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Research Article

Development of e-worksheet based on engineering design process for composition function material

Lutfi Cahya Kurniawan [a,1,*], **Indah Wahyuni** [a,2]

[a] Department of Mathematics Education, Faculty of Tarbiyah and Teacher Training, Universitas Islam Negeri Kiai Haji Achmad Siddiq Jember, Jl. Mataram, Jember, East Java 68136, Indonesia
[1] lutficahya967@gmail.com*; [2] indahwahyuni@uinkhas.ac.id
* Corresponding author

Abstract: Mathematics learning poses several challenges, making the utilization of technology, particularly e-worksheets, a promising solution to offer a more interactive learning experience and bolster student success. This research aims to describe the validity, practicality, and effectiveness of using Engineering Design Process (EDP)-based e-worksheets in composition function material in high school. The research subjects are 35 eleventh graders at SMAN 1 Tegaldlimo, Banyuwangi, East Java. The Research and Development (R&D) utilized the ADDIE model and collected data through observation, interviews, and tests. The results of expert validation approval obtained a score of 83.33%, which indicates valid or reasonable to use but requires slight updates. The practical results obtained from the analysis of student questionnaires were 76.69%. The pretest and post-test values are analyzed using the Wilcoxon Test with a significance value of < 0.05. The utilization of EDP-based e-worksheets significantly influences composition function material in high school. The N-Gain score shows the mean value was 70.09 %, which is categorized as high (quite effective). Developing e-worksheets based on feedback from teachers and students, as well as further studies on their long-term influence on student learning outcomes, is needed.

Keywords: composition function; engineering design process; e-worksheet

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1. Introduction

In today's modern era, mathematics is inherently intertwined with rapidly evolving technology and information systems. Information technology stands out among the swiftly advancing technologies of our time (Lepper & Malone, 2021). Information sources have expanded beyond traditional book texts to encompass broader dimensions (Argaw et al., 2017). With the advancements in information technology, accessing available data or information can occur swiftly, efficiently, and accurately It is hoped that each country has sufficient capabilities and expertise to meet current demands and needs due to the rapid development of science and technology. With existing limitations, learning tools that support learning achievement are necessary (Niegemann & Heidig, 2012). In this case, mathematics learning requires a strategy or learning model so that students can develop the ability to solve problems in the material they receive.

In the context of mathematics lessons, one learning strategy that is suitable to be applied is the Engineering Design Process (EDP). Engineering is the practical application of scientific knowledge to solve everyday problems (Lee et al., 2014). EDP is one of the elements that can be found in STEM (Science, Technology, Engineering, and Mathematics) learning strategies. As noted by Tipmontiane and Williams (2021), STEM learning involves various components, with EDP being one of them. The EDP is a systematic and intelligent process in which designers generate, evaluate, and determine concepts for devices, systems, or processes whose form and function achieve client or user goals while meeting a specified set of constraints (Chiu et al., 2013).

The EDP model comprises several stages that help students apply their knowledge comprehensively, improving their problem-solving and critical-thinking skills (Sulaeman et al., 2022). The use of open problems in the EDP is to provide real-world industry

practice, as well as give students more flexibility and choice (Hafiz & Ayop, 2019). The EDP includes iterative dynamic interactions, where fundamental ideas from science, mathematics, and design are used and created to track down the most ideal answer to achieving a predetermined goal. The EDP is a learning approach that can be used by educators to overcome learning challenges and introduce engineering concepts to students. This way, learning materials offer students the necessary tools to conduct science and engineering practices. Moreover, EDP acts as a crucial foundation across STEM disciplines, enabling students to appreciate how various ideas, approaches, and tools can be used to solve complex problems with multiple solutions (Bulgis, 2020).

Through the implementation of STEM education, a crucial component of the EDP, educators aim to equip students with problem-solving skills that can be utilized throughout their academic journeys. This approach also emphasizes the development of critical thinking abilities, enabling students to make informed decisions when faced with real-world challenges. The EDP learning model has proven effective in increasing student engagement and academic performance. A model can take various forms, such as graphical, physical, or mathematical representations, that help facilitate the EDP process (Mentzer et al., 2014). Pandiangan et al., (2018) have emphasized the role of interests in shaping the educational experience, underscoring the importance of a stimulating learning environment. Therefore, participating in learning activities can increase interest.

