17]. Project-based learning provides students with opportunities to solve complex problems, engage in ongoing inquiry-based learning, find answers to authentic questions, contribute to project determination, reflect on the process, conduct evaluations, and present products [18]. Project-based learning emphasizes authentic learning contexts that relate to students' identities, interests, and communities. The implementation of project-based learning in education can have a significant positive effect on improving students' learning outcomes [19].

Project-based learning is also one of the characteristics of the Merdeka Curriculum, which emphasizes student-centered learning [14]. Project-based learning in the Merdeka Curriculum is designed with the goal of developing soft skills and the character of the Pancasila Student Profile [20]. The Merdeka Curriculum provides teachers with the freedom to implement meaningful and enjoyable learning

experiences, while also allowing students to focus on freedom and creative thinking [21,22].

In several studies, project-based learning has been applied in mathematics education, particularly in the topic of statistical data presentation [23]. The results of these studies have shown that project-based learning can enhance students' learning achievement in studying statistical concepts. In another study, project-based learning was implemented in the topic of flat-sided spatial figures using mathematical card media. The improvement in students' learning outcomes was significantly observed in each cycle, and students responded positively to the project-based learning approach [24]. Project-based learning was found to be able to develop students' mathematical communication skills [25]. Another study indicated that project-based learning can also enhance students' creative thinking abilities in the context of set theory [26].

On the other hand, students tended to be passive and lack enthusiasm in learning mathematics due to teacher-centered instruction and the lack of appropriate teaching materials [27]. Teachers often rely on downloaded teaching materials from the internet, face challenges in selecting appropriate media and instructional strategies, and struggle with determining the depth of the content, individual student characteristics, and assessment methods [28]. Teachers face difficulties in establishing competency achievement indicators, setting learning objectives that meet the ABCD criteria, and determining information and concepts in developing teaching materials [29]. Additionally, teachers encounter challenges in creating an effective learning environment as they struggle to determine suitable instructional models for delivering the content [30].

However, it is crucial for teachers to make informed decisions in developing appropriate teaching materials as it significantly impacts classroom instruction [31]. Through instructional design, teachers can establish learning objectives, formulate appropriate learning activities, prepare activity designs, and determine suitable assessments [32]. This is supported by previous study which stated that several components were necessary to create a comprehensive instructional design, including instructional problems, context, task analysis, learning objectives, content sequencing, instructional strategies, instructional development, and evaluation instruments [33]. By preparing appropriate and comprehensive teaching materials, teachers effectively promote students' understanding and internalization of the taught mathematical concepts [34].

In developing instructional materials, the Plomp model can be utilized as it is suitable for educational interventions [35]. The Plomp model consists of three phases: preliminary research, prototyping phase, and assessment phase, which involve iterative activities and formative evaluations to generate valid, practical, and effective educational interventions [36]. In several studies, the Plomp model has been implemented to develop mathematics instruction, school curricula, and teaching materials [35, 37, 38].

In the context of statistics, many teachers lack comprehensive teaching materials due to limited proficiency in instructional methods and strategies [39]. This is supported by research indicating that the design of activities in statistics teaching materials is not varied and the use of real-life contexts is limited to mere examples rather than

facilitating students' learning of the topic [40, 41]. However, teachers can leverage diverse teaching materials that are tailored to the learning needs [42]. Furthermore, in the implementation of the "*Kurikulum Merdeka*" (Independent Curriculum), teachers still face challenges in creating appropriate statistics teaching materials as they struggle to understand learning outcomes and develop instructional goals to design instructional modules, resulting in information that is difficult for students to comprehend [43, 44].

Therefore, researchers initiated the development of project-based learning materials for the subject of mathematics, specifically focusing on the topic of statistics, targeting 7th-grade students in junior high school. The developed materials consist of instructional modules and project worksheets using the Plomp three-phase model, which includes preliminary research, prototyping phase, and assessment phase, incorporating formative evaluations to produce learning materials that meet the criteria of validity, practicality, and effectiveness.

