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Development of Electronic Student Worksheet Using Problem-Based Learning Model with the Wizer.me Platform on Momentum and Impulse Materials

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Abstract – *This research departs from the problem of limited tools and practicum materials in the laboratory, and students need help understanding the concept of momentum and impulse material. An effort to overcome these problems is to develop an electronic student worksheet using a problem-based learning model with the Wizer.me platform. This study aims to describe the development process, validity level, and practicality of electronic student worksheets using the problem-based learning model with the Wizer.me platform on momentum and impulse material. The research method used is research and development (R&D) with the ADDIE development model. The population of this research is all class X MIPA SMA Negeri 13 Garut, consisting of seven classes with 252 students. The research sample was taken by using the cluster random sampling technique for classes X MIPA 1 and X MIPA 2, with 36 students in each class. The data analysis technique used in processing the validation results was Aiken's V index. The results showed that the Aiken index of material, media, and learning experts were respectively 0.91, 0.94, and 0.96 with excellent categories, and the average practicality percentage is 89% with efficient criteria. Therefore, it can be concluded that the electronic student worksheets developed using a problem-based learning model with the Wizer.me platform on the momentum and impulse material meets valid and practical criteria for use in the learning process.*

Keywords: *ESW; momentum and impulse; problem-based learning; wizer.me*

I. INTRODUCTION

Student Worksheets (SW) is a learning media that educators can use to increase the involvement or activity of students in the teaching and learning process (Diana & Makiyah, 2021; Ika & Doa, 2021; Warnida et al., 2023). SW serves to provide more understanding regarding the material provided by educators because it contains essential and interactive elements that are useful for attracting or motivating students (Ragilia et al., 2018; Sa'diah et al., 2022). The SW contains several questions, preparations, and activities that students must carry out. SW can develop students' process skills which are expected to be able to build their knowledge structure from the data they obtain through direct involvement in observation (Safitri et al., 2022). According to Isnaini et al. (2019), SW, nowadays, only contains theoretical summaries and practice questions. This results in insufficient scientific problem-solving procedures and does not encourage students to discover a concept.

SW is currently used as a learning support medium, not the main learning medium. To motivate further students' learning process and effectiveness, it is necessary to develop more attractive worksheets. Especially now in an era where everything uses technology. Developing worksheets that use technological models will further motivate students and make it easier to facilitate the learning process. In addition, another advantage of having SW using technology models is that it can be inserted videos, images, audio, and practicum simulations, has an attractive appearance, can be accessed anywhere and anytime, and can provide feedback, corrections, and grades automatically (Pabri et al., 2022).

Based on the results of interviews with Physics educators and an analysis of the needs of students at SMAN 13 Garut. The results of the interviews showed that the learning media currently used was SW but only as a support for learning which contained a summary of the material and practice questions. In addition, the implementation of learning in the laboratory is slightly hampered due to renovations; the tools and practicum materials available must be completed according to the needs of learning physics. Based on the results of the analysis of the students' needs shows that 97% of students need engaging worksheets for learning physics, and 91% of students need worksheets that can be accessed online via a smartphone or computer.

One model that can construct students' understanding in achieving learning objectives is the Problem-Based Learning (PBL) model. The PBL model uses problems in everyday life that students must solve to be skilled in solving problems (Diana & Makiyah, 2021; Nurazmi & Bancong, 2021). The implementation of the PBL model consists of 5 process stages: student orientation to problems, organizing students, conducting investigations, presenting data, and analyzing and evaluating (Lespita et al., 2023; Pratiwi et al., 2019; Zhou, 2018). Electronic Student Worksheets (ESW) using the PBL model has the potential to help create fun learning and improve problem-solving abilities that occur in students' daily lives (Muslem et al., 2019; Nasar & Kurniati, 2020). According to Rachmasari et al (2019), The application of the PBL model to ESW can make learning activities more meaningful, including (1) Students learn to apply their various knowledge to find solutions to problems so that their understanding of the concepts or material being studied can increase. (2) The learning raised in learning is real, which can encourage the motivation and interest of students to learn the concepts being studied. (3) Develop thinking skills and train students to learn to build concepts. Applying PBL-based ESW in learning activities encourages students to develop problem-solving skills and critical thinking (Diana & Makiyah, 2021; Munika et al., 2021). According to Mulyasari et al. (2022), the implementation of PBL-based ESW encourages students to conduct research, collaborate, and actively apply knowledge through electronic platforms independently. Based on the results of research conducted by Nyeneng et al. (2019), they stated that PBL-based ESW helps students improve problem-solving skills concerning the relationship between classroom learning and everyday life.