Learning motivation is internal and external encouragement for students to change their general behavior with several indicators or elements (Lastri et al., 2020). As one gains more experience, one can review data about different facets of life, such as education, employment, and more. However, there is a noticeable decline in student achievement, particularly in science, due to a general lack of interest or motivation to learn. The problem of low interest experienced by almost all students in Taiwan is usually accompanied by low motivation (Yeh et al., 2019). As explained by Ningsih and Nurrahmah (2016), the results of the review based on the Third Global Math and Science Study-Report (TIMSS-R) 2011, estimation results and instructive evaluations show that Indonesian students still have low learning achievements by international standards, indicating that there is still much work to be done to improve mathematics learning achievement in Indonesia, particularly at the high school level.

The quality of mathematics education in senior high schools depends on the effectiveness of the learning models applied during the learning process. An essential component of an effective learning model is the availability of quality teaching materials. The primary objective of using teaching and learning materials is to facilitate learning, whether in a classroom or an online setting (Dwirahayu et al., 2022). Teaching and learning materials are tools utilized to deliver the educational content (Bušljeta, 2013). One common learning tool used in schools is student worksheets (Farman et al., 2021). These worksheets provide summaries, assign tasks, and serve as learning materials that reduce reliance on educators while increasing student engagement. To enhance learning outcomes, teachers can organize worksheets systematically, use color, and incorporate visuals to make them more appealing to students.

Some researchers have developed electronic worksheets to improve student learning experiences. As Puspita and Dewi (2021) research, e-worksheets are a set of learning activities utilized by students to solve problems. These electronic worksheets have been designed to assist students in grasping complex concepts and can be conveniently accessed through a range of digital devices, including workstations, tablets, and smartphones. In addition, Ulum et al. (2021) research prove that using EDP in student worksheets can help students learn the engineering thinking process. Ramadhani et al. (2022) research, which focused on developing a student worksheet on global warming using the EDP, showed that this approach was effective for teaching sciences. Mauludyah et al. (2023) research also highlighted the impact of using student worksheets based on the EDP, showing that it improved computational thinking skills and test results. However, these studies are generally carried out on science subjects, while research on mathematics subjects is carried out at elementary school level.

Looking at the results of research conducted by researchers at SMAN 1 Tegaldlimo, precisely in Banyuwangi Regency, the school had a double track extracurricular or entrepreneurship in producing donut cakes. The process of producing donut cakes can be effectively linked with the concept of composition functions. This mathematical material holds great potential in streamlining the production process and ensuring consistent quality in every batch of donut cakes. As mentioned by Wahyuni and Alfiana (2022) the aspect of science called mathematics consists of several mathematical concepts and problems that arise from thought processes that use logic and the principle of compositional function. Therefore, this research aims to explore and develop students' ideas and concepts in solving challenges that arise in the context of everyday life. Through this study, an evaluation will be carried out on the impact of EDP on understanding the concept of composition function, mathematical thinking skills, and learning motivation of high school students.

2. Materials and Methods

This e-worksheet development research is included in the Research and Development (R&D) research category. EDP based worksheets are needed to give students example questions and concise information that can help them learn related subjects. The steps of EDP learning model are listed in Table 1 (Bulgis, 2020). This research used 35 class XI students from SMAN 1 Tegaldlimo as subjects. The research was carried out on January 25, 2024. This research adopted the ADDIE model which includes the stages of analysis, design, development, implementation, and evaluation (Walter et al., 2015). An overview of this model can be seen in Figure 1.

