Digital Trainer (Diner) as the learning media to support dynamic electricity concept

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Abstract. The 2013 curriculum applies nationally to improve learners' thinking ability in high-level. Graduate Competency Standards include attitudes, knowledge, and skills. One of the problems in teaching and learning activities (KBM) is students have difficulties in understanding the concept of materials, especially Dynamic Electric materials. It because the classroom learning tends to be declarative, procedural activities (practicum) is not optimal as well as the availability of learning media to support the achievement of learning objectives. The study was conducted to determine the feasibility of digital trainer as a medium of learning in improving understanding the concept of Dynamic Electricity judging from the validity and implementation of learning and knowing the effectiveness of digital trainer as a medium of learning to improve understanding the concept of Dynamic Electricity. This research method follows the development phase of the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The digital trainer is designed in series electricity connected to electrical components and electronic devices which already exist in the community then modified with the addition of resistors, capacitors, and inductor as well as using LCD so that the result or measurement value can be read directly by the system. The props are simulated in classroom learning by taking the sample and then be evaluated. The results show that the digital trainer is valid as a medium of learning based on the validity of learning media along with the device, while based on digital trainer implementation is good used as learning media, and based on learning outcomes for the cognitive domain is declared valid so a digital trainer can be declared as viable and effective as learning media to improve the concept understanding of Dynamic Electricity.

1. Introduction

The 2013 curriculum is the improvement of Education Unit Level Curriculum (SBC) that has 3 spheres of assessment covering cognitive, skill, and affective. The learning objectives will be achieved using a scientific approach [1]. Physics is a branch of science that applies methods scientific approach in teaching and learning activities (KBM). Physical learning emphasizes on providing direct

experience so that learners are able to explore and understand nature scientifically [2]. Direct experience can be obtained by students by doing activities practicum [3]. Learners are faced with authentic problems, then the collection of data or information supported by related theories, then analyzed so that the ability to easier mastery of the material [4]. Especially on material that is abstract like electricity [5]. Electricity learning difficulties, among others, are caused by the weak mastery of concept, low mathematical ability, and inability to convert units [6]. The results showed that the average electrical learning difficulty occurs in sub-discussion: electric current, ohms law, obstacles of a type of carrier, Kirchoff II law, energy, electric power, and transformer. Activities labs can help improve learners' learning outcomes [7].

An electric current is defined as the rate of flow of electrical charge through an area cross-section. The direction of the current is considered in the direction of the positive charge flow. This convention is established before it is known that the free electrons, which are negatively charged, are particles which actually moves and consequently produces a current on the conductor wire. The motion of negatively charged electrons in one direction is equivalent to the positive charge flow in the opposite direction. Thus, the electrons move in the opposite direction of the current [5]. The Ohm Law state "The amount of electric current (I) flowing through a conductor or conductor will be proportional to the potential/voltage (V) effect applied to him and inversely with his obstacle (R), for example a river or a pipe affected by gravity." The current flow on the wire depends not only on voltage but also on the resistance provided by the wire to the electron. The edge of the river or the rocks that are on the middle of the river becomes an obstacle to the flow of the river, as well as the flowing electrons on electric current is also slowed by the interactions of the wire atoms, so that affects the magnitude electric current is not only a big voltage but also big barrier [8].

The electric current in the stream also has branched. When the electric current goes through branching, the electric current is divided into each branching and the magnitude depends on it whether or not the obstacles on the branch. The sound of Kirchhoff's Law I: "The strong amount of electric current that going into a node is equal to the strong amount of electric current coming out of the node. "As for the use of Kirchhoff's 2nd Law on a closed circuit that is because there is a series that can not be simplified using series and parallel combinations. Law II Kirchhoff reads: "In a closed circuit, the number of algebraic electric motion (ε) with the voltage drop (IR) is equal to zero"[9].