One platform that can help in making ESW is Wizer.me. Wizer.me is a platform that can be used to create student worksheets digitally (Kopniak, 2018). The advantages of Wizer.me are that it is user-friendly, which means it is easy to use, with open source code (Open Source) without knowing the HTML programming language. In addition, many tools are fast and easy to understand. You can insert videos, animations, pictures, and simulations into quizzes with automatic feedback, corrections, and grades not found in printed worksheets. Based on the results of research conducted by Mayasari et al. (2023), States that the Wizer.me-assisted ESW developed is feasible and has high effectiveness. Still, the presentation of the developed ESW has yet to use a particular learning model's syntax, so the learning process is less directed and systematic. The advantages of Wizer.me provide positive support in developing ESW using the PBL model.

Based on this background, the researchers were interested in developing ESW using the problem-based learning model with the Wizer.me platform on momentum and impulse material. The purpose of this study is to describe the development process, level of validity, and level of practicality of ESW using the problem-based learning model with the Wizer.me platform.

II. METHODS

This research used the type of Research and Development (R&D). According to Cahyadi (2019), R&D methods are a scientific way to research, design, produce, and test the validity of existing products. The product developed in this study was an ESW using a problem-based learning model with the Wizer.me platform on momentum and impulse material in digital form. The research model used was the ADDIE development model. The ADDIE development model is a development model consisting of five stages, namely analysis, design, development, and implementation (Cahyadi, 2019; Rizal et al., 2022).

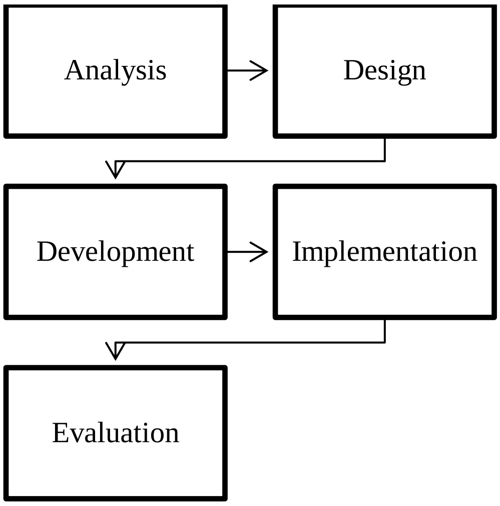

Figure 1. ESW development procedure flowchart

The analysis phase was carried out by analyzing the data obtained in the field; the results are as follows: (1) SW is used as learning support and contains a summary of the material and practice questions. (2) Implementing learning in the laboratory experiences limitations of practicum tools and materials. (3) 97% of students need engaging worksheets, and 91% need worksheets that can be accessed online. (4) The curriculum used refers to the 2013 curriculum. The design stage was carried out by compiling a framework in the form of flowcharts and storyboards, preparing materials, preparing the ESW format, and choosing the leading platform, namely Wizer.me, and the supporting platforms Flaticon, Freepik, Google Sites, Microsoft PowerPoint 2013, and Canva. The development stage was done by making ESW, validating material experts, validating media experts, and validating learning experts. The implementation phase was conducted on 72 students from class X MIPA 1 and X MIPA 2 SMA Negeri 13 Garut. Finally, the evaluation stage was carried out by improving the ESW according to suggestions from educators and students.

The types of data used in this development research are quantitative and qualitative. Quantitative data is in the form of evaluating the ESW's validity from material, media, and learning expert validators, as well as the results of product practicality assessments from students. Quantitative data is in the form of validator ratings contained in the questionnaire based on the Likert scale questionnaire presented in Table 1, and qualitative data is in the form of input, suggestions, and comments.