Table 1. Steps in the EDP learning model

Steps	Information
Define the problem	Scope of the problem: • Who needs something and why? • What type of knowledge/science background is required? • What mathematical sciences will be required?
Learn about the problem	• What materials will be required? • What has been implemented to resolve the problem? • What products have similar needs? • How should we measure success and improvement?
Plan a solution	• Use evidence from problem scoping to generate many initial ideas for design solutions. • Systematically evaluate multiple solutions based on a problem to narrow down to a single design solution. • Give reasons why the proposed design solution is appropriate.
Try a solution	• Put the plan into action. • Evaluate risks and strategies to optimize performance. • Leverage criteria/constraints and consider trade-offs of the problem/plan to build a prototype (testable representation of a solution), model, or product.
Test a solution	• Consider applicable questions or hypotheses. • Create an experiment or rubric to assess whether the solution meets the criteria that have been explained, and consider constraints and needs. • Collect data and analyze data.
Decide whether solution is good enough	Can design be a tool for users to solve their problems?

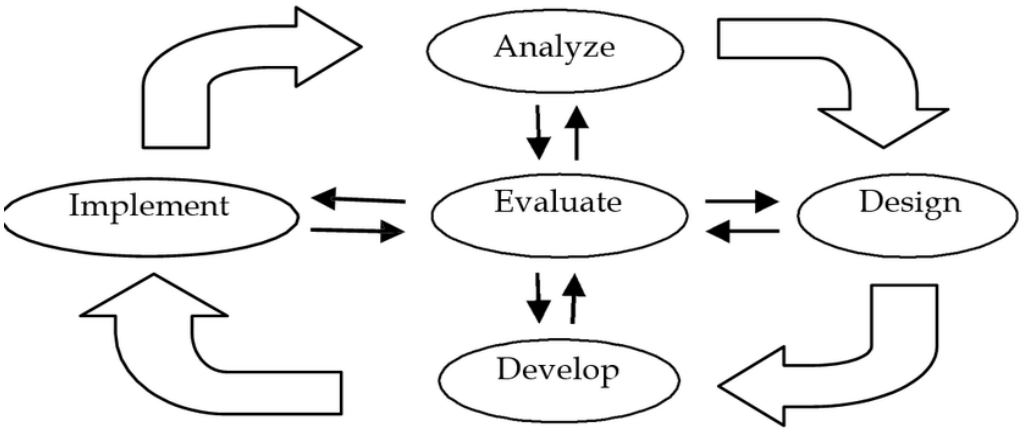

Figure 1. The ADDIE model

2.1 Analysis

During the analysis phase, it takes several steps to ensure the success of our learning programs. These steps include conducting a needs analysis, curriculum analysis, and student character analysis. Our primary focus during this stage is identifying any obstacles students may face and determining research objectives accordingly. To achieve this, the ADDIE model is used to identify instructional needs and then establish learning objectives. Additionally, we apply analytical principles from Dick and Carey's theory to gain a comprehensive understanding of the audience and the learning context.

2.2 Design Phase

At the design stage, this stage is the stage of processing the results in the form of data obtained during the observation and interview process at schools which then becomes a design. The design of the learning tools that will be used in developing the e-worksheet consists of: (a) The title of the e-worksheet which describes the material that will be included in the e-worksheet; (b) The competencies or sub-competencies to be achieved after studying e-worksheet; (c) Goals that student want to achieve after studying e-worksheet; (d) Material consists of compositional functions expressed in everyday life; (e) The guidelines that students should follow to ensure they can use the worksheets; (f) Questions, exercises, or assignments that require completion by students; and (g) Evaluation or assessment to measure students' abilities in working on e-worksheets (Prayitno & Suryadarma, 2019). The ADDIE model is used to design the general structure of learning materials and apply design theory from Dick and Carey to develop an instructional model that includes components such as learning objectives, content structure, and learning strategies.

2.3 Development

At the development stage, the designed e-worksheet is created. The other data collection instruments are also being created. The development stage is intended to produce a revised e-worksheet based on expert validation, namely, a revision of the validation tool. This stage aims to obtain suggestions to determine the correctness of the content and format as well as the validity of the e-worksheet design. The validation process involves three validators, namely media experts, language experts, and material experts. Once the initial design of the e-worksheet is approved and any necessary revisions are made, the next step is to conduct tests on students to ensure its effectiveness and usability. This process will involve gathering feedback and analyzing the results to make adjustments before the final version is released. The implementation of the ADDIE model is to create learning

materials, including the development of teaching materials, activities, and supporting resources, which is adapting the development process to the development principles of Dick and Carey's theory, which includes creating instructional materials and learning media.