Preliminary data obtained from the results of pre-research in the form of questionnaires filled by students in SMA N 1 Tongas class XI IPA II that 87.5% of learners more easily understand physics by a practicum. 84.4% of students said the school has a practicum tool physics related to the dynamic electrical materials. 87.5% of learners say dynamic electrical material is difficult and 81% of students have difficulty working on dynamic electrical problems. As for that factor causing learners to have difficulty covering internal factors ie lack of interest and motivation of learners, while external factors are lack of media variations, and methods learning and lack experiments conducted directly by learners [10].

Learning media is a tool or a tool that is visible to clarify the message or information so as to facilitate and improve the process and learning outcomes [11]. Learning outcomes learners can be known by assessing the mastery of the material (cognitive) through pre-test and post-test, assessment of the ability to practice (skill) through the assignment results in LKPD (Student Work Sheets) and observation sheets, and assessment to attitudes (affective) through the observation sheet [12].

Based on observations made at the Basic Physics Laboratory of the State University of Surabaya, practicum tools on Dynamic Electric materials that exist today are still manual, inter-components separately so that learners have difficulty in assembling and understanding the concept of some subsection such as Ohm's Law, Kirchoff's Law, power supply. In addition, the interviews with physics class XI teachers were held. "Laboratories are in reconstruction so that practicum activities are not done well, primarily for electrical materials. The ability of learners also decreased in understanding the concept of matter. So in one class there are 2-3 students who are not doing remedial ", said Mr. Rudi Hariadi.

Interviews were also conducted on learners. "The schools have physics labs and various practicum tools, but not for dynamic electric. Tool labs are also rarely used. The dominant learning is textual," said Nur Kholis. The learning of dynamic electrical materials will be supported by the formation media props trainer.

Trainers or calculators in electrical circuits related to the components of electricity and electronics, which already exist in the community modified with the addition of resistors, capacitors, and inductors as well as using LCD so the results or measurement values can be directly known by practice. it will make it easier to practice in the lab. The object of this study is the upper secondary learner of SMAN 1 Tongas which located at the end of Probolinggo district, precisely in Tongas Wetan, Tongas. This research aims to determine the feasibility of Digital Trainer props in improving learning outcomes high school students of SMAN 1 Tongas on Dynamic Electrical materials.

2. Method

The research is the improvement of ADDIE (analysis, design, development or production, implementation or delivery, and evaluations) learning mode [13].

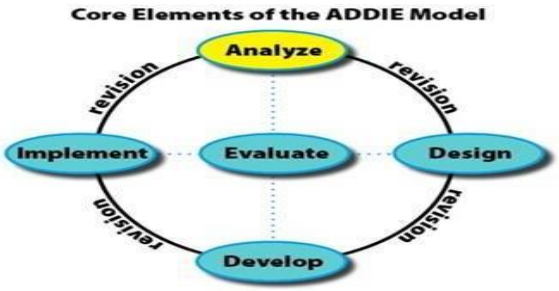

Figure 1. Chart of research methods [14].

ADDIE model is an easy model to use in which the process used is systematic with a clear framework to produce effective, creative, and efficient products [15]. ADDIE model is a design or learning model that can facilitate learners to develop the science process. They are cooperative, flexible, and adapt to a learning environment that is oriented towards the simulation structure [16].

The method used in this research covers the first stage, it is exploration study to analyze any problem or information related to the place of study, accompanied by literature study to align the results of data obtained with supported theories. Problem analysis stages carried out in SMAN 1 Tongas. Then, the trainer props design with details of the implementation such as the selection of electronic components and materials, design, and placement of a system. Digital trainers are developed with additions supporting components such as resistors, capacitors, and conductors.

