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Development and Validity of Electronic Worksheet Based on POE (Predict-Observe-Explain) to Enhance Students Conceptual Understanding on Measurement Materials

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ABSTRACT

Low learning outcomes and poor conceptual understanding remain key challenges in secondary school physics learning, particularly in the topic of measurement. This study aims to develop and describe the characteristics of an Electronic Worksheet (E‑worksheet) based on the Predict‑Observe‑Explain (POE) model, as well as to determine its validity for classroom use. This research is classified as design research applying the Plomp development model, carried out up to the prototyping phase including expert validation. Data were collected through need analysis questionnaires and validation sheets assessed by three experts from the Physics Department, Universitas Negeri Padang. Analysis used Aiken's V coefficient and percentage description. The results show that the POE‑based E‑worksheet is structured into prediction, observation‑measurement, conceptual explanation, and evaluation phases. It obtained a validity index of 0.93, categorized as valid in terms of content, language, presentation, visual design, POE implementation, and digital quality. It is concluded that the developed E‑worksheet meets valid criteria and is suitable for use in physics learning on measurement material.

Keywords: Design research, Electronic Worksheet, measurement, POE model, validity

I. INTRODUCTION

The continuous development of technology has transformed the patterns and methods of delivering information in various fields, including education. This situation highlights the necessity for adjustments in the development of teaching materials to align with the needs and abilities of students in the current digital era [1]. One form of digital teaching material developed in line with technological advancement is the electronic student worksheet, which can be accessed through various digital devices[2]. In physics learning, the use of electronic student worksheet (e-worksheet) is considered highly essential, given that most of the studied materials are abstract in nature and difficult to understand solely through verbal explanations or written texts [3]. Therefore, the development of technology-based teaching materials such as electronic worksheet serves as a strategic measure to create a learning process that is easier to comprehend, engaging, and meaningful for students.

Electronic worksheet is a teaching material arranged systematically in digital form, containing instructions, tasks, and exercises designed to assist students in achieving the defined learning objectives [4]. The main advantage of electronic worksheet lies in its ability to present material in various forms such as text, images, animations, and videos, thereby enabling the visualization of physical phenomena that are difficult to observe directly [5]. Through this diverse presentation, students are expected to find it easier to connect theoretical concepts with real-life occurrences in their surroundings. However, to maximize the benefits of electronic worksheet, its development must not only focus on presentation aspects but also be integrated with appropriate learning approaches or models. The combination of technology and effective learning models is the key to success in improving the quality of students' learning outcomes.

One learning model proven effective in helping students understand concepts and correct their misconceptions is the Predict-Observe-Explain (POE) model [6]. This model was first developed by White and Gunstone, and it consists of three main stages: predicting the outcome of a phenomenon or event, making observations to verify the prediction, and explaining the reasons for the agreement or discrepancy between the prediction and the observation results [7]. Through these stages, students are encouraged to think actively, become aware of their prior knowledge, and transform it into scientifically correct understanding.

The POE learning model offers various advantages in the learning process, including training critical thinking skills, increasing student participation, and helping students develop the ability to construct logical and systematic arguments [8]. Research conducted by Rianita et al. shows that implementing the POE model can significantly improve students' conceptual understanding and science process skills, as it engages them directly in every stage of learning [9]. Furthermore, this model is highly suitable for topics that require strong conceptual understanding, such as measurement material, which serves as the foundation for all Physics topics at the senior high school level. Thus, the POE model not only helps students understand the material better but also motivates them to keep learning and exploring knowledge independently.

Based on preliminary observations conducted at SMAN 4 Sumatera Barat, it was found that the learning process at this school has been running well, yet several challenges remain, leading to relatively low student learning outcomes. One topic showing unsatisfactory results is measurement material among Grade X students of phase E. This is evidenced by data from the Mid-Semester Assessment, which shows an average score of 68.8 for class X E.1, 56.2 for class X E.2, and only 42.9 for class X E.3. Based on these data, none of the classes have met the Learning Achievement Criteria set by the school, which is 75 [10]. These low learning outcomes occur because students require a considerable amount of time to understand Physics material, and they tend to memorize content rather than understand concepts deeply. Additionally, the worksheets currently used at school only contain direct work procedures and do not guide students to predict phenomena or events prior to making observations. In fact, the prediction stage is crucial for stimulating students' creative thinking patterns and providing them with opportunities to compare their initial ideas with facts found in practice [8].

Based on interviews with Physics teachers at SMAN 4 Sumatera Barat, the teachers stated that they were not previously familiar with the POE-based learning model. However, based on its basic definition, they recognized that this model aligns with the independent curriculum currently implemented at the school. Digital teaching materials have been frequently used in the school, yet teachers have never developed electronic worksheet integrated with the POE model. Furthermore, they expressed their support for the development of digital teaching materials (electronic worksheet) for the Physics topic of measurement, as it is expected to improve students' conceptual understanding and consequently enhance their learning outcomes.

One solution to address the various issues outlined above is to develop and utilize teaching materials that are appropriate and tailored to students' needs. The use of high-quality teaching materials is an effective strategy to improve the quality of both the learning process and learning outcomes in Physics [10]. Well-structured teaching materials help advance students' thinking skills to higher levels and facilitate a deeper and more comprehensive conceptual understanding [11]. ELECTRONIC WORKSHEET is a type of teaching material that enables students to learn independently and flexibly while leveraging technological advancements [4]. Therefore, the development of ELECTRONIC WORKSHEET serves as a suitable solution, as it is equipped with interactive media that supports conceptual understanding, provides opportunities for students to practice and self-assess their learning progress, and accommodates diverse learning styles and interests among students.