2.4 Implementation

At the implementation stage, this stage will carry out product trials on 35 class XI students of SMAN 1 Tegaldlimo. The test results obtained will be tested using tests such as the normality test, Wilcoxon test, and N-Gain test by using the ADDIE model to plan and implement the implementation of learning material in a natural instructional environment and applying the implementation principles of Dick and Carey's theory to ensure that the learning material can be applied effectively in authentic learning situations.

2.5 Evaluation

At the evaluation stage, which is the final stage of the ADDIE model, the process is carried out to analyze the product; in the implementation part, there are still weaknesses and deficiencies in the product; applying the evaluation stage of the ADDIE model to assess the effectiveness of learning materials and applying evaluation principles from Dick and Carey's theory to improve and improve instructional design based on the evaluation results.

The instruments used in this research include interviews with teachers and students, questionnaires validated by media experts, language experts, and material experts, as well as student response questionnaires and tests. The data analysis approach used involves evaluating expert validation questionnaires, which are analyzed using Formula 1. Note: P = percentage; f = indicator validation value; n = total indicator validation value. The percentage of validation values resulting from these calculations will be explained by referring to Table 2.

$$P = \frac{f}{n} \times 100\% \quad (1)$$

Table 2. Validity Assessment Criteria

No.	Percentage (%)	Criteria
1.	85.01 – 100.00	Very valid, or usable without revision
2.	70.01 – 85.00	Valid, or usable but needs minor revisions
3.	50.00 – 70.00	Not valid, it is recommended not to use it because it needs major revisions
4.	01.00 – 50.00	Invalid, or may not be used

Next, to analyze the questionnaire, student responses are sought using the percentage of the response value for each aspect of the statement. The calculations used use Formula 2. Information: $\%NR$: percentage of response value; $\sum_{i=1}^{n} NR$: total response value for each aspect; $NR\ Maximum$: total score of the response questionnaire for each aspect. Furthermore, the percentage of student response scores resulting from these calculations will be explained by referring to Table 3.

$$\%NR = \frac{\sum_{i=1}^{n} NR}{NR\ Maximum} \times 100\% \quad (2)$$

Table 3. Student response assessment criteria

No	Percentage (%)	Criteria
1	80 ≤ p ≤ 100	Very practical
2	60 ≤ p ≤ 80	Practical
3	40 ≤ p ≤ 60	Quite practical
4	0 ≤ p ≤ 20	Very impractical

Analysis of the effectiveness of using e-worksheet based on EDP in composition function material was obtained from the results of students' pretest and posttest. Then, the data was analyzed using a paired sample comparison test. Before carrying out this test, the data distribution was checked first using the Kolmogorov-Smirnov test. When the data is declared to be normally distributed, a parametric test using the paired sample t-test is carried out. However, if the data does not meet the normalization assumptions, the analysis is transferred to a nonparametric test using the Wilcoxon Signed Rank Test. After that, the next step is to carry out data analysis using normalized gain (g). After calculating the N-Gain, the value or results obtained from the N-Gain can be categorized into Table 4.

Table 4. N-gain score criteria

No	Percentage (%)	Criteria
1	< 40	Ineffective
2	$40 - 55$	Less effective
3	$55 - 75$	Effective enough
4	> 75	Effective

3. Results

3.1. Analysis

The first stage is analysis, which includes needs analysis, curriculum analysis, and student character analysis. From the results obtained, the initial stage is to identify the competencies that students must have by outlining Core Competencies (KI) and Basic Competencies (KD). After that, the next step is to determine competency achievement indicators, which involve KD 3.6, which is related to explaining composition function operations, and KD 4.6, which concerns solving contextual problems related to composition function operations.