2 Materials and Methods

This research employed Plomp's research and development model as a development-type study. The model consists of three stages: preliminary research, prototyping phase, and assessment phase [36]. The focus of this study was the development of project-based learning materials, specifically an instructional module and project worksheet on statistics for 7th-grade students. Additionally, formative evaluation, was incorporated to assess the validity, practicality, and effectiveness of the project-based learning materials [45].

During the preliminary research, the following tasks were performed: analyzing requirements and contexts, conducting a literature review, and outlining the research framework. The gathered information was employed to create a project-based learning material. Subsequently, in the prototyping phase, the activities were focused on constructing learning materials, including instructional modules and project worksheets. To ensure the quality of the produced learning materials, they underwent validation tests to assess their validity, as well as walkthrough tests and micro-evaluations to evaluate their practicality. Moving forward to the assessment phase, the learning materials were tested through try-out evaluations to determine its effectiveness.

This research was conducted in one junior high school in Surabaya, Indonesia. The research subjects were divided into two schemes. In the micro-evaluation test, the learning materials were employed by two experienced mathematics teachers with less than five years of teaching experience, who taught six students each. These students were further categorized into groups of two with varying levels of mathematical abilities: low, moderate, and high. Conversely, for the try-out test, the learning materials were utilized by a single experienced mathematics teacher with less than five years of teaching experience, instructing a total of 32 students. The research was conducted over a span of four months (February-May 2023).

In carrying out this research, a set of research instruments were utilized, comprising a validation form, an interview guide, student response sheets, learning implementation observation sheets, and assessments. The validation form was administered to three validators, which included an expert mathematics education lecturer with a specialization in instructional tools, as well as two junior high school mathematics teachers. The outcomes of the validation process were examined to establish validity criteria for the learning materials. To assess practicality, an interview guide was developed and employed during a walkthrough test conducted with an experienced mathematics teacher who had less than 5 years of teaching experience. Student response sheets were employed to gather data on the actual practicality of the project-based learning material. The learning implementation observation sheets were used to observe the implementation of project-based learning, while assessments were conducted to evaluate student learning outcomes and determine effectiveness criteria.

3 Result

3.1 Preliminary Research

The preliminary research step of this study began with a needs and context analysis. Based on early observations, it was discovered that the curriculum used by 7th-grade pupils at the target school was the *Kurikulum Merdeka* (independent curriculum). Teachers, on the other hand, have never designed instructional modules or implemented project-based learning as part of the *Kurikulum Merdeka*, particularly in mathematics. This was due to instructors' ongoing efforts to change the preparation of instructional modules that previously relied on lesson plan. As a result, the potential for establishing project-based learning materials in these institutions is critical, as they have never been used in mathematics classrooms.

Learning resources in statistics are confined to preset texts. Typical learning exercises include the teacher delivering the content ahead of time and requesting pupils to listen to the explanation. The content that has been delivered is then followed by a question-and-answer session. However, not all students were actively engaged in learning throughout the question-and-answer exercise, and only a few students actively participated in class. As a result, it is critical to provide learning resources that can fit students' active learning in class. Project-based learning will allow students to engage in meaningful learning and experiences that are not restricted to source materials.

In addition to needs analysis, another thing to do is to analyze the context of learning in statistics material. The context analysis was carried out by analysing the learning outcomes used in studying statistics material for 7th-grade at the *Kurikulum Merdeka* junior high school. The learning outcomes are based on the domain of data and opportunity analysis for grade 7 junior high school students. In addition, to analyzing learning outcomes and the sub-material being taught, it is necessary to determine the design of project activities that are appropriate to that context. The design of the project activities undertaken is *Atomic Habits: Isi Piringku dengan Makanan Bergizi Setiap Hari* (Fill My Plate with Nutritious Food Every Day). The choice for this design activity

was based on the phenomenon of many teenagers consuming junk food without paying attention to the nutritional content that suits the needs of each individual [46].

The Pancasila student profiles that will be built in project learning must also be considered while designing these activities. The Pancasila student profiles are as follows: 1) critical reasoning: students share comments on teens' pastime of consuming junk food and make judgments in groups based on data trends and present explanations; 2) collaborative: students can work in groups to create the Leaflet of *Isi Piringku* (My Plate); and 3) creative: students present many options to detect patterns in BMI data in their group and arrange leaflets creatively.

