Validity of physics e-handouts based on the STEM approach to improve students' knowledge competency

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Abstract. Physics e-handouts based on the STEM approach to improve students' knowledge competence is able to facilitate students to increase knowledge optimally. Before using this e-handout, an e-handout feasibility test is needed. The purpose of validation is to determine the suitability of e-handout with physics learning material by using the Aiken’s V formula by 4 validators. Data collection by questionnaire method. Validation is assessed from 3 aspects, first the Material Substance Eligibility with a value of 0.80 is a valid category, secondly a visual display worthiness obtained of a value of 0.85 with a valid category. Third, the feasibility of the learning design obtained a value of 0.81 with a valid categorization. The overall conclusion is that the validity value of the physics e-handout based on the STEM approach is 0.82 with a Valid category. So that e-handouts are appropriate to be used in physics learning to improve the competency of high school students' XI knowledge.

1. Introduction
In 21st century learning expects the emergence of quality human resources in the era of technology and digitalization. This is in accordance with the objectives of the 2013 curriculum education by expecting student-centered learning which is expected that students have the ability to understand, analyze, apply and evaluate in an effort to increase the knowledge competence of students. Educators are the main key to the success of students in learning. Learning activities at school, teaching materials are needed as a tool for teachers in the classroom to achieve learning objectives [1]. From observations that have been made in several schools in the city of Padang, several facts have been found including, there has been no development of teaching materials in an effort to train the independence of students in learning. One of the teaching materials that can be developed is non-printed teaching materials in the form of e-handouts. The existence of non-printed teaching materials helps teachers achieve learning goals. This is because students are more interested in learning new things that are more interactive and challenging.

An interesting learning process cannot be separated from the teacher's creativity in creating an active and enjoyable learning atmosphere. During the learning process the teacher must be creative in creating a pleasant atmosphere. The use of teaching materials is one way to create an active and fun learning atmosphere that can increase student motivation. One form of teaching material that is currently interesting to develop is electronic teaching materials, namely e-handouts. An electronic handout is an electronic version of a pre-printed handout that can be read on a computer and designed with the required software. E-handout is a learning tool or tool that contains materials, methods,
assessment techniques are designed systematically and attractively to help improve the achievement of student competencies that are expected to be in accordance with the level of complexity in the current digitalization era [2]. E-handout is a brief learning material that is sourced from several literature that is relevant to basic competencies and the main material taught to students to make it easier to follow the learning process. Furthermore, in the preparation of e-handouts, there are several structures in the e-handout. [3] The structure of the e-handout is as follows: a) The title is an e-handout identity, namely the name of the school, class, name, subject, e-handout and so on. b) Supporting information in the form of information related to the material and concept of the lesson to be taught, based on relevant sources.

A learning approach that can increase the knowledge competence of students, one of which is integrates science, technology, engineering and mathematics into an approach that can help students to achieve student knowledge competencies is the STEM learning approach. Learning with the STEM approach in e-handout is an integration of learning science, technology, engineering, and mathematics, one of the suggested approaches to help the success of 21st century learning skills [4]. The STEM approach develops with learning that connected with the natural surroundings, so that concrete learning with events that can be directly tried out in everyday life by students [5]. so that through the STEM approach students have an understanding of the concept which is not only memorized but directly applied in a concrete manner. the goal is that students’ understanding of concepts is achieved and understand scientific concepts and their relationship to everyday life [5].

In the learning process so that the developed e-handouts can increase the knowledge competence of students, the e-handouts must be of high quality. One of the quality e-handouts must have high validity. The validity (validity) of e-handouts is generated from the results of expert expert assessments (expert reviews) of the results of product development which indicate meaning, conformity and usefulness [6].

The level of validity of the e-handout consists of several components, namely validation of the material substance (validity of content or material and language), validation of learning designs (suitability of titles, learning objectives, presentation order, use of fonts, layouts, illustrations and pictures, learning design) and validation. display (visual communication aspects of language and clarity of information) [7]. Validity criteria were used to assess the validity of the e-handout developed [8].

Based on the explanation above, it is necessary to assess or validate e-handouts based on the STEM approach to improve the knowledge competence of high school students to ensure the appropriateness of using e-handouts as an answer in overcoming learning problems that have emerged so far.

2. Research Methods
This type of research is research and development, with the selection of the development model used is the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model [9]. Validity is carried out at the development stage of the ADDIE model sequence. Development is the realization of the design process into reality. This means that if the design is still a planning framework, then the development of digital e-handouts must be developed. It is important during the development stage, one of which is testing the validation of the validation experts before it is implemented [10].