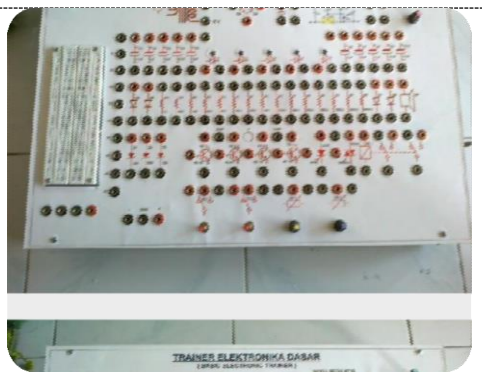

Figure 2. Component of *Trainer*.

Figure 3. *Digital Trainer*.

Stages of the work tool are done at the Physics Electronics Laboratory, Universitas Negeri Surabaya. Digital trainer simulation is conducted in a classroom learning simulation. To know the practicality tools, they are given pre-test as a means of measuring learners' knowledge at the beginning of learning. In the class simulation, students do a practicum with guidance given in LKPD when practicum activities of skills and attitudes assessment of the learners can be observed. After that, an error analysis is performed. The analysis is done with a material test (post-test). At the end of the learning, the learners are given a questionnaire to determine the interest of learners to follow class simulation. Evaluation is given to the error or deficiency in the simulation process and also props so that the error and shortcomings of the simulation process and props can be improved.

This research was conducted in SMAN 1 Tongas. The subjects of this study are Science learners. The type of research is descriptive quantitative research with pre-experimental approach design. The design of this study is one group pre-test and post-test design to know the results of the treatment provided. Instruments which is used in this study are pre-research questionnaires, attitude and skill observation sheets, LKPD, pre-test and post-test, and questionnaire response of learners to the class simulation by using digital trainer, learning tools include syllabus, instructional design, handout, LKPD, evaluation test, device validation sheet, media validation sheet, and learning report sheet. The validators are the lecturer from physic education and physic teacher SMAN Tongas. Media validators are electric technique lecturers, physic education lecturers, and physic teacher of SMAN 1 Tongas. The validators are expert lecturers in their field who are consulted to our advisor.

The data collection technique is doing instrument validation research to physics lecturer, physics teacher of SMAN 1 Tongas, and lecturer of media expert. While the data technique analysis performed is the analysis of learning effectiveness, analysis of pre-test and post-test result with n-gain score analysis, analysis of device validation sheet and media (props digital trainer) using calculations. Percentage rating scale and learners respond analysis related to class simulation with the digital trainer using Likert scale calculations.

The stags of props validation analysis and learning tools as follows the syllabus, instructional design, handout, LKPD, evaluation and lift sheets are done through expert lecturer validation sheet analysis. The percentage of this validation data is obtained based on Likert scale calculations as follows [17]:

a) 4 = Excellent
b) 3 = Good
c) 2 = Medium
d) 1 = Low

$$Percentage = \frac{number\ of\ result\ score}{score\ criteria}\ x\ 100\% \quad (1)$$

Criteria of score = high score x number of aspects x number of the respondent (2)

Table 1. Criteria of validations [17].

Percentage (%)	Criteria
0 – 20	Very Less
21 – 40	Less
41 – 60	Enough
61 – 80	Good
81 – 100	Very Good

To know the practicality of digital trainer as props can be analyzed using observed observation sheets observed by the observer when the class simulation using guided inquiry. The implementation of the learning process is observed by the teacher. The criteria for the implementation of the learning process as follows [18]:

a) 1 = less
b) 2 = enough
c) 3 = good
d) 4 = very good

The percentage of this validation data is obtained based on *Rating Scale* calculations as follows:

$$Percentage = \frac{number\ of\ result\ score}{score\ criteria}\ x\ 100\% \quad (3)$$

Criteria of score = high score x number of aspects x number of the respondent (4)

Table 2. The criteria of rating scale's percentage [19].