After conducting a needs and context analysis, the next step was to conduct a literature review related to the learning materials that would be made. A literature study was carried out by gathering information about the design of project activities, instructional modules, and project worksheets. When designing project activities, the information collected was the concept of *Isi Piringku* as a solution to the phenomenon of rampant consumption of junk food by teenagers. The contents of *Isi Piringku* were a guide to consumption in one meal by dividing half of the plate for foods that contain carbohydrates and protein and the other half for fruit and vegetables [47]. In this project activity, students produced Leaflet of *Isi Piringku* which contained the student's food menu based on their daily nutritional needs.

Literature studies related to instructional modules and project worksheets were carried out to find out the components of each learning materials according to the chosen project topic. In addition, it is necessary to determine the project-based learning syntax to facilitate the preparation of the activity flow. In this study, the chosen project-based learning syntax which consisted of determining basic questions, preparing project designs, preparing work plans, monitoring projects, testing results, and evaluating and reflecting [48].

After carrying out the two activities above, the next step was to develop a research framework. The preparation of the research framework was based on facts found in the field regarding project-based learning materials in statistical material, supporting theories, and relevant research [49]. The purpose of compiling this research framework was to serve as a guide in conducting research by demonstrating the importance of this research being carried out, the suitability of the research design and the methods used, emphasizing the relationships between variables in research, and providing directions for completing research [49].

3.2 Prototyping Phase

In the prototyping phase, the activity carried out was to develop project-based learning materials on statistics material for grade 7 junior high school referring to the activity design *Atomic Habits: Isi Piringku dengan Makanan Bergizi Setiap Hari* **(**Fill My Plate with Nutritious Food Every Day**)**. In developing these learning materials, the main thing for concern was compiling the flow of project-based learning activities. The activities accommodated in the learning materials were divided into three main activities, namely determining the trend of the student's Body Mass Index (BMI) data in groups with the mean, median, and mode as well as the range of the data. Furthermore, from the trends

in the data found, students could use these trends to make decisions in choosing student menus. Furthermore, students organize food menu data in the form of tables, bar charts, and pie charts. The presentation of the data in the form of a pie chart representing *Isi Piringku* was initiated by the Ministry of Health so that it helps students to know the proportions of what they eat.

Through the activities shown in the two snippets of the learning materials, students were expected to be able to achieve the learning objectives of using data trends to make decisions through project discussions. In addition, this activity was expected to accommodate the Pancasila student profile "*Gotong-royong*" by actively discussing with their group mates. "*Gotong-royong*" is defined as cooperation among students in completing project activities.

Furthermore, students were expected to be able to complete the learning objectives, namely presenting food menu data in tables, bar charts, and pie charts through project talks, through the activities in the part of the learning module above. This activity was also expected to accommodate the profile of "Creative" Pancasila students by offering them the option to prepare Leaflets depending on students' dietary needs.

Through these activities, students are expected to be able to achieve the learning objectives, namely determining the trend of data with the mean, median, and mode as well as the range of data. As for the activity, students determine model students with information on data trends in their groups.

For the Pancasila student profile Critical Reasoning, it was expected that it can be accommodated in the activities listed in the excerpt of the instructional module. Students' critical reasoning is trained by giving opinions regarding the preferences of teenagers who consume junk food and its dangers. In addition, students can also make decisions on selecting model students based on BMI tendencies in their group.

After developing learning materials in the form of instructional modules and project worksheets according to George Lucas's project-based learning syntax, the next step is to test the validity of these learning materials. The following table presents the results of the validation of instructional modules and project worksheets:

Table 1. Instructional module validation result

Assessment Aspects	Validator 1	Validator II	Validator III
Instructional module equipment	15	14	15
Formulation of learning outcomes and objectives	22	22	25
Selection of learning models	17	19	20
Learning activities	59	59	63
Language usage	10	10	9
Total Score	123	124	132
Percentage	91,8%	91,1%	97,78%
Category	Very valid	Very valid	Very valid

Very valid criteria are obtained if the validation sheet analysis is in the range of 75-100% [50]. Referring to this opinion, the validation results by the three validators show

that the instructional module has very valid criteria. Overall, the developed instructional modules obtain eligibility criteria and can be used. However, it is necessary to pay attention to several notes from the three validators to correct several things that are not appropriate in the design of the instructional module. Some things that need to be considered are the consistency of the writing of students' and students' words, the opening activities on the core components, as well as the question sentences in the assessment.