Table 1. Likert scale guidelines

Criteria	Symbol	Score
Very less	(VL)	1
Less	(L)	2
Fairly good	(FG)	3
Good	(G)	4
Very good	(VG)	5

(Sugiyono, 2019)

Validation data analysis employed the calculation of the Aiken index for material experts, media experts, and learning experts to test the validity of the developed ESW. The calculation results were then interpreted based on the product validity criteria table presented in Table 2. The formula used for validation was Aiken's V index. The item validity index proposed by Aiken, according to Retnawati (2016), is formulated as follows.

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

Information:
V = Respondent's agreement index regarding item validity
s = The score set by the respondent minus the lowest score ($s = r - 1$)
r = Choice category score on the respondent
n = Number of respondents
c = The number of categories filled by respondents

Table 2. Product validity criteria

No	Value range V	Validity Level
1	0,81-1,00	Very valid
2	0,61-0,80	Valid
3	0,41-0,60	Valid enough
4	0,21-0,40	Invalid
5	0,00-0,20	Very invalid

(Retnawati, 2016)

The analysis of product practicality was based on questionnaires that students and educators have filled in. Practicality questionnaire results in data analysis were carried out with the following steps:

a. Accumulating up the total score for all indicators
b. Calculating the average value of practicality. The average value of the practicality test questionnaire was converted into a percentage. According to Riduwan & Akdon (2015), to manage the data for each group of all items, you can use the formula:

$$\% = \frac{\sum Y}{\sum X} x\ 100\% \quad (2)$$

Information:
Y= Score given by students
X= Maximum score

To find the percentage of the overall score obtained using the formula:

$$\% = \frac{\sum Y}{\sum (X)(N)} x\ 100\% \quad (3)$$

Information:
Y= Score given by students
X= Maximum score
N= Many Students

The calculation results were then interpreted based on the product practicality criteria table in Table 3.

Table 3. Product practicality criteria

Average (%)	Category
85-100	Very practical
70-84	Practical
55-69	Quite practical
50-54	Less practical
0-49	Impractical

(Arikunto, 2009)

III. RESULTS AND DISCUSSION

Developing ESW using the problem-based learning model with Wizer.me. A platform on momentum and impulse material was carried out in stages to produce products suitable for use in the learning process. The development model used to develop these products was the ADDIE model, namely analysis, design, development, implementation, and evaluation (Cahyadi, 2019; Rizal et al., 2022). This development research was carried out to assess the feasibility of the product in the form of validity and practicality, not to assess the effectiveness of the product being developed.

The first stage was the analysis stage. The analysis stage is the initial stage carried out to analyze or identify potentials and problems. At this stage, the researcher obtained information through direct interviews with the class X physics teacher at SMA Negeri 13 Garut, learning observations, providing ESW needs analysis questionnaires, and analyzing the curriculum used. Based on the observations and interviews, data was obtained that the SW was used only as a learning support which contained a summary of the material and practice questions. According to Muslem et al. (2019), SW presentation needs to be designed with a learning model to enhance students' learning activities and creative thinking in finding a concept. Other data was obtained that implementing learning in the laboratory experienced limited practicum tools and materials. Based on the results of the student needs analysis questionnaire show that 97% of students need engaging worksheets in physics learning, and 91% need worksheets that can be accessed online. Based on the analysis of the curriculum used in Garut 13 Public High School, the 2013 curriculum, which refers to the core and essential competencies, refers to Permendikbud Number 37 of 2018.

The second stage was the design stage. The design stage is the planning stage of the ESW, where the researchers compiled a framework in the form of flowcharts and storyboards, preparation of materials, preparation of the ESW format, and selected a supporting platform for the creation of the ESW. The ESW format created by the researcher refers to 6 elements: titles, study guides, learning indicators, supporting information, work steps, and assessment (Sudarmin et al., 2019). The draft that has been made is then consulted with the supervisor. At this design stage, the researcher prepared the leading platform for developing ESW, namely Wizer.me, to create learning activities. Researchers also prepared supporting platforms, including Flaticon, Freepik, Google Sites, Microsoft PowerPoint 2013, and Canva.