ELECTRONIC WORKSHEET is a teaching material packaged in electronic or digital form that can be accessed via computers or mobile devices, presenting learning content through a combination of text, images, videos, animations, and learning simulations [2]. The use of ELECTRONIC WORKSHEET in learning offers various advantages, including enhancing students' learning motivation, enabling them to assess their own level of knowledge mastery, presenting material in a sequential and systematic manner, and allowing students to evaluate their learning outcomes independently through practice questions and answer keys provided within the material [12]. Following the implementation of teaching materials such as ELECTRONIC WORKSHEET, the next important consideration is the selection of an appropriate learning model—in this case, the POE learning model. This model is designed to help students correct their misconceptions and transform them into scientifically accurate understanding, thereby significantly improving both their conceptual comprehension and learning outcomes [6].

The primary objective of developing this POE-based ELECTRONIC WORKSHEET is to enhance students' conceptual understanding of measurement material. The POE learning model consists of three main stages: (1) Prediction Stage, (2) Observation Stage, and (3) Explanation Stage [7]. The first stage aims to elicit and identify students' prior knowledge and existing understanding before the learning process begins. The second stage involves presenting phenomena or experiments so that students can make observations and collect relevant data or facts. The third stage focuses on explaining the observation results and relating them to the predictions made earlier, leading to accurate conceptual understanding that is retained in students' long-term memory [8]. The main strength of the POE model lies in its ability to address misconceptions and significantly improve the quality of students' conceptual understanding [9]. Therefore, the development of this POE-based ELECTRONIC WORKSHEET is highly necessary, especially for measurement material, to overcome the low level of conceptual understanding and misconceptions still experienced by students. The objectives of this study are to describe the design of the developed ELECTRONIC WORKSHEET and determine its validity level, ensuring that it is feasible and suitable for use in the school learning process.

II. METHOD

This research is categorized as development research, also known as design research. The development process employs the Plomp model, which is designed to develop and validate products to ensure they are suitable for use [13]. In this study, the product to be designed is ELECTRONIC WORKSHEET based on the Predict-Observe-Explain (POE) model for the Physics topic of measurement at Senior High School level. The research procedure consists of three stages: (1) Preliminary Research; (2) Development or Prototyping Phase; and (3) Assessment Phase. The development process in this study is limited only to the second stage, namely the Development or Prototyping Phase, specifically at the expert review step.

The first stage is preliminary research, which includes needs and context analysis, and literature review. Needs and context analysis for students is carried out by administering student needs analysis instruments and examining previous learning outcomes to determine their level of understanding of the material that has been studied. Meanwhile, needs analysis for teachers is conducted using an instrument containing several fundamental questions regarding the use of teaching materials in Physics learning, teachers' needs for teaching materials, the implementation of learning models, and teachers' assessment results of students. A literature review is also conducted to examine the use of teaching materials and appropriate learning models, aiming to enhance students' conceptual understanding of the material, support the effectiveness of the learning process, and consequently improve student learning outcomes.

Second, the development or prototype stage. There are two stages in this phase: prototype design and formative evaluation, followed by prototype revision. At this prototype design stage, the goal is to design several prototypes, evaluate them, and revise them repeatedly to achieve good results. Meanwhile, formative evaluation and prototype revision were conducted to test the validity of the prototype, beginning with self-evaluation by the researchers themselves. Then, the prototype is validated by experts (expert review).

The instruments used to collect data in this study are applied in two stages: the preliminary stage and the development stage. In the preliminary stage, instruments for analyzing the needs of students and teachers are administered. The development stage involves the use of a self-assessment instrument and a validation instrument. The validation instrument for experts is developed based on several components, namely content/material, language, presentation, graphic design, application of the Predict-Observe-Explain (POE) model in ELECTRONIC WORKSHEET, and digital media aspects.

The instrument validity analysis technique for experts using Aiken's V validity index (V) is formulated as follows [14].

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

Categories based on Aiken's V index are shown in Table 1.

Table 1. Aiken's V validity index

Interval	Kategori
V<0,92	Tidak Valid
V>0,92	Valid

The product underwent expert validation to assess its accuracy and appropriateness. During this process, experts provided feedback and recommendations, which were subsequently incorporated to refine and enhance the developed products.

III. RESULTS AND DISCUSSION

Results

1. Preliminary Research Stage

In the preliminary research stage was carried out by administering student needs analysis instruments and teacher needs analysis instruments containing several questions to teachers at SMAN 4 Sumatera Barat. The student needs analysis involved 92 Grade X students of Phase E. Through this analysis, information was obtained regarding student characteristics, the implementation of physics learning, the use of teaching materials, and students' needs for teaching resources. The results showed that 64% of students still experienced difficulties in understanding physics concepts. Meanwhile, the findings from the teacher needs analysis revealed that the learning models and teaching materials currently used have not been effective in improving students' conceptual understanding of the measurement topic. Innovations in the form of experimental activities and appropriate learning models are therefore required to enhance conceptual understanding and support better quality learning.