Table 5. The results of the needs analysis are based on interviews with mathematics teachers

Question	Results
What difficulties do you experience when teaching mathematics subjects, especially composition function material?	The difficulty that you face in delivering the material is that it is not always easy for some students to understand due to a lack of interest in learning, especially mathematics, so you use minimal media to help students understand the material.
What media do you use in the learning process?	Worksheet and textbooks
In your opinion, what causes students to have difficulty understanding mathematics material?	Mathematics cannot be separated from numbers/symbols, so students also need to relate problems in mathematics to everyday life situations to make it easier to understand the material.
Do you need different teaching materials?	Yes, of course, because diversity in teaching materials can create student interest and increase their learning motivation.
If teaching materials are developed, what are the criteria for the required teaching materials?	What is clear is that it must be adjusted to students' competencies, goals, development, and developments in science and technology.

Then, regarding the results of interviews with a mathematics educator and several class XI students, it was revealed that effective, efficient, and exciting teaching materials were needed for composition function material. Details of the results of discussions with mathematics teachers can be found in Table 5, while the results of discussions with students can be seen in Table 6.

Table 6. Results of needs analysis based on interviews with students

Question	Results
What teaching materials/learning resources are used for learning in class?	Worksheets and textbooks
Are the example questions in the teaching materials used sufficient?	Yes, that's enough
In your opinion, why is understanding mathematics material difficult?	do a lot of calculations using formulas
Do teachers often use the same teaching model/method without variation?	Yes, teaching as usual
Have you ever used e-worksheet teaching materials in mathematics lessons regarding composition functions?	Never

From the two interview results, there is a real relationship with regard to mathematics lessons, especially composition function material. After making observations at school, there is a double-track extracurricular, namely donut entrepreneurship. Therefore, the researcher tries to link the process of making donut cakes with knowledge from composition function material contained in e-worksheet form or content. The material used is one meeting with the stages or syntax of EDP based learning.

3.2. Design

The second stage is design, which is preparing the framework for the e-worksheet teaching materials. The preparation is carried out systematically, which is part of the design stage. Creating a framework for e-worksheet teaching materials in the form of a cover, concept map, instructions for using the e-worksheet, links, and bibliography, all of which are in the e-worksheet. Explanation of the composition function, determining the formula for the composition function $f \circ g$ if the functions f and g are known and vice versa, as well as determining contextual problems related to the operation of the composition function, are indicators of the material that makes up the e-worksheet. This content is presented using an EDP based learning strategy. EDP learning refers to the steps contained in it, as Bulgis (2020) stated that EDP steps, namely: a) "Define the problem", is the name given at the beginning of the problem orientation on the e-worksheet; b) "Learn about the problem", namely students are required to think creatively about known problems; c) "Plan a solution", students look for information or solutions to be designed to solve the problem; d) "Try a solution", students try to solve the problem after finding a suitable design; e) "Test a solution", from the problem that has been resolved, students try to check again whether the answer is correct or not; f) "Decide whether the solution is good enough", students will conclude the results of solving the problem. The e-worksheet is created by utilizing a web instrument in the form of a live worksheet, and each sub-material is also given a standard identification connection as a test practice for each individual. Figure 2 is the design result of the e-worksheet that has been created.

3.3. Development

The third stage, namely development, is the process of creating an e-worksheet with a mathematics quiz based on the EDP. To access the e-worksheet here, researchers use one of the websites, namely LiveWorksheets. With the help of a live worksheet, it is easier for researchers to enter content that has been previously designed, and a link has been provided to access it. The first link is a pretest question, and the second link is a posttest question. After the writing stage is complete, the e-worksheet is consulted with the supervisor for review, and suggestions for improvement are given. At this development stage, several experts also carried out validation. Validation results can be seen in Table 7.