The third stage was the development stage. The development stage was making the ESW with the Wizer.me a platform and presenting the results of expert validation by the validators. The development of the ESW was intended for class X MIPA students at SMA Negeri 13 Garut. The ESW was developed using Wizer.me as the leading developer platform and Google Site as support for storing links generated from the leading developer platform. The manufacturing process is carried out in stages to produce a proper ESW. ESW validation was carried out by three material experts, three media experts, and three learning experts. This validation aimed at obtaining data with improvements to achieve a valid ESW so that it is suitable for use and value for its users. The average results of the validation of material, media, and learning experts showed that the developed ESW is in an outstanding category. The product is declared feasible by the researcher if it has gone through a validation test and is revised according to suggestions and comments from the validator (Mukti et al., 2018; Pabri et al., 2022). According to Retnawati (2016), the outstanding category is in the interval from 0.81 to 1. The following shows the intro and contents of the ESW presented in Figures 2 and 3.

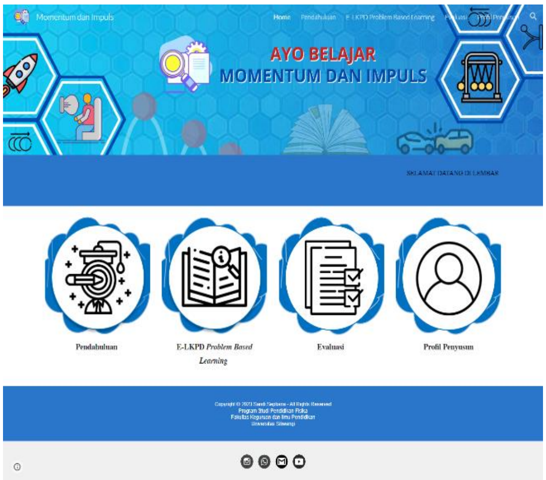

Figure 2. Display of the ESW intro

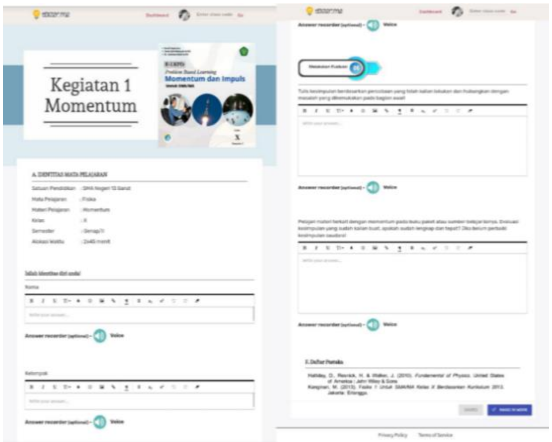

Figure 3. Display of the contents of the ESW

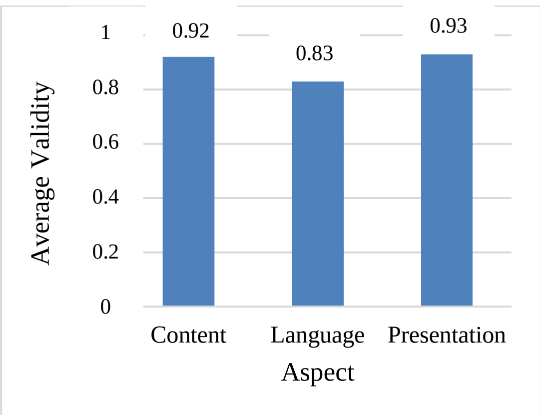

Figure 4. Graph of validation results of material experts for each aspect

The validation results by material experts consisted of three assessment aspects: content, language, and display. The total number of indicators used was 17 indicators. The results showed that the material expert validation score was in an outstanding category, with an Aiken index of 0.91. Figure 4 shows the analysis of validation results in each aspect, getting an outstanding category. The presentation aspect obtained the highest Aiken index of 0.93 with a good category. Furthermore, the content aspect obtained an Aiken index of 0.92 with a good category. In the language aspect, the lowest Aiken index is 0.83, with a good category. These results show that the developed ESW is good in content, language, and appearance. Purnawati et al. (2020) revealed that the advanced ESW material must be adapted to the needs of students based on the scope of core competencies and essential competencies and use colors and text sizes that are easy to understand not to disturb the material's content.