Table 2. Project worksheet validation result

Assessment Aspects	Validator 1	Validator II	Validator III
Fitting & fit	33	33	34
Suitability of LKP content with the PjBL model	48	45	50
LKP design accuracy	18	19	18
Language suitability in LKP	20	20	18
Total Score	119	117	120
Percentage	95,2%	93,6%	96%
Category	Very valid	Very valid	Very valid

Based on the validation carried out, the result was that the project worksheet obtained very valid criteria referring to the categories in prior research with a score range of 75-100% [50]. Overall, the developed project worksheets met the eligibility criteria and can be used with revisions. It is necessary to pay attention to several notes from the three validators to correct some things that are not suitable for the design of the project worksheet.

Several things need to be considered related to project worksheets, namely the conclusion of each activity should be written in questions referring to specific conclusions, the need for an explanation of what is meant by the mean, median, and mode to guide students, and the need to include sources of images and formulas for material credibility.

After making improvements to the learning materials in accordance with the validators' input, the next thing to do was to do a walkthrough test which was conducted by interviewing a mathematics teacher. Interviews were conducted to collect data related to the expected practicality of the learning materials being developed. The interview questions posed were used to assess aspects of the material, language, and presentation format of the developed project-based learning materials so that it could be determined whether or not the tools were practical. In general, this learning materials obtained a positive response to be applied in learning by respondents. This refers to the three main aspects that are assessed in the walkthrough test, namely the suitability of the material aspects in the learning materials, the use of language that is appropriate to the thinking level of junior high school students and is also easy for teachers to understand, and an easy-to-use presentation format.

After obtaining the expected practicality criteria, the next step is to try out limited learning materials through micro-evaluation test. In this test, two mathematics teachers

used project-based learning materials to teach six students each, which were then called group of micro-1 and group of micro-2. In the micro-evaluation test, teachers and students used some of the teaching materials to find out actual practicality. Actual practicality is obtained through student response questionnaires after using learning materials. The following presents the results of the questionnaire analysis in the following table:

Table 3. Practicality analysis of Project-based Learning Materials

Assessment Aspects	Validator II	Validator III
Student responses to project-based learning activities	238	241
Student responses to practical project worksheets	224	218
Total Score	462	459
Maximal Score	528	
Percentage	87,5%	86,93%
Category	Very practical	Very practical

From the analysis of the student response questionnaire, the result was that the project-based learning materials that had been developed met the very practical criteria through a micro-evaluation trial. A product development category that is very practical is obtained if the results of the questionnaire analysis meet the percentage range of 80-100% [51]. The students' responses collected were reviewed from the aspects of project-based learning activities that had been taught by their teachers as well as opinions related to project worksheets as their learning material for studying statistics material.

After developing a prototype that meets the validity and practicality criteria, the next step is to conduct an assessment phase to obtain an effective project-based learning materials.

3.3 Assessment Phase

After obtaining the practicality criteria in the micro-evaluation, the next step is to carry out the try-out phase or extensive trials [36]. The try-out learning was conducted by a grade 7 math teacher at one of middle school in Surabaya who taught a class of 32 students. In the try-out activities, the teacher teaches using the developed statistical material project learning materials. This phase is carried out to determine the effectiveness of learning materials when tested in large classes through student learning outcomes. In addition, the learning activities were also observed by an observer to determine the implementation of learning.

Project-based learning activities through try-out tests are carried out in four meetings. Activities carried out are based on lesson plans in instructional modules that use the project-based learning model based on previous study which consists of determining fundamental questions, preparing project designs, preparing work plans, project monitoring, testing results, as well as evaluation and reflection [52]. This learning is carried out with the main product produced by students in the form of Leaflet

of *Isi Piringku* in accordance with the design of the activities carried out to study statistics material.

