

THE DEVELOPMENT OF FLIP PDF-ASSISTED MATHEMATICS TEACHING MATERIAL: DATA CENTRALIZATION AND DATA DISPERSION

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ARTICLE INFO

Article history:

Received Sep 16, 2025

Revised Sep 18, 2025

Accepted Oct 01, 2025

Keywords:

Data Centralization

Data Dispersion

Flip PDF

Teaching Material

ABSTRACT

The scarcity of teaching materials is a contributing factor to students' delays in comprehending mathematics concepts. During lessons, students use textbooks, but these are collected by the teacher afterward, which causes delays in their understanding of the material and results in low learning outcomes. Therefore, this research aims to develop a valid and practical electronic teaching material using Flip PDF Corporate for the topics of data centralization and data distribution, allowing it to be used anytime and anywhere. This study is a development research that uses the Plomp model, which consists of three stages: preliminary research, prototyping, and assessment. The data on the validity of this research was obtained from a validation sheet instrument used to assess the validity of the developed product. The validation assessment involved two experts: a material expert and a media expert. Meanwhile, the practicality data was obtained from a student response questionnaire to assess the practicality of the product. The results from the student response questionnaire were analyzed from one-to-one evaluation, small group evaluation, and field trials. Based on this study, the validity percentage of the electronic teaching material as assessed by the material expert was 97% with a very valid category, and by the media expert was 87% with a very valid category. The practicality percentages were 90% from the one-to-one evaluation, 87% from the small group evaluation, and 84% from the limited field trial, with all three categories being very practical. It can be concluded that the teaching material developed using Flip PDF Corporate for the topics of data centralization and data distribution is suitable for use in mathematics learning, falling into both the valid and practical categories.

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How to Cite:

Mahrifa, Ismail, S., & Usman, K. (2025). The Development of Flip PDF-Assisted Mathematics Teaching Material: Data Centralization and Data Dispersion. *JIML*, 8(4), 738-750.

INTRODUCTION

In the current era, education is very important for improving the quality of human resources (HR). Education is the process of instilling thought, skills, and life ethics in every individual (Khairiah, Usman, & Isa, 2025). If the education process is implemented effectively, then the quality of education can be said to be very high, and people gain meaningful experiences for

themselves (Habuke, Hulukati, & Pauweni, 2022). An important factor in educational success is a quality learning process to achieve excellent and high-quality education (Pauweni, Uwange, Ismail, & Kobandaha, 2022). Mathematics is one of the important subjects for education. Mathematics is a crucial science in helping to meet human demand for technology, which is why mathematics has become a compulsory subject at every level of education. According to (Pendidikan, 2022), mathematics plays an important role in various disciplines and in advancing human thinking. Mathematics is viewed as learning material that must be understood, as well as a conceptual tool for constructing and reconstructing that material, honing, and training the thinking skills needed to solve problems in life. After understanding mathematics as a fundamental tool for training ways of thinking and problem-solving, we can see how these principles are concretely applied through statistics. Statistics is a branch of science that uses mathematical concepts to analyze data, which is essential for understanding phenomena in the surrounding environment. In statistics, the trained mathematical thinking is used to process data, especially in two main aspects: measures of central tendency and measures of data dispersion (or variability). Understanding measures of central tendency and dispersion is indeed a key step in statistics. However, it is not uncommon for students to face several common difficulties in mastering these two important concepts. According to (Syahriadi, 2022), the material on measures of central tendency and dispersion is very difficult because there are too many formulas and it is confusing to differentiate between the formulas. Furthermore, according to (Cooper, 2018), students are often confused when comparing the data distribution of two or more similarly sized histograms. They mistakenly assume that data variability (dispersion) is viewed from how varied the bar heights are in the histogram. Students think that if the histogram bar heights vary greatly (for example, some bars are very high and some are very low), it means the data has high variability. Conversely, if the bar heights look almost the same or flat, they assume the variability is low. In fact, this understanding is incorrect. The actual data dispersion must be seen from how far the data values are spread along the horizontal axis, not from the difference in bar heights. Speaking of the various difficulties students face, this problem is not limited to individual understanding. In reality, previous research conducted by (Sari, 2022) showed that out of 29 students' daily test average scores, only 6 students met the Minimum Mastery Criteria (KKM) and passed, while the other 23 students did not reach the KKM and did not pass. The low student learning outcomes in understanding central tendency and dispersion underscore the importance of improvements in the learning process. Therefore, the role of the teacher in learning is greatly needed to create a quality learning process and overcome these problems. According to (Akuba, Abbas, & Ismail, 2024), in the learning process, teachers are expected to deliver the taught material and facilitate learning, while students can understand the material being taught. Therefore, teaching materials are no less important in mathematics learning. Throughout the learning process, students certainly need teaching materials as a tool that serves as a source of learning information.