Percentage (%)	Criteria
$0 < x \leq 20$	Very Less
$21 < x \leq 40$	Less
$41 < x \leq 60$	Enough
$61 < x \leq 80$	Good
$81\% < x \leq 100$	Very Good

The design of this study is one group pre-test and post-test design is described below [17]:

$O_1 \rightarrow x \rightarrow O_2$

O_1 = pre-test is performed before treatment is given
x = treatment performed using a digital trainer
O_2 = post-test performed after treatment

The analysis technique used is n-gain score test with the following equation:

$$\langle g \rangle = ((Sf\text{-}St))/((Smaks\text{-}St)) \quad (5)$$

In which: <g> = improved learning outcomes of learners
St = learners score on pre-test
Sf = learners score on post-test
Smaks = maximum score

Table 3. Interpretation of n-gain.

g	Criteria
$g > 0,7$	High
$0,3 < x \leq 0,7$	Medium
$g \leq 0,3$	Low

3. Results and Discussion

Data obtained in this study, including questionnaire data, validation data, data the implementation of learning, and data on improving the results of eblajar learners SMAN 1 Tongas. Data a pre-research questionnaire was proposed as the background to the problem. After knowing existing conditions,

supported by natural knowledge that has been obtained and guidance by lecturers appear solution offered is in the form of product props (digital trainer). This tool is used for enhancing the understanding of dynamic electrical concepts. The digital trainer is the result of trainer modification which has grown in society by adding components in a system.

Table 4. The differences of digital trainer and ordinary trainer.

Digital Trainer	Ordinary Trainer
1. Form Display (Wooden Suitcase): Isolator	1. Standard display form
2. There are three main rooms: Power, Circuit Board, Tools	2. There is only 1 space, that is only the drawing board
3. Multi-Power Supply: There are 3 kinds of voltage source, (3V, 9V, 12V). Tools contain tools used for practicum.	3. There is only 1 kind of voltage source as experiment material
4. Portable circuit board: Can be disassembled	4. Less flexible if you want to be taken out for practicum
5. More interesting view: there are LED lights as accessories (backlight)	5. Standard display, there are no additional accessories that are used as material to attract interest from learners to learn
6. There is a Practicum Handbook: the book contains a number of experiments that can be used on the DINER.	6. There is no practical manual. Handbook of learners is also not there
7. Transparent: on a circuit board is a transparent board. It is intended that learners should know what components they connect.	7. Acrylic uses non-transparent material. The downside is that participants do not know the connection components
8. Using digital measuring tools: This will facilitate learners in knowing the results of measurements in the circuit.	8. The used measuring instrument is AVO meter lab. AVO meter is an analog measuring instrument.
9. Media learning is very flexible, can be taken anywhere	9. Less flexible because the shape is too big

The goal can be done with the enactment of practicum activities. In addition, to support the practicum activities a module was produced. A module plays role as a guide for learners to easily understand the tools and can carry out the practicum properly and correctly.

Before the simulation, in the school, the product has been validated to the validators who are experts in their field. The digital trainer will be known feasibility as a medium of learning in improving the understanding of learners then need to be simulated in the classroom. The support of classroom learning required the existence of learning tools that contain syllabus, RPP (Learning Plan), handouts, LKPD (Worksheet Learners), and evaluation sheet. The device before being simulated needs to be validated to the validator in order to be applied in the class according to the current curriculum.