The e-handout developed is validated first by an expert who acts as a validator. The validation of the e-handout aims to see the correctness of the concepts, forms, appearance and grammar used in the e-handout as well as the impact indicators developed. Validation is a process to determine the benefits or failures of a product based on material, construction and language criteria. The main part of the validated e-handout is the suitability of the material presented does not deviate from the truth of science, conformity with the depth of the material, conformity with scientific developments and the use of grammar that smells and is easy to understand [11]. The validation process is complete if the validator states that it is valid for the e-handout so that it is ready to be tested. Revisions and input from the validator were used to improve the e-handout developed. Validation was carried out using the e-handout validation sheet and the practicality instrument was filled in by the practitioner.
The stages of testing the validity of the e-handout by the validator are: 1) the validator lecturer is asked to be willing to see the feasibility of the e-handout and see the truth of the physics learning concept in the e-handout, 2) the validator lecturer provides an assessment of the e-handout product based on a scale the assessment that is on the validity instrument sheet. 3) then revised according to suggestions from the validator.

In this study, the validity data collection instrument consisted of an instrument validation sheet and an e-handout validation sheet [12]. The validity analysis uses a Likert scale based on the validation sheet, with the following steps: 1) scoring for each item with alternative answers: (4 = Strongly Agree, 3 = Agree, 2 = Disagree, 1 = Strongly Disagree), 2) Adding up the total score of each validator for all indicators, 3) Granting validity values using the Aiken formula in Equation 1.

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

Where:
- \( s = r - lo \)
- \( lo = \) the lowest number of validity assessments (in this case = 1)
- \( c = \) the highest number of validity assessments (in this case = 4)
- \( r = \) Number given by the validator

The validity criteria can be seen in Table 1 below:

| No | Criterion |
|----|-----------|
| 1  | ≥ 0.6     | Valid    |
| 2  | ≤ 0.6     | Tidak valid |

(Source: Azwar, 2015) [13]

3. Results and Discussion

The results of the e-handout design at the design stage are then developed at the development stage. The e-handout that has been designed is tested for its validity. The validation process was carried out by 4 validator lecturers from UNP. The validation results are explained as follows:

3.1. Instrument Validation Results

The product validation process is carried out after conducting instrument validation first which aims to determine the assessment tool for the material to be assessed so that the instrument really assesses what should be assessed [14]. To get a valid data collection instrument, an instrument assessment was carried out which was validated by 4 instrument validators showing that the e-handout validation sheet was categorized as valid. Then the results of the instrument validation assessment with a value of 0.92. the value of the validation instrument is greater than the value of \( V \) so that it is categorized as valid, meaning that the instrument can be used.

3.2. Results of the e-handout validation

After validating the instrument, the e-handout validation process is then carried out. The e-handout validation instrument consists of 3 components as follows: the feasibility component of the material substance, the learning design component, the visual communication display component. The instrument uses an easy to understand, simple assessment format and the language used is in accordance with good and correct language rules. The results of the e-handout validation can be seen in Table 2.

| No | Evaluated Aspect       | K    | Criterion |
|----|------------------------|------|-----------|
| 1  | Validity of Material Substance | 0.80 | Valid     |
| 2  | Validity of visual appearance | 0.85 | Valid     |
| 3  | Validity of learning design | 0.81 | Valid     |
Table 2 explains that the average validation value of the four expert lecturers is 0.82 in the valid category. This shows that the physics e-handout based on the STEM approach is feasible and can be used in the learning process to assist enrichment activities. In the aspect of the feasibility of the material substance, the results obtained are 0.82, this shows that the main content or the essence of the material in the e-handout is declared valid and suitable for use in the development of e-handouts. The presentation of the material is in accordance with the depth of the material, the presentation is in accordance with the development of science and finally the presentation of the e-handout uses standard and understandable grammar. Both aspects of the feasibility of visual appearance obtained results of 0.85 so that it can be said that the display on the e-handout can be seen clearly by the eye and declared valid. The assessment items on the component of display validity (visual communication) include: readability of e-handouts, clarity of information on e-handouts, conformance to good and correct Indonesian rules, use of language effectively and efficiently (clear and concise), easy access between slides, proportional between the size of the letters and the size of the display, the images, sounds, videos that are displayed in accordance with the material presented, good color harmonization, and the display design of e-handout teaching materials. Then in the learning design aspect, a value of 0.81 was obtained, this shows that the preparation of communication technology media and the contents of the e-handout is feasible and can be applied to the development of e-handout teaching materials because it has been declared valid by the validator lecturer. For the learning design component, the assessment items consist of the suitability of the title with the material, the suitability of KI and KD, the suitability of indicators with the achievement of student competencies, material according to KI and KD, examples of questions presented in accordance with material achievement indicators, there is an identity of the compiler and displays a list of references. Those are some points of assessment on aspects of learning design that have obtained valid results.

4. Conclusion
From the results of the validity of the e-handout on the development of teaching materials based on the STEM approach by experts and practitioners, it is in the valid category. The validation of e-handout teaching materials for class XI SMA based on the STEM approach is stated to be feasible and valid in the aspects of material substance, learning design and visual communication display aspects with valid categories.

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