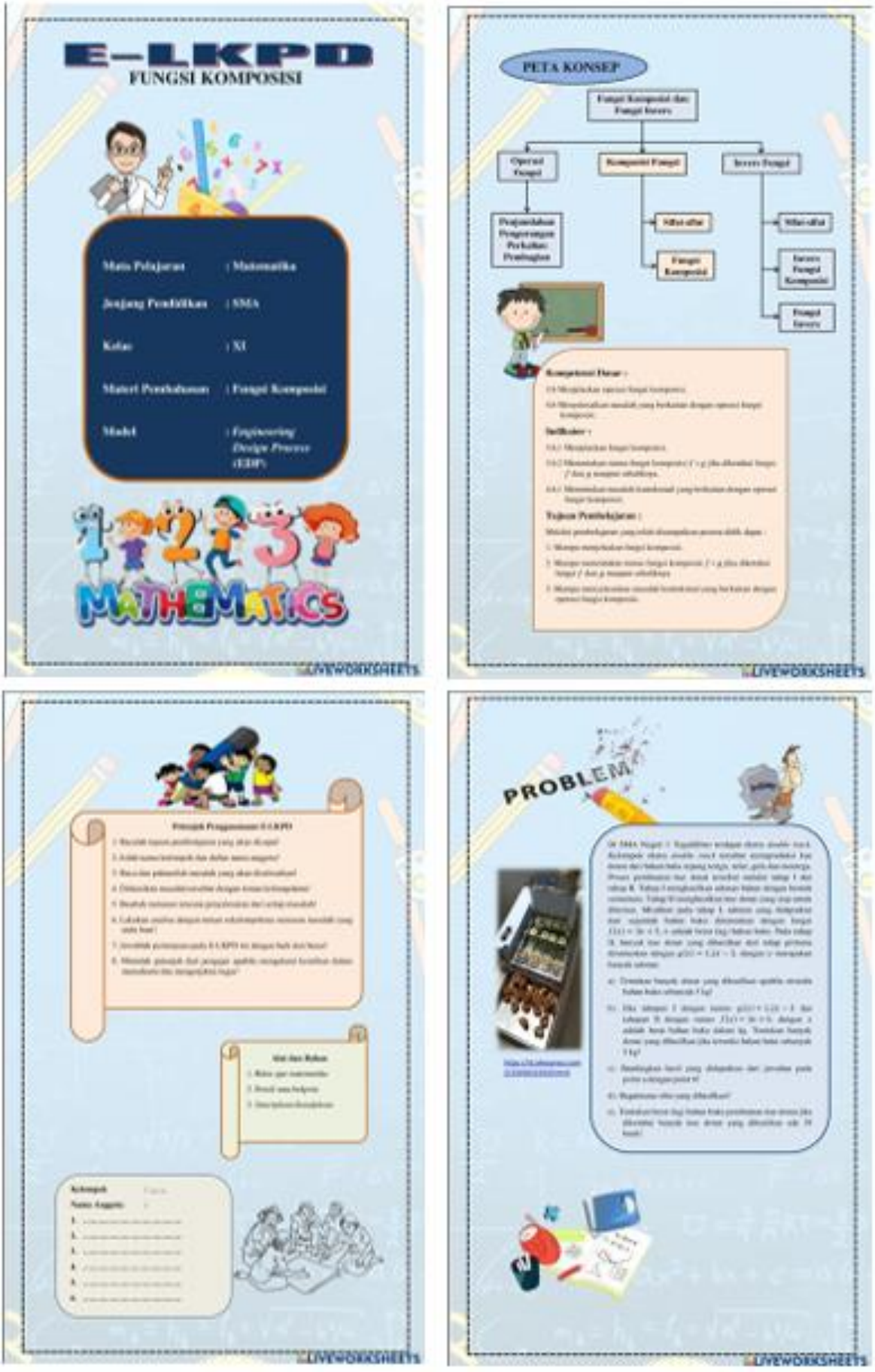

Figure 2. EDP- based e-worksheet framework and display

Table 7. E-worksheet validation results

No	Validator	Total score	Max score	Percentage (%)
1	Materials Expert	57	75	76.00
2	Linguist	35	40	87.50
3	Media Expert	58	65	89.23
	Total	150	180	83.33

Based on the results of expert validation test calculations on e-worksheet products or teaching materials, an assessment of 83.33% was obtained, which is included in the valid criteria or reasonable to use but requires slight revision.