2. Development Stage Results

2.1. POE (Predict-Observe-Explai)-Based ELECTRONIC WORKSHEET Design

This phase focuses on design teaching materials in the form of ELECTRONIC WORKSHEET to improve students' conceptual understanding of the measurement topic. The model applied in this ELECTRONIC WORKSHEET is the Predict-Observe-Explain (POE) learning model. Its structure is developed in accordance with the teaching material development guidelines issued by the Ministry of National Education (Depdiknas, 2008). The designed structure consists of: (1) Cover/Title; (2) Learning Instructions; (3) Learning Outcomes; (4) Supporting Information; (5) Work Procedures (experimental activities); and (6) Assessment. Several illustrations of the structure of the POE-based learning model implemented in ELECTRONIC WORKSHEET are presented in Table 2.

Table 2. POE (Predict-Observe-Explai)-Based ELECTRONIC WORKSHEET display

Structure E-worksheet	ELECTRONIC WORKSHEET Display	Explanation
1. Cover Page/ Title Page		The cover serves as the outer section of the ELECTRONIC WORKSHEET, containing the identity and distinctive features of the teaching material itself. It includes the title of the ELECTRONIC WORKSHEET, the author's name, institutional logo, institution name, and information indicating that this material is intended for Grade X students of Senior High School/Islamic Senior High

			School, Phase E. It also features illustrations representing the content covered in the ELECTRONIC WORKSHEET. The cover is designed with attractive colors and visuals.
2.	Learning Instructions		This section functions as a guide for students in using the ELECTRONIC WORKSHEET and facilitates the learning process. It comprises a prayer before learning and an explanation regarding the ELECTRONIC WORKSHEET to be used.
3.	Learning Outcomes		The formulation of learning outcomes refers to the applicable curriculum—specifically the Kurikulum Merdeka (Independent Curriculum) used in this ELECTRONIC WORKSHEET. This section covers learning outcomes, learning objectives, and the learning objective flow to be achieved. Indicators are formulated in alignment with the established learning outcomes. The added learning objectives are derived from the learning outcomes concerning measurement, consisting of four points. Meanwhile, the learning objective flow serves to provide clear direction for learning activities.
4.	Supporting Information		This section contains fundamental learning theories and references used. The theoretical foundation provides a brief explanation of the material students will work on, serving as a reference for completing practical activities. In addition to subject matter, this section also includes references to indicate the sources of the content being studied. Furthermore, learning videos are provided in this section as supplementary material.

		
5. Work edures erimental vities)	  	This section is developed based on the Predict-Observe-Explain (POE) model and is structured according to its stages. It includes: students' initial hypotheses (prediction) regarding the practical work to be carried out; the observation component, which lists tools and materials, detailed activity steps, and data analysis; and the explanation component, where students are required to relate their initial predictions to the results obtained from the observations.
6. Assessment		This section contains exercises and questions that students must complete after finishing the practical activities.

2.2. Self-Evaluation

After designing the ELECTRONIC WORKSHEET, the researcher proceeded to the self-evaluation stage. Self-evaluation involves checking the completeness of the material, revising any errors, and adjusting sections by adding or removing content as required. The results of the self-evaluation conducted by the researcher indicate that the prototype design of the ELECTRONIC WORKSHEET is complete, both in terms of its structural arrangement and the stages of the Predict-Observe-Explain (POE) learning model. The assessed aspects refer to established indicators, covering the characteristics of ELECTRONIC WORKSHEET, its components, its design, and the syntax of the POE model. In the graph, each indicator aspect is presented on the X-axis, while the score for each component is plotted on the Y-axis within an XY coordinate system. The mapped score data for each indicator from the self-evaluation is presented in Figure 1.

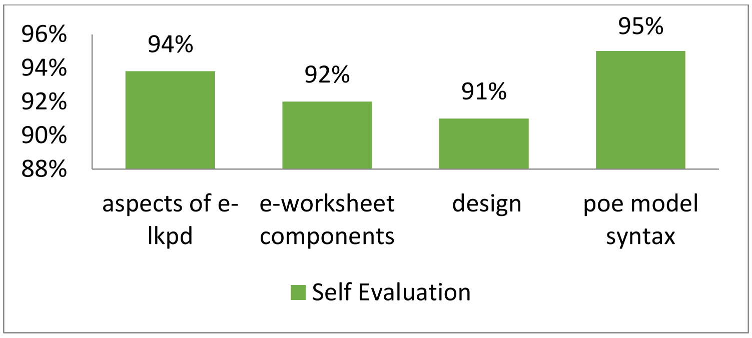

Fig. 1. Self-Evaluation Results

Based on Figure 1, the average scores for each indicator aspect in the self-evaluation of the POE-based ELECTRONIC WORKSHEET on measurement material vary, ranging from 91% to 95%. The overall average score obtained from the self-evaluation is 93%, meaning all indicators fall into the very good category. The assessment results of the four evaluated aspects confirm that the POE-based ELECTRONIC WORKSHEET on measurement material developed by the researcher is classified as very good.