At the first meeting, the activity carried out was to determine the trend of BMI data according to their group. The students collected data on their respective weight and height, then determined the calculation of BMI and its trends based on the mean, median, and mode and determine the range of the data. Then, students in groups determined one of their group mates who was used as the subject to determine the appropriate food menu.

At the second meeting, the teacher asked students in their groups to discuss determining the appropriate food menu for making Leaflet of *Isi Piringku* according to the nutritional needs of their friends.

At the third meeting, students presented the Leaflets they had made and discussed them with the teacher and other group mates. However, at the third meeting not all groups could present the Leaflet, so the fourth meeting was used to continue the presentation and reflect on project activities. In addition, during the last lesson, students carry out a summative assessment to determine learning outcomes while participating in project-based learning activities.

The implementation of project-based learning was observed by an observer using an observation sheet. Based on these observations, the observed activities are divided into three main activities: introduction, core, and closing [53]. Furthermore, in each of these main activities there are several other activities that refer to the chosen project-based learning syntax.

In the preliminary activities, all aspects of the activities observed by the observer were carried out in project-based learning activities. The teacher began the learning activities by conditioning the class, providing motivation to learn contextually and linking learning material with real-world experiences related to the benefits of statistics to determine individual nutritional guidelines, as well as conveying the goals and benefits of learning the Atomic Habits project. Furthermore, in the phase of determining the fundamental questions, it was carried out by giving trigger questions, conveying the design of project activities carried out according to learning objectives, organizing students in several groups, and dividing project worksheets for each group [24].

In the core learning activities, there were four phases according to the observed project-based learning syntax; preparing project designs, preparing work plans, implementing and monitoring projects, and testing results. In the project design phase, the activities carried out were the teacher actively building discussions with students, inviting students to design projects, agreeing together on project evaluation criteria, and giving students the opportunity to express opinions regarding project implementation. The activity step that was not carried out was setting a schedule for project activities with students. In the work plan preparation phase, all aspects consisting of motivating students to play an active role in project learning, giving students the opportunity to discuss in groups, giving students the opportunity to find information related to projects, and motivating students to produce creative work are carried out entirely.

In addition, during the project implementation and monitoring phase, the teacher carried out four of the five activities observed. The aspects that are carried out are inviting students to be dynamic in class, monitoring students in working on projects,

guiding students who have difficulties, and making the learning process student-centered. The aspect that was not carried out was asking students to report the progress of the project being carried out. In the results testing phase, three of the four aspects were not implemented. Three aspects that can be carried out are students demonstrating products, teachers providing input and feedback, and assessing project products. While the aspect that was not implemented was the inappropriate use of time allocation.

In the closing activity or the evaluation and reflection phase, all observed activities were carried out. These aspects including reflection on activities by teachers and students, the teacher gave students the opportunity to express opinions regarding project activities, provided feedback, and carried out follow-up activities after the activity ends.

In addition to the description of the implementation of learning, the observation sheets developed were also analyzed quantitatively using the Guttman scale. The observation sheet with a Yes-No scale is then analyzed by giving a score of 1 for the answer "Yes" and 0 for the answer "No" [54]. Based on the observation sheet, the results are presented in the following table:

Table 4. Analysis of learning activity observation sheet

Observed Aspects	Score
Preliminary activities	8
Core activities	15
Closing activities	4
Total Score	27
Maximal Score	30
Percentage	90%
Category	Good

In try-out test, student performance is assessed through formative assessments from teachers and colleagues as well as summative assessments to determine the effectiveness of learning materials. As for the results of the summative assessment of the trial students' try-out presented in the following table:

Table 5. Assessment result on try-out

No	Name	Score	Category
1	AC	80	Successful
2	AW	85	Successful
3	AFO	85	Successful
4	AF	90	Successful
5	AR	100	Successful
6	AAW	90	Successful
7	CQAP	75	Successful
8	DJI	75	Successful
9	DR	95	Successful
10	ER	90	Successful
11	FF	100	Successful