Teaching materials are very important in learning. Therefore, teaching materials should be designed and written in accordance with learning principles (Khadijah, Ismail, & Resmawan, 2020). According to (Mahulae, 2023), teaching materials are the materials or sources used by teachers to convey information, concepts, and knowledge to students. (Suprihatin & Manik, 2020) also explain that teaching materials are all forms of materials used to help teachers carry out teaching and learning activities. Teaching materials come in various forms, such as: books, modules, handouts, student worksheets, audio teaching materials, and interactive teaching materials (Dafit & Mustika, 2021). Teaching materials play a role for both the teacher and the students. According to (Lestari, Lestari, & Magfirah, 2025)), the role of teaching materials for teachers includes saving the teacher's time in learning, changing the teacher's role to that of a facilitator, and enhancing the learning process to be more effective

and interactive. Meanwhile, the role of teaching materials for students is that students can learn anywhere without the presence of an educator or peers, students can choose the material they want to study themselves, and it helps students become independent learners. With the presence of teaching materials, classroom learning will be more structured and planned. Not only that, the material will also be well-designed so that it can make the concepts of measures of central tendency and measures of data dispersion easier to understand. Well-designed material makes the concepts of central tendency (mean, median, mode) and data dispersion (variance, standard deviation) much easier because it effectively bridges the gap between abstract formulas and real-world meaning. Effective material first contextualizes the concepts, ensuring students understand *why* they need to calculate the average and *why* dispersion is important for assessing risk or reliability. This is achieved through the use of real-world examples and relevant application cases. Second, the material deliberately reduces the cognitive load by presenting concepts gradually and visually. Abstract concepts are transformed into something intuitive through graphs, diagrams, or simulations—for example, showing two curves with different standard deviations to visually illustrate the difference in risk. In this way, students do not just memorize procedures, but truly develop a statistical intuition, allowing them to grasp the vital role of both concepts in comprehensive data analysis.

To make teaching materials more attractive and interactive, the aid of applications is needed. One application that can make teaching materials more attractive and interactive is Flip PDF Corporate. (ZINNURAIN, 2021) explains that Flip PDF Corporate is one of the applications that can develop a PDF into a teaching material that provides various formats such as text, audio, video, images, and many more. Flip PDF itself has advantages, including its multimedia interactivity; beyond the realistic page-flipping effect, the Corporate version allows users to embed videos, audio, pop-up image galleries, and clickable links directly onto the pages, transforming a passive document into a dynamic and engaging experience. This opinion is in line with Febrianti (2021) in (Dewi, Pangesthi, Handajani, & Romadhoni, 2023), who states that Flip PDF Corporate is a tool that can transform a PDF into a flipbook format that can be turned like a book, thereby creating more interactive teaching materials with the features available in Flip PDF Corporate.

Along with technological developments, the teaching materials used in learning are also evolving and undergoing innovation in the world of education. Specifically, the utilization of technology in learning can be interpreted as the use of digital hardware and software to support, facilitate, and improve the quality of the teaching and learning process (Baroroh, Kusumastuti, & Kamal, 2024). Therefore, now is the right time for educational institutions to introduce and use technology in the learning process, considering that technology is a primary factor that facilitates the transfer of knowledge to students. Electronic teaching materials are one such development that utilizes technology. Using electronic teaching materials can facilitate independent learning for students because they contain material, audio explanations of the material, video explanations of sample problems, practice questions, and online-based quizzes. Additionally, electronic teaching materials also simplify the teacher's duties in learning.