2.3. Validation test (*Expert Review*)

The validation results of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material were obtained through validation instruments completed by three experts, namely lecturers from the Physics Department of the Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang. These validation data were used as a reference for revising the ELECTRONIC WORKSHEET and as a basis for assessing the feasibility of the developed product. The validation instrument consists of six assessment components: content/material appropriateness, language suitability, presentation quality, graphic design quality, appropriateness of the POE model in ELECTRONIC WORKSHEET, and media/digital aspect feasibility. Each component in the validation instrument comprises measurable indicators.

a. Content / Material Appropriateness

This component includes the following indicators: (1) the material in the developed POE-based ELECTRONIC WORKSHEET is in accordance with the established Learning Outcomes and Learning Objectives; (2) the concepts/theories presented are scientifically correct; (3) the material is relevant to scientific developments and real-world phenomena; (4) activities clearly incorporate the Predict–Observe–Explain stages; and (5) questions and activities relate to daily life phenomena and demonstrate good readability. In the graphical representation, indicators of material substance are plotted on the X-axis, while the average score of each indicator is plotted on the Y-axis. The plotted data for the content/material appropriateness component is presented in Figure 2.

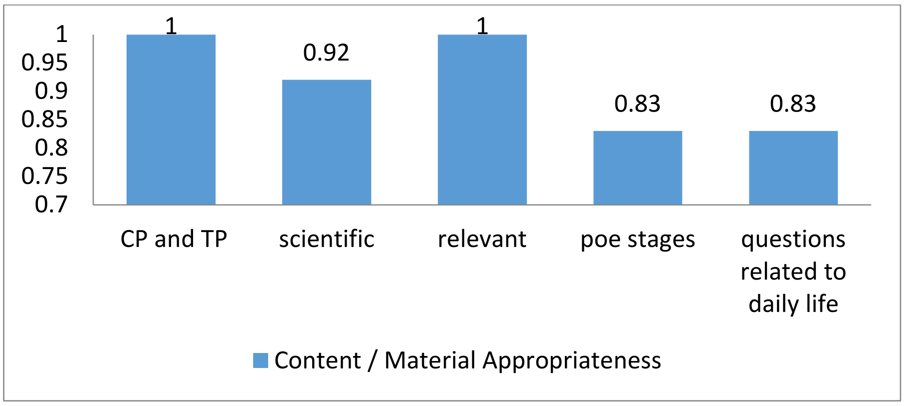

Fig. 2. Validation Results of Content / Material Appropriateness

Based on Figure 2 above, it can be seen that the scores for content/material indicators range from 0.83 to 1.0. The validity scores obtained for each indicator are as follows: alignment with Learning Outcomes and Learning Objectives (1.0), scientific accuracy (0.92), relevance to scientific developments and real phenomena (1.0), clear presentation of POE stages (0.83), and questions relating to daily life phenomena (0.83). Therefore, the average validity score for the content/material component is 0.92. This indicates that the content/material appropriateness of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material falls into the valid category.

b. Language Suitability

This component includes the following indicators: (1) instructions and questions in the POE-based ELECTRONIC WORKSHEET are easy to understand; (2) language use is appropriate to the students' education level; (3) writing conforms to correct and standard Indonesian language rules; and (4) terms and symbols are used consistently throughout the material. In the graphical representation, indicators of language suitability are plotted on the X-axis, while the average score for each indicator is plotted on the Y-axis. The plotted data for each indicator of language suitability is presented in Figure 3.

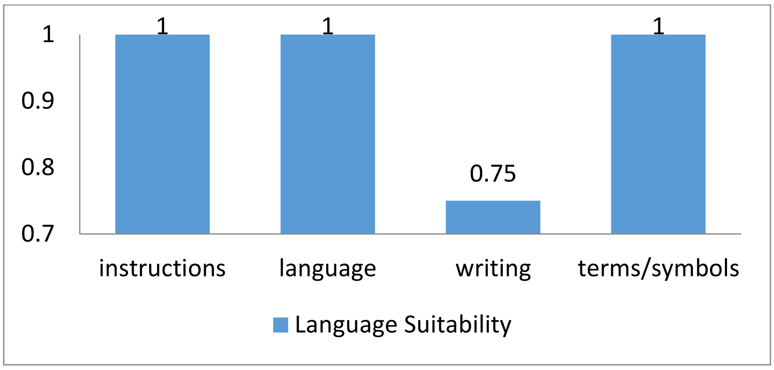

Fig. 3. Results of Language Suitability Component Assessment

Based on Figure 3 above, it can be seen that the scores for language suitability indicators range from 0.75 to 1.0. The average scores obtained for each indicator are: ease of understanding instructions (1.0), language appropriateness to student level (1.0), compliance with Indonesian language rules (0.75), and consistency of terms and symbols (1.0). Consequently, the average validity score for the language suitability component is 0.94. This means that the language suitability of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material is categorized as valid.

c. Presentation Quality

This component includes the following indicators: (1) clear learning objectives; (2) appropriate title corresponding to the material; (3) correct formulation of Learning Outcomes aligned with the content; (4) clear supporting information; (5) clear and easy-to-follow work procedures; (6) appropriate assessment and evaluation sections; (7) systematic presentation structure; and (8) clear activities that foster interaction during the learning process. In the graphical representation, indicators of learning design assessment are plotted on the X-axis, while the average score for each indicator is plotted on the Y-axis. The plotted data for each indicator is presented in Figure 4..