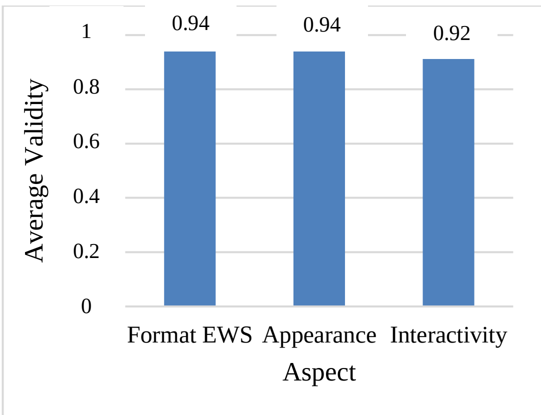

Figure 5. Graph of media expert validation results for each aspect

The results of the validation by media experts consisted of three aspects of the assessment, namely the format aspect, the display aspect, and the interactivity aspect. The total number of indicators used was 18 indicators. The media expert validation results were excellent, with an Aiken index of 0.94. Figure 5 shows the analysis of the validation results of media experts in each aspect, getting an outstanding category. The aspect of the ESW format and appearance obtained the highest Aiken index of 0.94 in the outstanding category. Regarding interactivity, the lowest Aiken index was 0.92, with a correct category. These results indicate that the developed ESW is good in terms of format, appearance, and interactivity. According to Pratiwi & Margunayasa (2022), In making ESW and compiling content, it is also necessary to pay attention to interactivity, layout, and appearance design to make it attractive.

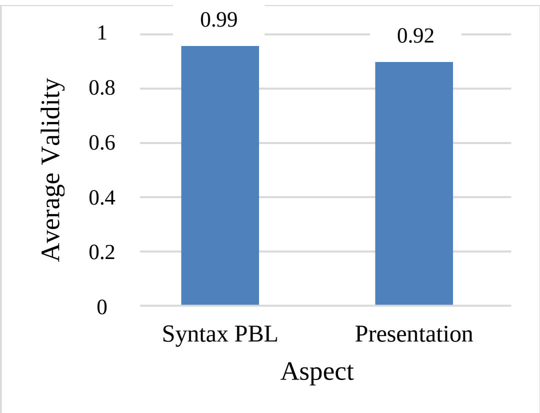

Figure 6. Graph of validation results of learning experts for each aspect

The validation results by learning experts consisted of two aspects of the assessment: the PBL syntax aspect and the presentation aspect. The total number of indicators used was 10 indicators. The media expert validation result was in the outstanding category, with an Aiken index of 0.96. Figure 6 shows the analysis of the validation results of learning experts in each aspect, categorized as outstanding. The PBL syntax aspect obtained the highest Aiken index of 0.99 with an outstanding category, and the display aspect obtained the lowest Aiken index of 0.92 with a very valid category. These results show that the developed ESW is good regarding PBL syntax and presentation. Presentation of problems in the ESW with the PBL model can be a stimulus for students in their learning process (Gabriella & Mitarlis, 2021). From the results of the assessments and improvements that have been made based on suggestions from material, media, and learning expert validators, the ESW uses the problem-based learning model with the Wizer.me platform on momentum and impulse material, which is declared very valid/feasible to be tested on students and can proceed to the implementation and evaluation stage.

The fourth stage is implementation. The implementation stage is the application of the product to determine the practicality of the product being developed. Product implementation was conducted on 72 students in class X MIPA 1 and X MIPA 2 SMA Negeri 13 Garut. Based on the analysis of the ESW practicality test data from product implementation carried out on students, it shows that the percentage score is 89%. These results conclude that the ESW is very practical to use in the learning process. The practicality test is assessed based on four aspects of the assessment: (1) The aspect of interest. (2) The aspect of effectiveness. (3) The material aspect. (4) The language aspect. The total number of indicators used is 13 indicators. The percentage results from the practicality test of the ESW show that the product developed is good in terms of interest, effectiveness, materials, and language. This is in line with the results of the study Mayasari et al. (2023), that ESW with the Wizer.me platform gets 95% in the efficient category.