Based on observations at SMP Negeri 2 Telaga, it was found that students do not possess their own textbook. The textbooks are only used during lessons, but after the lesson concludes, the books are collected back by the teacher. This situation can lead to low student learning outcomes. Seeing the high cost of books on the market, the researcher offers a solution by developing electronic teaching materials that can be used anywhere and anytime. Electronic teaching materials are reading materials in electronic form that contain content in the form of audio, audiovisual, or interactive multimedia (Sriwahyuni, Risdianto, & Johan, 2019). The

teaching materials are developed using Flip PDF Corporate to include video explanations of sample problems, audio explanations of the material, and online-based quizzes. The addition of several features such as audio, video, and interactive quizzes is done to make the electronic teaching materials more engaging (Yunus, Abbas, & Djakaria, 2023). Based on this, research on the development of electronic teaching materials is important to conduct. Therefore, the purpose of this research is to develop electronic teaching materials that are valid and practical with the aid of Flip PDF Corporate, which will include video explanations of sample problems, audio explanations of the material, online quizzes, and practice questions.

METHOD

This research is a development study, commonly known as Research and Development (R&D). According to (Sudaryono, 2016), R&D is a research method used to determine the effectiveness of a product. The development model used in this research is the Plomp model, which consists of three phases: preliminary research, the prototyping phase, and the assessment phase. The final product of this research and development is an electronic teaching material developed with Flip PDF Corporate on the topics of data centralization and data spread.

In this article, the design for developing electronic teaching materials is carried out in three stages: the preliminary research phase, the prototyping phase, and the assessment phase.

In the preliminary research phase, a needs analysis, curriculum analysis, and material analysis were conducted. In the prototyping phase, the teaching materials were designed and developed, which included several evaluations: self-evaluation, expert review, one-to-one evaluation, and small group evaluation. In the assessment phase, a limited trial was conducted to see the practicality of the teaching materials. The instruments used in this study were observation, interviews, validation sheets, and questionnaires. The validation sheets were used to assess the validity of the teaching materials, while the questionnaires were used to assess their practicality. The data analysis technique for this research was descriptive analysis, which aims to explain the validity and practicality of the teaching materials.

$$V = \frac{TSe}{TSh} \times 100\%$$

The formula for calculating validity test data according to (Sarip, Amintarti, & Utami, 2022) which are the following.

Where:

V = validity

TSe = total score from the validator

TSh = Expected maximum total score

The results of the validity calculation can be seen in the criteria according to Akbar (Sarip, Amintarti, & Utami, 2022) as shown in the following table.

Table 1. Criteria for the Validation of Electronic Teaching Materials

No	Numbers	Validity Categories
1	86,00 -100,00%	Very valid
2	71,00 - 85,00%	Valid

No	Numbers	Validity Categories
3	56,00 - 70,00%	Quite valid
4	41,00 - 55,00%	Less valid
5	25,00 - 40,00%	Not valid

Practicality test data calculation formula according to (Yanto, 2019) which are the following.

$$\% \text{ praktilisasi} = \frac{\text{total score}}{\text{maximum score}} \times 100\%$$

To determine the practicality level of the developed product, the following assessment criteria are used.

Table 2. Criteria for the Practicality of Electronic Teaching Materials

Percentage (%)	Validity Categories
0 - 20	Not practical
21 - 40	Less practical
41 - 60	Quite practical
60 - 80	Practical
81 - 100	Very practical

RESULTS AND DISCUSSION

Results

1. Preliminary Research

At the start of this research, the initial step was to analyze preliminary information to identify problems within the learning process. This analysis then served as a guide for developing the teaching materials.

During this stage, a needs analysis, curriculum analysis, and material analysis were conducted. Based on the needs analysis, it was found that students used textbooks during class, but these books were collected by the teacher after each lesson. This consequently caused most students to have difficulty in learning mathematics. Furthermore, students also felt bored with mathematics lessons. Therefore, teaching materials that align with their needs were required.

The curriculum analysis revealed that the curriculum used for mathematics instruction was the "Kurikulum Merdeka" curriculum. Finally, the material analysis aimed to determine if the content in the teaching materials was consistent with what was taught at school. Based on this material analysis, it was found that the content in the teaching materials was indeed consistent with the material taught at school.