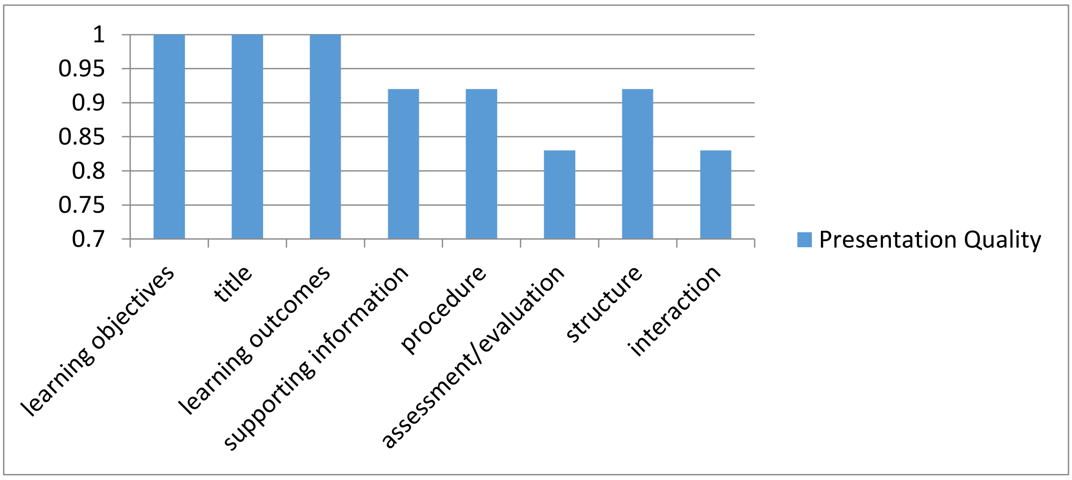

Fig. 4. Results of the Presentation Quality Component Assessment

Based on Figure 4 above, the scores for presentation quality indicators range from 0.83 to 1.0. The average scores obtained for each indicator are: clear learning objectives (1.0), appropriate title (1.0), correct Learning Outcomes (1.0), clear supporting information (0.92), clear work procedures (0.92), appropriate assessment (0.83), systematic structure (0.92), and interactive activities (0.83). Therefore, the average validity score for the presentation quality component is 0.93. This indicates that the presentation quality of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material is categorized as valid.

d. Graphic Design Quality

This component includes the following indicators: (1) proportional font type and size; (2) appropriate layout and subheading arrangement; (3) attractive illustrations, images, and photographs; and (4) high-quality visual design. In the graphical representation, indicators of graphic design quality are plotted on the X-axis, while the average score for each indicator is plotted on the Y-axis. The plotted data for each indicator of graphic design quality is presented in Figure 5.

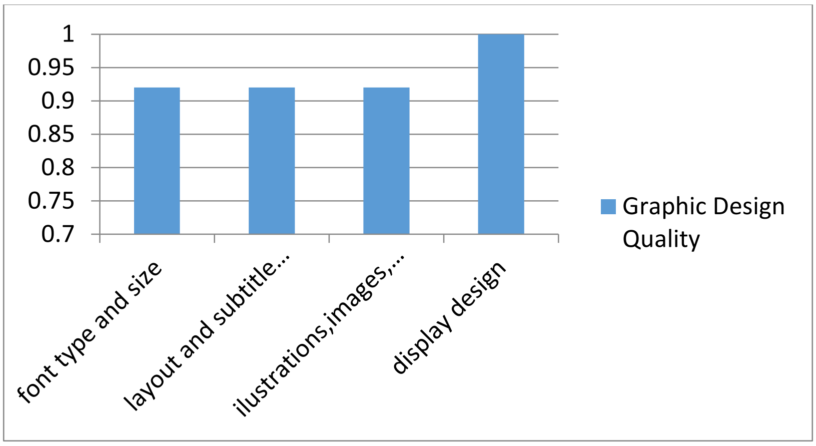

Fig. 5. Results of Graphic Design Quality Component Assessment

Based on Figure 5 above, the scores for graphic design quality indicators range from 0.92 to 1.0. The average scores obtained for each indicator are: font type and size (0.92), layout and subheading arrangement (0.92), illustrations and images (0.92), and visual design (1.0). Consequently, the average validity score for the graphic design quality component is 0.94. This means that the graphic design quality of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material falls into the valid category.

e. Appropriateness of the POE Model in ELECTRONIC WORKSHEET

This component includes the following indicators: (1) the ELECTRONIC WORKSHEET contains the Prediction stage, which helps students predict or make assumptions about a phenomenon; (2) the ELECTRONIC WORKSHEET contains the Observation stage, which guides students in carrying out experimental activities; and (3) the ELECTRONIC WORKSHEET contains the Explanation stage, which assists students in explaining the correspondence or discrepancy between their initial assumptions and the experimental results obtained during the observation stage. In the graphical representation, indicators for the appropriateness of the POE model are plotted on the X-axis, while the average score for each indicator is plotted on the Y-axis. The plotted data for each indicator is presented in Figure 6.