The fifth stage is evaluation. The evaluation stage is receiving input from educators and students on the ESW, which is developed and then analyzed into the advantages and disadvantages of the ESW (Ika & Doa, 2021). The analysis of suggestions or comments from educators and students shows several advantages and disadvantages of this ESW. The advantages, according to comments from educators and students, include: (1) The ESW is inserted by various multimedia products such as pictures, videos, and virtual practicums so that they are attractive to users. (2) The existence of a virtual practicum presented in learning activities is beneficial in overcoming the limitations of learning in the laboratory. (3) Separating learning activities into activities 1, 2, 3, and 4 helps students understand the material in the learning process. (4) ESW uses a form of assessment from the national assessment model, namely multiple choice. The developed ESW has drawbacks, including the absence of an observation table that can be filled in directly.

The specialty of ESW is using the problem-based learning model with the Wizer.me, a platform on momentum and impulse material, including presenting various multimedia products that support physics learning. ESW is facilitated by pictures, videos, and virtual practicums, which aim to help students understand the material and motivate them to learn. Another feature of the ESW is automatic feedback on corrections and grades not found in printed worksheets.

The specialty of ESW using the PBL model has the potential to help create fun learning and improve problem-solving abilities that occur in students' daily lives (Fitriyani et al., 2019; Zulfawati et al., 2022). According to Rachmasari et al. (2019), the application of the PBL model to ESW can make learning activities more meaningful, including (1) Students learn to apply their various knowledge to find solutions to problems so that their understanding of the concepts or material being studied can increase. (2) The learning raised in learning is authentic, which can encourage the motivation and interest of students to learn the concepts being studied. (3) it can develop students' thinking skills and train students to learn to build concepts.

This study concluded that the ESW developed was in an outstanding and convenient category for use in physics learning. The results of this study are in line with research conducted by Diana & Makiyah (2021), revealing that one of the advantages of problem-based learning-based worksheets is increasing results and interest in learning physics. This is also supported by research conducted by Adikalan et al. (2022), the advantages of using ESW, namely: (1) it can be used anywhere and anytime. (2) it is environmentally friendly because it does not use paper and ink. (3) it is available all the time because it is in digital form. (4) it is presented in small size and capacity so that it can accommodate many ESWs. (5) It saves time and space. (6) Save costs. (7) Videos, images, audio, practicum simulations, animations, and games can be inserted. (8) it can provide feedback quickly.

This research can be used as a standard for further research in developing a product as an ESW. This research has been adapted to the stages of the development model, namely ADDIE, with the results concluding that the ESW is very valid based on validity tests by three expert validators and very practical based on practicality tests by students as users.

The development of the ESW is only partially running smoothly. The limitations in this development research include field trials of the ESW only limited to students of SMA Negeri 13 Garut, and the developers only know the feasibility and practicality of the ESW using the problem-based learning model with the Wizer.me platform on momentum and impulse material without knowing the effectiveness in the learning process.

IV. CONCLUSION AND SUGGESTION

In this study, the development process for the development of ESW using the problem-based learning model with the wizer.me platform on momentum and impulse material was carried out through five stages, namely analysis stage, design stage, development stage, implementation stage, and evaluation stage. The results showed that the Aiken index of material, media, and learning experts were 0.91, 0.94, and 0.96, respectively, with very valid categories and an average practicality percentage of 89% with very practical criteria.

Based on the results of the research discussion and conclusions, it can be suggested (1) The development of this ESW can be used as a school program so that it allows educators to develop other Basic Competencies; (2) The implementation of the ESW should not be carried out in just one school so that it can see the benefits of the ESW in other schools; and (3) The further development of ESW does not only reach the feasibility assessment stage based on validity and practicality, it should evaluate learning media to the effectiveness of the learning process.

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