2. Development or Prototyping Phase

a. Electronic Teaching Material Design Phase

Based on the results of the preliminary analysis, which consists of a needs analysis, curriculum analysis, and material analysis, the researcher will develop an electronic teaching material using Flip PDF Corporate for the topics of data centralization and data distribution.

The first step in the design phase is to prepare the material on data centralization and data distribution. The electronic teaching material will be created with the help of several applications, namely Word, Flip PDF Corporate, Canva, and Website 2 Apk Builder. The components of the electronic teaching material are as follows. (<https://online.flipbuilder.com/vdakf/pcmr/>)

a) Electronic Teaching Material Cover

The cover of the electronic teaching material consists of the title of the material, the subject, the educational level of the user, the academic year, and the name of the author of the material. The appearance is shown in the following image.

Figure 1 shows the cover of the electronic teaching material.



Figure 1. Cover of the electronic teaching material.

b) Table Of Contents

The table of contents contains instructions to make it easier for users to know what is included in the electronic teaching material. The appearance is shown in the following image.

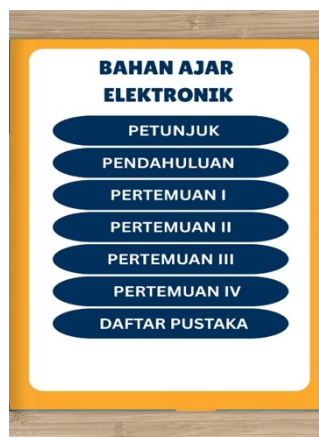


Figure 2. Table of contents of the electronic teaching material.

Figure 2 shows the table of contents of the electronic teaching material.

c) Instructions

The teaching material instructions are intended to make it easier for users to use the electronic teaching material. The appearance of the electronic teaching material instructions can be seen below.

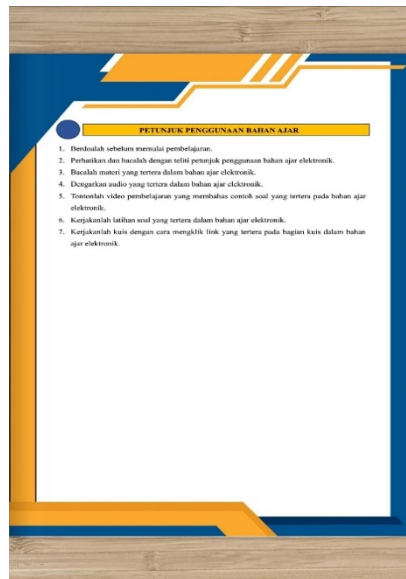


Figure 3. shows the instructions for the electronic teaching material.

Figure 3 Instructions for using the electronic teaching material.

d) Activities per Meeting

In each meeting's activities, there are materials, practice questions with images, video explanations of example problems, audio explanations of the material, and online-based quizzes.