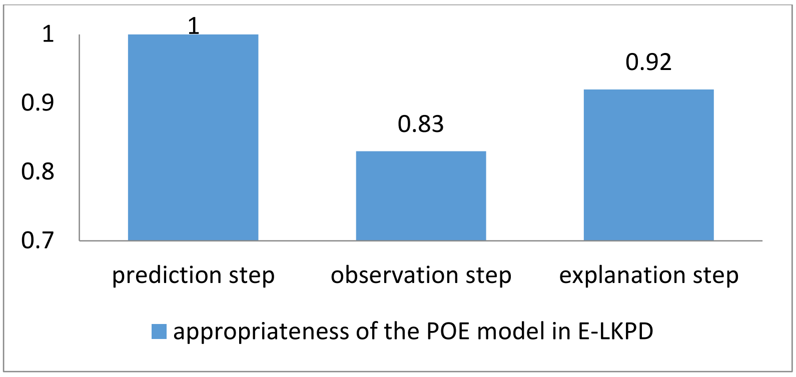

Fig. 6. Results of appropriateness of the POE model in ELECTRONIC WORKSHEET Quality Component Assessment

Based on Figure 6 above, the scores for these indicators range from 0.83 to 1.0. The average scores obtained for each indicator are: Prediction stage (1.0), Observation stage (0.83), and Explanation stage (0.92). Consequently, the average validity score for this component is 0.92. This indicates that the appropriateness of POE model implementation in the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material is categorized as valid.

f. Media/Digital Aspect Feasibility

This component includes the following indicators: (1) the ELECTRONIC WORKSHEET enables students to interact with the content; (2) videos, audio, or animations used are relevant to the material; (3) the ELECTRONIC WORKSHEET is easily accessible across various devices (mobile phones/laptops); and (4) the interface design is easy to understand and user-friendly for students. In the graphical representation, indicators for media/digital feasibility are plotted on the X-axis, while the average score for each indicator is plotted on the Y-axis. The plotted data for each indicator is presented in Figure 7.

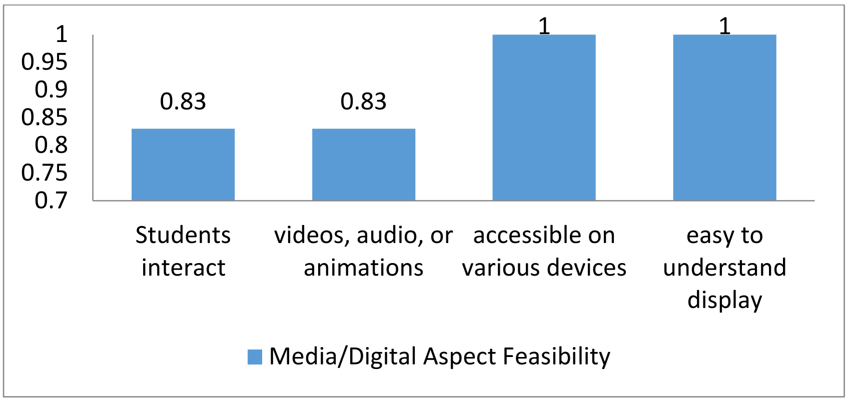

Fig. 7. Results of Media/Digital Aspect Feasibility Quality Component Assessment

Based on Figure 7 above, the scores for these indicators range from 0.83 to 1.0. The average scores obtained for each indicator are: interactivity (0.83), relevance of multimedia content (0.83), accessibility across devices (1.0), and ease of use and interface clarity (1.0). Consequently, the average validity score for the media/digital aspect is 0.92. This means that the media/digital aspect feasibility of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material falls into the valid category.

The following presents the plotted data of scores for all components regarding the validity of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material, as shown in Figure 8.

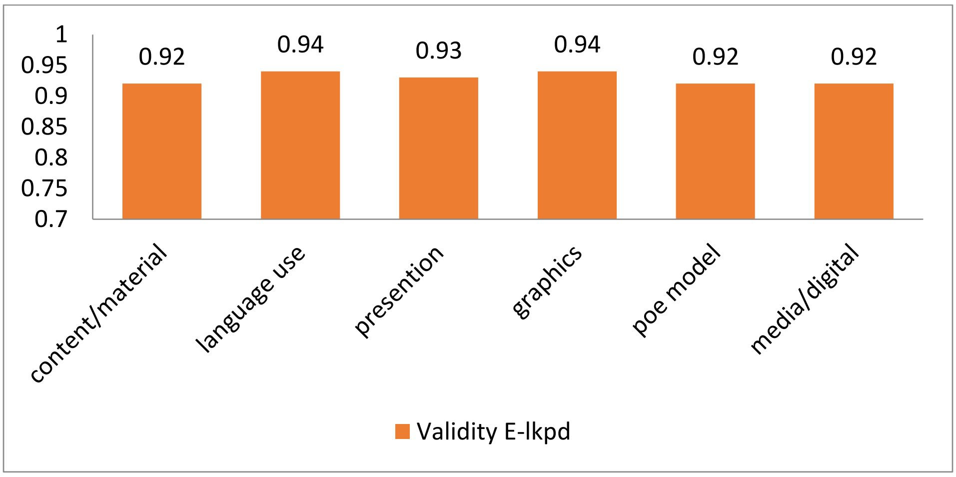

Fig. 8. Validity Result

Based on Figure 8, it can be seen that the average validity score of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material, calculated from the six assessment components, is 0.93. Accordingly, the validity level of the POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET on measurement material is categorized as highly valid.