No	Name	Score	Category
12	GRZK	95	Successful
13	HNA	75	Successful
14	KMJ	90	Successful
15	LS	100	Successful
16	MAA	90	Successful
17	MSB	60	Failed
18	MDS	90	Successful
19	MAF	80	Successful
20	MNF	70	Failed
21	MHA	100	Successful
22	NPJ	90	Successful
23	NPW	75	Successful
24	NRMP	65	Failed
25	NTP	80	Successful
26	PK	80	Successful
27	QMS	75	Successful
28	RAFPP	100	Successful
29	RRM	85	Successful
30	RRA	60	Failed
31	TV	85	Successful
32	ZAS	80	Successful

Note: Minimum mastery criteria = 75

Based on the results of the assessment in the table, it was found that 28 out of 32 students obtained the results of the study tests 75. If students get a learning achievement test score KKM, then these students meet the individual learning mastery criteria [50]. Furthermore, based on the results of the assessment, it was found that 87.5% of students in the try-out class obtained individual mastery criteria. This meets the criteria of classical learning mastery when 80% of students in class complete individually [50]. Therefore, the project-based learning materials that has been developed is effectively used to study statistics material for grade 7 junior high school.

After completing the process of developing and evaluating formative learning materials, the results of project-based learning materials were obtained that are valid, practical, and effective. The project-based learning materials developed are in the form of instructional modules and project worksheets on statistics for grade 7 junior high school.

Based on the description of the research results, a project-based learning materials was obtained in the subject of mathematics in statistics with the Plomp development model. The three stages of Plomp development carried out consisted of preliminary research, prototyping phase, and assessment phase [36]. In addition, the developed project-based learning materials have gone through a formative evaluation in order to obtain criteria for validity, practicality, and effectiveness. The results of the formative evaluation show that this project-based learning materials meets the valid criteria with the results of the validity test analysis obtaining a percentage of 95.2%; 93.6% and

96%, practical criteria with the analysis of student response questionnaires obtained 87.5% and 86.93%, and fulfilled the criteria of effectiveness through classical learning mastery as much as 87.5% of students fulfilled the Minimum Mastery Criteria (MMC) in the try-out phase.

4 Discussion

This research was supported by several other studies with similar themes. In previous study, results obtained were modules that met valid, practical, and effective criteria [55]. The distinguishing aspect of this research was the resulting product in the form of PjBL-based modules for grade 5 of the 2013 Curriculum Elementary School as teaching materials with the ADDIE development model [55]. Whereas in this study, the results developed were project-based learning materials in the form of instructional modules and project worksheets for grade 7 students of Merdeka Curriculum Middle School with the Plomp development model. However, this research has become a reference for researchers in developing learning materials in statistics subjects [55].

In other study, the modules developed were only tested for validity, while in this study the development products were in the form of instructional modules and project worksheets for statistics material for grade 7 junior high school with an independent curriculum that is valid, practical and effective [56].

In carrying out this research, there were several challenges that researchers encountered, especially during the prototyping phase. The main challenge in carrying out this research was determining the design of the project activities. This is due to the importance of understanding the characteristics of project activities which are the driving force for teaching knowledge and skills to students [57]. The content used in project-based learning is built from ideas around students [18]. In addition, there are important characteristics in project activities, namely emphasizing contextual and complex learning to produce a product and provide authentic experiences for students [19, 58]. Therefore, it is important to conduct in-depth research related to learning design in designing projects so as to provide contextual learning experiences and involve students actively in class activities [26].

In determining the design of activities for project topics, researchers look for other references that discuss more deeply about project-based learning and its implications for learning. Another study discussed the effectiveness of project-based learning in junior high school students' statistics learning [59]. The design of the activities raised as the topic of the project in this research, namely the demonstration of the principal's plan for the construction of a new building and asking students to construct buildings based on known information. In other study, it was discussed that project-based learning through the activity of determining fruit salad recipes can help students learn collaboratively and develop problems [60]. Previous study also used the activity design of The History on Tape Project to engage elementary school students' analytical skills [61].

These studies provided inspiration for researchers in determining the design of activities that are carried out in the development of project-based learning materials.