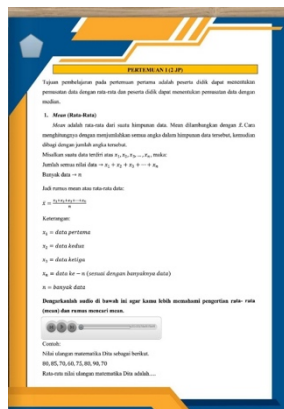


Figure 4. material on the mean

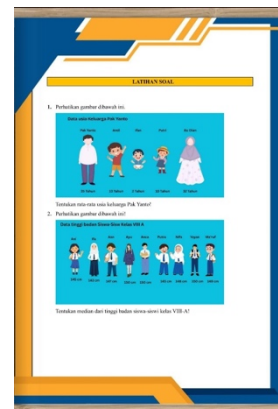


Figure 5. practice problems

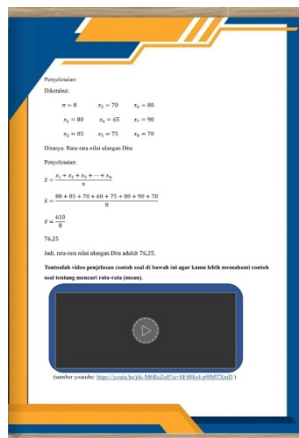


Figure 6. video explanation

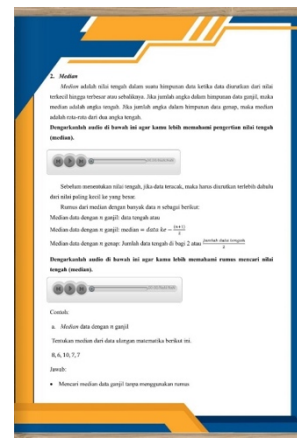


Figure 7. audio explanation



Figure 8. Quiz

The product generated in this research is an electronic teaching material developed using Flip PDF Corporate with the aid of several other applications, including Word, Canva, and the 2Apk Builder website. This teaching material includes audio explanations of problems/questions, instructional videos, and online-based quizzes.

b. Development Phase

a) Self-Evaluation

In the self-evaluation phase, the initial prototype was evaluated by the researcher. This involved checking for errors within the electronic teaching materials, such as spelling mistakes and incorrect placement of images, videos, and other elements. The self-evaluation concluded that no revisions were needed, so the prototype was able to proceed to expert validation.

b) Content Expert and Media Expert Validation

Material Expert Validation

The first validation was the material expert validation, which aimed to assess the electronic teaching materials from a content perspective. This validation involved two validators: two lecturers from the Mathematics Department at Gorontalo State University.

Table 3. Results of the Material Expert Validation

No	Aspects Evaluated	Validation Score
1	Quality of the teaching materials	57
2	Language	20
3	Evaluation	20
Total score		97
Percentage		97%
Category		Very valid

Based on the material expert validation, a score of 97% was obtained. This percentage indicates that the electronic teaching materials are in the very valid category and are suitable for use in teaching and learning activities.

Media Expert Validation

Lastly, there was the media validation, which aimed to identify the quality of the electronic teaching materials. This validation was conducted by two lecturers from the Mathematics Department at Gorontalo State University.

Table 3. Results of Media Expert Validation

No	Aspects Evaluated	Validation Score
1	Cover design	35
2	Text design	52
Total score		87
Percentage		87%
Category		Very valid

Based on the results of the media expert validation, a score of 87% was obtained. This percentage indicates that the electronic materials fall into the "very valid" category and are suitable for use in classroom learning.

c) One-to-One Evaluation

The respondents for this evaluation were three students from class VIII.2, divided into three different knowledge levels: high, medium, and low.

Table 4. Results of the One-to-One Trial.

No	Total Score	Percentage	Category
1	14	93%	Very practical
2	12	80%	Practical
3	15	100%	Very practical
4	13	87%	Very practical
5	14	93%	Very practical
6	12	80%	Practical
7	12	80%	Practical
8	12	80%	Practical
9	14	93%	Very practical
10	15	100%	Very practical
11	15	100%	Very practical
Total score		987%	
Average		87%	Very practical

From the results of the one-to-one evaluation above, a trial result of 90% was obtained, which falls into the "very practical" category. The next step will be the small group evaluation.

d) Small Group Evaluation

This small group evaluation was completed by six students with different knowledge levels: high, medium, and low. Two students were included in each knowledge level.

Table 5. Results of the Small-Scale Trial

No	Total Score	Percentage	Category
1	26	87%	Very practical
2	26	87%	Very practical
3	27	90%	Very practical
4	27	90%	Very practical
5	26	87%	Very practical
6	27	90%	Very practical
7	25	83%	Very practical
8	26	87%	Very practical
9	27	90%	Very practical
10	25	83%	Very practical
11	26	87%	Very practical
Total score		960%	
Average		87%	Very practical

From the results of the small group evaluation, an average score of 87% was obtained, which falls into the "very practical" category. The next step will be the assessment phase.

3. Assessment Phase

The results of the student response trial were obtained from the questionnaires distributed during this phase and the previous assessment phases, namely the one-to-one evaluation and the small group evaluation. For the field trial, the researcher used 15 students from class VIII.2 at SMP Negeri 2 Telaga.

Table 6. Results of the Student Response Trial.