Discussion

In the preliminary stage, analysis of conceptual understanding and learning outcomes conducted at SMAN 4 Sumatera Barat revealed that students' learning outcomes in the measurement topic were still relatively low and had not reached the established mastery criteria. This is evident from the average scores of the Mid-Semester Assessment, which remained below the Learning Achievement Criteria of 75. Specifically, class X E.1 obtained an average score of 68.8, class X E.2 scored 56.2, and class X E.3 only reached 42.9. These low learning outcomes occur because students tend to merely memorize material without understanding concepts deeply, and they require a long time to master Physics content [2]. Furthermore, the worksheets used so far only contain direct procedural steps, failing to guide students to predict phenomena prior to making observations. In fact, the prediction stage is crucial for stimulating students' critical and creative thinking, and providing them with the opportunity to compare their initial ideas with discovered facts [8]. Interviews with teachers also showed that the learning models implemented to date have been direct instruction and problem-based learning. Although these models have involved students in learning activities, they have not specifically facilitated the gradual and systematic development of conceptual understanding. Additionally, the teaching materials used have not fully supported effective interaction between teachers and students, nor have they accommodated students' learning needs in the current digital era. Based on these preliminary findings, POE (Predict-Observe-Explain)-based ELECTRONIC WORKSHEET was developed as a solution to address the challenges encountered in teaching and learning the measurement topic.

Subsequently, three main research findings were obtained during the development or prototyping stage. First, an initial design of POE-based ELECTRONIC WORKSHEET was produced, structured in accordance with the characteristics of measurement material and the learning needs of senior high school students. In this stage, the researcher designed the structure and content of the ELECTRONIC WORKSHEET by referring to guidelines for developing digital teaching materials suitable for use in learning [15]. This ELECTRONIC WORKSHEET was developed using Canva Pro to design the layout, arrange content, and edit materials, and was packaged using Heyzine Flipbook to enable access in the form of attractive and interactive digital pages. Heyzine Flipbook was selected due to its ease of use, ability to display content such as text, images, animations, and learning videos, accessibility via links that can be opened on mobile phones or computers, and freedom from advertisements that might distract students during the learning process [12].

Second, a self-evaluation was conducted on the initial design that had been developed. The results indicated that the developed ELECTRONIC WORKSHEET fell into the very good category. This is because its preparation followed the teaching material development guidelines established by the Ministry of Education, Culture, Research, and Technology, in terms of presentation structure, completeness of components, and alignment with the intended learning objectives [15]. Moreover, this ELECTRONIC WORKSHEET systematically and sequentially integrates the stages of the POE learning model—from prediction and observation to explanation—so that students can follow the learning flow clearly and in a guided manner [6]. In terms of layout and language use, the ELECTRONIC WORKSHEET was also rated as good, as it uses communicative language that is easy for students to understand, and features an attractive design that prevents boredom. This is in line with research conducted by Anwar et al., which states that digital teaching materials developed with attention to appropriate structure, alignment with learning model syntax, and appealing visual design will achieve a very good rating at the self-evaluation stage [15].

Third, the feasibility test or validation of the POE-based ELECTRONIC WORKSHEET prototype was carried out through assessment by experts, consisting of three validators with expertise in relevant fields. The assessment results showed that overall, the developed prototype falls into the valid category and is deemed suitable for use in the learning process. The assessment covered six feasibility components: (1) content/material appropriateness; (2) language suitability; (3) presentation quality; (4) graphic design quality; (5) appropriateness of POE model implementation in ELECTRONIC WORKSHEET; and (6) media/digital aspect feasibility. These six components cover key criteria that must be fulfilled to ensure ELECTRONIC WORKSHEET not only aligns with learning principles but is also easy to understand, engaging, and functions effectively as a technology-based learning tool [4].

The validation result for the first component, content/material appropriateness, is categorized as valid. Assessment of this component includes alignment of material with Learning Outcomes and Learning Objectives, scientific accuracy of concepts, relevance of material to scientific developments and real-world phenomena, presentation of activities incorporating Predict-Observe-Explain stages, and connection of material to daily life events. The results confirmed that all material presented in the ELECTRONIC WORKSHEET is structured in accordance with the scope of content, indicators, and requirements of Learning Outcomes and Learning Objectives for the measurement topic within the Independent Curriculum. From a scientific perspective, the concepts presented are accurate, up-to-date, free from misconceptions, and relevant to developments in Physics and real phenomena in the surrounding environment. Furthermore, the material and activities integrate the stages of the Predict-Observe-Explain model, link content to everyday events, and are arranged systematically and logically—from basic concepts to more complex applications—making it easier for students to understand the material thoroughly and comprehensively. This aligns with the view of Fadhillah and Khairunisa, who emphasize that the substance of teaching materials must be developed based on the applicable curriculum, ensure scientific accuracy of concepts, and be aligned with intended learning objectives to optimally support students' competency achievement [16], [17].

The validation result for the second component, language suitability, is also categorized as valid. Assessment of this component includes clarity of instructions and questions, appropriateness of language to education level, adherence to Indonesian language rules, and consistency in the use of terms and symbols. Findings show that the sentences used are communicative, concise, and free from ambiguity. Scientific terms and their explanations are accurate and consistent throughout the ELECTRONIC WORKSHEET. The language is also adapted to the cognitive development and thinking abilities of senior high school students, ensuring content is conveyed clearly without causing confusion. Overall, the language aspect meets feasibility standards. Nonetheless, validators provided suggestions to revise several sentences for better compliance with Indonesian language rules. This is consistent with Hidayat's statement that the use of simple, clear, and precise language is essential in teaching materials to enable students to understand information easily and accurately [5].