The researcher determined the design of the project activity which was later called Atomic Habits: *Isi Piringku dengan Makanan Bergizi Setiap Hari* by utilizing a context that is close to the students' lives. The topic of this project is based on several phenomena of the rise of teenagers who often eat fast food [46] as well as the personal experience of researchers who have encountered similar facts in their surroundings. Supported by the Ministry of Health's efforts to provide education through the "*Isi Piringku*" campaign as a guide to individual daily meals to prevent various diseases such as stunting [62].

In addition to determining the design of project activities, the challenges experienced by researchers were determining the flow of project activities and integrating them with the mathematics material to be taught, namely statistics. It should be noted that the preparation of the activity flow plays an important role because it aims to facilitate students to build knowledge and critical thinking skills while participating in the project-based learning [63]. Therefore, the researcher also designed the flow of these activities by determining the learning objectives and linking them to the topic "Isi Piringku" is raised in the learning project. Then, the researcher arranged the flow which consists of determining fundamental questions, preparing project designs, preparing work plans, implementing and monitoring projects, testing results, and evaluating and reflecting [52].

In addition to the process of generating learning materials, researchers made many discoveries while conducting formative evaluations of learning materials. These findings were acquired after rigorous testing of learning materials during the trial period. Several aspects of assessment are not met in the examination of learning implementation. Concerning the key activities, the teacher quickly establishes a timeline for project activities without including students in the decision-making process. This was due to a lack of time for testing learning materials. Furthermore, the projected time allocation does not match the timeline because some action points demand more time than others; therefore, learning must be completed at the next meeting.

Other data linked to student evaluation were collected in addition to the implementation of learning. The majority of students who answered erroneously at number one when it came to assessing the tendency of the data were also inaccurate when it came to determining the mode of the data.

There is no data mode based on the data supplied in the query. This is because there is no particular piece of data that emerges frequently, or the data is heterogeneous. Students, on the other hand, had misconceptions and indicated that the data mode was Thursday since the amount of garbage was 74, which was the highest compared to previous days. According to the student's response, the misconception regarding the size of the data center persists [5].

In addition to determining the size of the center of the data, the majority of students who were not precise in working on problem number 2 related to data organization, still had difficulties and were not precise in organizing pie charts. Based on interviews conducted with teachers who teach in try-out classes, students have difficulty determining percentages or degrees when making pie charts. This is in accordance with

previous study which states that in studying pie charts, students find it difficult to use formulas and calculate fraction multiplication operations [64].

5 Conclusion

The development of this project-based learning materials follows the Plomp & Nieveen development paradigm, which consists of three stages: preliminary research, prototyping, and assessment. Preliminary research efforts include doing a requirements and context analysis, reading the literature, and developing a conceptual framework. A validity test on three validators was performed throughout the prototyping process, and prototype 1 was achieved with valid criteria. The prototype is next subjected to a test walkthrough by a math teacher, who acquired the criteria expected practicality, and micro-evaluation by two math teachers, each of whom taught six students, who obtained the criteria actual practicality. The activity carried out during the assessment phase is to test out the learning materials at the stage try-out carried out by one instructor and instructing a whole class, after which a successful project-based learning materials is acquired.

The developed project-based learning materials are in the form of instructional modules and project worksheets with activity designs Atomic Habits: *Isi Piringku dengan Makanan Bergizi Setiap Hari* (Fill My Plate with Nutritious Food Every Day). The results of project-based learning materials obtain the valid, practical, and effective criteria after going through formative evaluation according to each criterion. The validity results based on the validator's assessment that has been carried out are 91.8%; 91.1%; 97.78% for instructional modules and 95.2%; 93.6%; 96% for project worksheets so that very valid criteria are obtained for the two learning materials. Furthermore, through a test walkthrough with semi-structured interviews, learning materials gain criteria for predicted practicability. The learning materials are next evaluated on a small scale to determine the requirements for actual practicability via micro-evaluation. A student response questionnaire yielded 87.5% for micro class 1 and 86.93% for micro class 2 for each extremely practical area. Moreover, project-based learning materials were tested in full classes using tests try-out, and the results showed that 87.5% of students in the class fulfilled individual learning mastery or classical learning mastery, indicating that the learning materials met the criteria of being effective and that 90% of learning activities were implemented using observation sheet analysis.

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