No	Total Score	Percentage	Category
1	62	83%	Very practical
2	64	85%	Very practical
3	65	87%	Very practical
4	65	87%	Very practical
5	69	92%	Very practical
6	59	79%	Practical
7	68	91%	Very practical
8	62	83%	Very practical
9	59	79%	Practical

No	Total Score	Percentage	Category
10	59	79%	Practical
11	61	81%	Very practical
Total score		924%	
Average		84%	Very practical

Based on the results from the student responses, an average percentage of 84% was obtained. This percentage indicates that the electronic teaching materials can be categorized as very practical.

Discussions

Material expert validation was carried out by two mathematics lecturers from Gorontalo State University (*Universitas Negeri Gorontalo*). In this validation, the aspects assessed were the quality of the teaching materials, language, and evaluation. The average percentage score from this validation was 97%. Based on the validity criteria used, this electronic teaching material is in the "very valid" category. In other words, the electronic teaching material, which uses Flip PDF Corporate and includes video explanations of sample problems, audio explanations of the material, and online quizzes on the topic of measures of central tendency and dispersion, is declared valid and suitable for use in learning.

Media expert validation was carried out by two mathematics lecturers from Gorontalo State University (*Universitas Negeri Gorontalo*). The aspects evaluated in this validation included the cover design and text design. The average percentage score from the media expert validation was 87%. Based on the validity criteria used, this electronic teaching material is classified as "very valid". In other words, the electronic teaching material, which uses Flip PDF Corporate and includes video explanations of sample problems, audio explanations of the material, and online quizzes on the topic of measures of central tendency and dispersion, is declared valid and suitable for use in learning.

Based on the assessments from the material expert and the media expert, the teaching material developed using Flip PDF Corporate is categorized as "very valid," with a percentage of 92%. As explained in (Pratiwi, Halang, & Widiyastuti, 2024), the overall results of the product validation test show that the teaching materials developed using Flip PDF Corporate have met the "very valid" criteria. Furthermore, (Yunus, Abbas, & Djakaria, 2023) also explain that the development of teaching materials aided by Flip PDF Corporate using the Plomp model meets the validity criteria with a very valid category. This is supported by (Anjelina, Habibullah, & Rofi'ah, 2024), which shows that the media expert validation results obtained a percentage of 92% with the "very feasible" criteria. The material expert validation results obtained a percentage of 93% with the "very feasible" criteria, and the language expert validation results obtained a percentage of 90% with the "very feasible" criteria. Therefore, it can be concluded that the Flip PDF Corporate-based teaching material is feasible and effective to be implemented in learning.

After passing the expert assessment, the product trial was conducted on students by applying the teaching material in a learning setting. Following this, questionnaires were distributed to collect student responses to the developed teaching material. These responses serve as the basis for assessing the practicality of the teaching material. To obtain feedback from students, three evaluation stages were carried out: one-to-one evaluation, small group evaluation, and field testing.

The one-to-one evaluation involved three students, each representing a different level of knowledge. The average result from this trial was 90%, indicating that the electronic teaching material is in the "very practical" category. The small group evaluation involved six students, with two students assigned to each of the three knowledge levels. The average result from this trial was 87%, indicating that the electronic teaching material is in the "very practical" category. The field test was conducted with 15 students from class VIII.2 at SMP Negeri 2 Telaga. The average result from the field test was 84%, indicating that the electronic teaching material is in the "very practical" category. (Yunus, Abbas, & Djakaria, 2023) explain that the teaching materials developed with the aid of Flip PDF Corporate meet the practicality criteria as seen from the responses of students and teachers to the use of the materials. As explained in (Nisa, Purwidiani, Widagdo, & Astusi, 2024), the digital teaching material developed using the Flip PDF Corporate application is very feasible and received a very good category in student responses. This opinion is supported by (Yulaika, Harti, & Sakti, 2020), who state that the use of Flip Book-based teaching materials is considered more effective and practical because students can access the learning materials anywhere and anytime according to their needs and opportunities.

CONCLUSION

This research produced an electronic teaching material on the topics of data centralization and data spread, which was found to be very valid with a percentage of 92%. This was determined from the results of the expert validation. The developed teaching material also underwent several evaluation processes to assess its practicality, including a one-to-one evaluation, a small group evaluation, and a field trial. The results of these evaluations were as follows: the one-to-one evaluation obtained 90% (categorized as very practical), the small group evaluation obtained 87% (also categorized as very practical), and the field trial obtained 84% (categorized as very practical).

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