The validation result for the third component, presentation quality, is categorized as valid. Assessment of this component includes clarity of learning objectives, alignment between title and content, alignment with Learning Outcomes, clarity of supporting information, ease of understanding work procedures, completeness of assessment/evaluation instruments, systematic structure of presentation, and ability to foster interaction during the learning process. Results indicate that learning objectives and Learning Outcomes are formulated clearly and match the presented material. The title used is also appropriate and representative. Supporting information, activity guidelines, and work procedures are presented sequentially and clearly, allowing students to use the ELECTRONIC WORKSHEET independently or in groups. Material is presented gradually and systematically, supported by adequate assessment and evaluation instruments, though validators suggested adding evaluation sections within each activity. Additionally, the activity design effectively encourages interaction and active engagement, guiding students to discover concepts rather than merely receive information. This aligns with the theory stating that organized content with a clear flow helps students build knowledge in a continuous and progressive manner [7].

The validation result for the fourth component, graphic design quality, is categorized as valid. This aspect includes proportionality of font type and size, appropriateness of layout and subheading arrangement, attractiveness of illustrations, images, and photographs, as well as the overall visual design quality. The assessment shows that the selected font types and sizes are well-adjusted, ensuring readability and visual comfort. The layout and placement of subheadings are arranged accurately and in a balanced manner. The illustrations, images, and photographs presented are of good quality, visually appealing, and relevant to the discussed material. In general, the visual design of the electronic module is neat, consistent, and professional. This aligns with Hidayat's view, which states that layout, color composition, and the arrangement of every component must be organized in a balanced, harmonious, and coherent way, so that the teaching material appears attractive and can motivate students to learn [5].

The validation result for the fifth component, appropriateness of POE model implementation in ELECTRONIC WORKSHEET, is categorized as valid. This component assesses the suitability and clarity of the Prediction, Observation, and Explanation steps in guiding students through learning activities. The findings confirm that the POE model syntax has been applied systematically, comprehensively, and well-integrated within the ELECTRONIC WORKSHEET. In the Prediction stage, clear instructions guide students to state their initial assumptions or hypotheses before carrying out activities. In the Observation stage, the provided activities effectively facilitate students to make observations, conduct experiments, and collect data or facts directly. Furthermore, in the Explanation stage, students are guided to analyze and explain the similarities or discrepancies between observation results and initial predictions, as well as to draw scientifically sound conceptual conclusions. This structured implementation of POE stages aims to support students in constructing correct conceptual understanding and helps correct any misconceptions that may arise [2]. This is consistent with Gunstone and White's view, which states that the structured application of POE stages is highly effective in training students' critical thinking skills and conceptual understanding [7].

The validation result for the sixth component, media/digital aspect feasibility, is categorized as valid. Assessment of this component covers interactivity, relevance of videos, audio, or animations to the material, accessibility across various devices, and ease of understanding and using the interface by students. The results indicate that the ELECTRONIC WORKSHEET is designed interactively and equipped with multimedia content — including videos, audio, and animations — that is relevant and supportive for understanding the material. This media can be easily accessed via various devices, such as mobile phones or computers, through the provided link. The user interface is designed to be simple, intuitive, and informative, making it very easy to understand and use for both students and teachers. The use of Heyzine Flipbook and Canva Pro is considered appropriate, as these applications are capable of displaying digital content in high quality, stably, and in an engaging manner [12]. This demonstrates that the technical and technological aspects used meet the feasibility requirements for an effective digital-based teaching material.

Based on the assessments provided by three experts regarding the six evaluation components, the average validity score of the POE-based ELECTRONIC WORKSHEET is 0.93, placing it in the valid category. This result indicates that all elements within the ELECTRONIC WORKSHEET—including content/material, language, presentation, graphic design, application of the POE model, and digital media aspects—have been appropriately structured and are suitable for use. Naturally, this research and development process had certain limitations; therefore, experts provided suggestions and feedback to further refine and improve the quality of the ELECTRONIC WORKSHEET. These inputs were then used as references for revision and enhancement, ensuring that the final product is of high quality and truly feasible for implementation in learning activities. These validation findings are consistent with previous studies, such as research by Rianita, who developed POE-based teaching materials for the topic of quantities and units [9], and Ilahi, who designed digital teaching materials based on a constructivist approach for vector material [18]. Other studies involving POE-based teaching materials for topics such as optics [6] and kinematics [3] also reported similar results, confirming that the developed teaching materials were declared valid and suitable for use in terms of content appropriateness, presentation quality, and learning interface design.

IV. CONCLUSION

Based on preliminary research, an interactive ELECTRONIC WORKSHEET based on the Predict-Observe-Explain (POE) model has been designed for the measurement topic for Grade X students of Senior High School/Islamic Senior High School, with the following characteristics: (1) the ELECTRONIC WORKSHEET is structured according to the POE learning model, consisting of activities of predicting, observing & measuring, explaining understood concepts, and evaluation; (2) the ELECTRONIC WORKSHEET is developed using Canva Pro and Heyzine Flipbook; (3) the POE-based ELECTRONIC WORKSHEET obtained a validation score of 0.93, categorized as valid in terms of content/material appropriateness, language, presentation, graphic design, application of the POE model, and digital media aspects.

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