3.4. Implementation

The fourth stage is implementation, after passing several previous stages, which are assessed in terms of quality of content, quality of language, and quality of appearance, which includes the realization of the formation of systematic e-worksheet teaching materials. The results of the validation carried out by the validator are fundamentally about checking the instruments used legally during the research process in the field. Next, an evaluation was carried out, especially on the level of effectiveness and adequacy of the e-worksheet after previous actions were carried out. The validation sheet is used to implement the e-worksheet, which is then tested on students to find out whether it is appropriate to use the e-worksheet; apart from that, educators are also involved in this matter. The results of the analysis of student response questionnaires regarding the teaching materials that researchers will use can be seen in Table 8.

Table 8. Results of Student Response Questionnaire Analysis

Aspects and Assessment Criteria	Response Value(%)
The overall average value of student responses	2684.00
%NR	76.69%
Category	Practical

From the scores that have been obtained, it is known that the results of the analysis of student response questionnaires show a score percentage of 76.69%, which is included in the practical category, so the EDP-based e-worksheet on practical composition function material can be used.

Next, the level of effectiveness of the e-worksheet was evaluated. In the first step in determining the effectiveness of the e-worksheet, it is necessary to carry out a normality assumption check. The results from the normality test are obtained in Table 9. The pretest value (sig) was 0.095, and the posttest was 0.023. The sig value in the posttest shows 0.023 < 0.05, so H0 is accepted, and H1 is rejected, so the data is not normally distributed.

Table 9. Normality test results

Data	Statistic	df	Sig.
Pretest	.137	35	.095
Posttest	.160	35	.023

After carrying out the Normality Test, the results show that the data is not normally distributed. Therefore, the data will be tested using the Wilcoxon Test. The Wilcoxon test aims to evaluate the effectiveness of using e-worksheets by examining differences before and after implementing e-worksheets. Table 10 is the result of the Wilcoxon Test.

Table 10. Wilcoxon signed rank test results

Statistic	Posttest - Pretest
Z	-5.172
Asymp. Sig. (2-tailed)	.000

The data generated by the Wilcoxon Test is in Table 10. it was found that the Asymp.Sig (2-tailed) value was 0.000. The test analysis shows that the value 0.000 < 0.05, so H0 is rejected, and H1 is accepted. The information that can be drawn is that the alternative hypothesis is accepted, indicating that there are significant differences between the two sample groups. Thus, the use of EDP-based E-worksheets in composition function material in high school has a significant influence.

After carrying out the Wilcoxon Test, the next step is to carry out the N-Gain Test to evaluate the effect of using E-worksheet in classroom learning. The N-gain obtained was 70.09%, which shows in the N-Gain Test criteria table the value is 55-75, so the category obtained is relatively high, which means it is pretty compelling. Thus, it can be concluded that EDP-based e-worksheets on composition function material in high school are quite effective for use.

3.5. Evaluation

The fifth stage is the evaluation stage. At this stage, it needs to be used as a benchmark for the success of the process in motivating students to learn through digital teaching materials based on the EDP. This is also inseparable from the results of assessments from several previous experts, namely language, media, and materials experts. Even though this learning media is considered adequate for application, especially for educational purposes, there are still areas for improvement, such as having the help of the internet and needing to use electronic devices. Apart from these shortcomings, this learning media also has several advantages or benefits, such as acting as a tool to respond to student participation during the learning process. Apart from that, students become more creative in responding to problems in the media. The existence of this media also increases students' motivation to learn, especially at SMAN 1 Tegaldlimo.

By implementing e-worksheets, students can develop thinking patterns because they are required to solve problems related to real-life context situations. Students are also trained to design designs from known problems, and the results of these designs will make it easier for them to find solutions and be able to solve existing problems. However, the educator explained that even though there was e-worksheet D this year, it was generally not used during the learning process. Even though the educational programs used are sophisticated, the thinking about e-worksheets has remained the same year to year and is the root of the problem. The school then chose to use teaching materials such as worksheets and textbooks in general.

4. Discussion

The EDP-based e-worksheet that developed in this research are valid and reasonably practical and have potential value for the creative thinking process of mathematics students on composition function material. To solve problems in composition function material, group work is required, where students can use the information in the e-worksheets to find solutions, design them, and exchange thoughts and opinions. Participating in working on worksheets in groups will also stimulate collaboration among students, allowing them to help each other overcome individual difficulties and share thoughts. This skill is essential in today's era (González-salamanca, 2020; Silber-Varod, 2019). Collaborative learning activities will provide opportunities for students to build new knowledge together (Kasim et al., 2022). Optimal collaborative performance is an essential factor in group work (Haugland et al., 2022). Furthermore, collaborative learning in groups will increase the sense of shared responsibility for optimal teamwork (Donelan & Kear, 2018).

At this stage, the use of e-worksheets could work well as students interpret ideas regarding the function of composition material in everyday life, and students could develop the ideas they obtained through these e-worksheets.

At the design stage, teaching materials are prepared by taking into account the steps in the question model, core competencies, essential competencies, learning objectives, and indicators of competency achievement. The design of e-worksheets is arranged structurally; covers, concept maps, instructions for using e-worksheets, table of contents, pages in chapters, EDP steps in model questions, and other instructions are part of the e-worksheets as a whole structure. In the next stage, the preparation of e-worksheets and the creation of other research instruments are facilitated, such as the development stage, implementation stage, evaluation, and revision stage, which shows the quality of the e-worksheet development.

Usability testing of the e-worksheet by expert validators obtained a score of 83.33%, which shows it is valid and suitable for use but requires slight revision. This shows that the e-worksheet is ready to be used as a testing process for students, but before being tested on students, the product has been assessed by the validator in several parts and revised for improvement (Rahman et al., 2022). This has received a positive response because e-worksheets can make a contribution to students during the learning process. In the results of the questionnaire analysis of student responses to the e-worksheet, a score of 76.69% was obtained, which indicates the practical category. This positive response shows that users receive the visual appeal of the application or teaching material well. So, it has the potential to make a significant contribution to increasing user engagement and overall satisfaction (Pattiasina et al., 2024). Furthermore, the student response value was 76.69%, which shows that the teaching materials are included in the practical category. Despite showing positive perceptions, certain aspects that are considered supportive by users can further increase the educational impact of the application (Vlachopoulos & Makri, 2017).

The effectiveness test using the Wilcoxon Test shows that there is an influence of using EDP-based e-worksheets to increase student enthusiasm and learning outcomes. Self-discipline through providing teaching materials, thus ensuring the teaching and learning process remains exciting and dynamic (Anwar et al., 2023). The N-Gain Test score, with a value of 70.09%, shows 55-75, so the category obtained is quite effective. So, the EDP-based e-worksheet on composition function material in high school is quite effective for use. The development of e-worksheets has been carried out. It can help students interpret the material and the function of composition in everyday life. The results are as expected; namely, the classification is valid, reasonable, and reasonably practical when examining the information. Through the worksheet that developed from this research, the EDP model can be used more optimally, considering that various previous studies have reported the positive impact of this model. This model can influence not only student learning outcomes (Isabelle et al., 2021) but also students' critical thinking (Putra et al., 2023), collaborative skills, and creativity (Han & Shim, 2019). Through this learning, students will also have more opportunities to apply the mathematics and science they learn (Berland et al., 2014).

5. Conclusions

The process of developing e-worksheets based on the EDP, which has been carried out, involves five phases using the R&D method and the ADDIE model. These stages include analysis, design, development, implementation, and evaluation. Preliminary results suggest that the e-worksheets meet valid standards and are suitable for use. The results of the expert validation analysis obtained a value of 83.33%, which shows it is valid and suitable for use but requires slight revision. Then, the analysis of student response questionnaires and e-worksheets obtained a score of 76.69%, which indicates the practical category. Then, testing its effectiveness using the Wilcoxon Test shows the influence of using EDP-based e-worksheets on increasing student enthusiasm and learning outcomes. Then, in the N-Gain Test, the score was 70.09%, which showed 55-75, so the category obtained

was quite effective. It can be concluded that EDP-based worksheets on composition function material in high school are pretty effective to use.

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