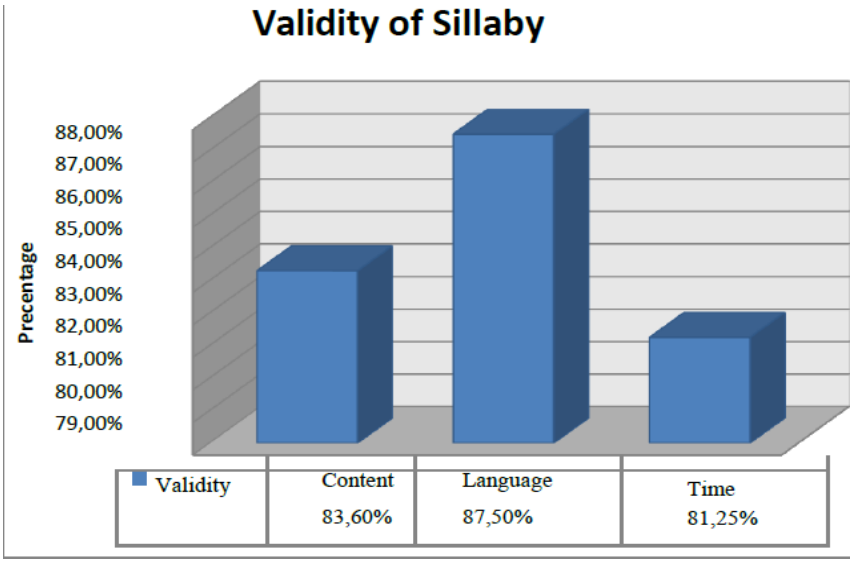

Figure 4. The validity of syllabus.

Based on the graph above, there are four aspects of the assessment aspect. The objectives sphere (assessment includes clarity of Competency Standards and Basic Competencies, Competency Standards Compliance and Basic Competencies with learning objectives; accuracy of elaboration Basic Competence into indicator; conformity of indicators with learning objectives; and the suitability of indicators with levels development of learners) reached 83.30%; content domain (assessment includes the systematic arrangement of instructional design; suitability of learning activities with guided inquiry model; clarity of the scenario learning (learning activity stage, beginning, core cover); and instrument completeness evaluation (question, key, scoring guidance) reached 83,30%; language domain (assessment includes; the language used in accordance with PEUBI; the language used communicatively, and simplicity of sentence structure) reaches 83.30%; and the realm of time (judgments include: conformity allocation used; and details of time for each learning stage) reached 87.50%. Then based on the result criteria from the Likert scale calculation shows that the RPP is very valid can be simulated class.

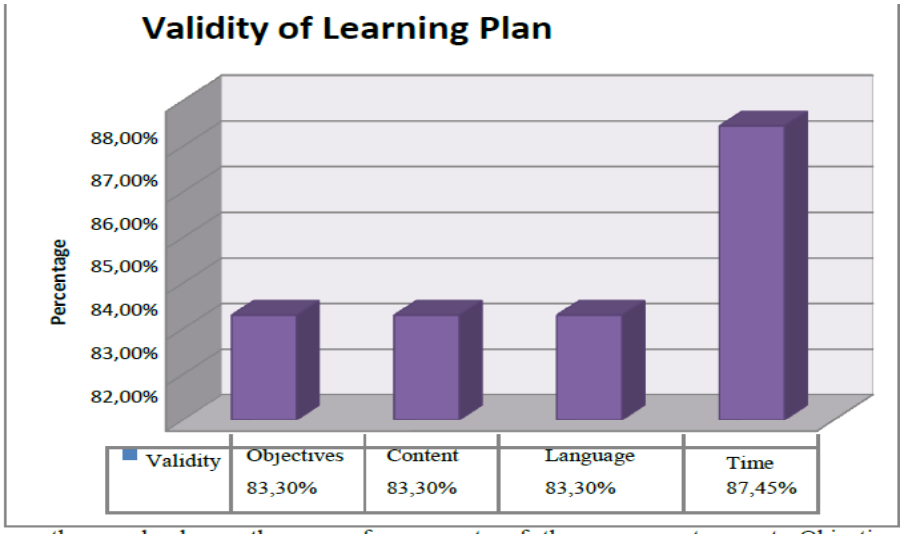

Figure 5. The validity of RPP (Learning Plan).

Based on the graph above, there are four aspects of the assessment aspect. Objectives (assessment includes of Competency Standards and Basic Competency, Competency Standards and Basic Competency Compliance with learning objectives, accuracy of elaboration of Basic Competence into indicators, conformity of indicators with learning objectives, and conformity of indicators with level of learner development) reaches 83.30 %; (learning, key, scoring guidance) reaches 83.30%; and the completeness of evaluation instruments (questions, keys, guidance) reaches 83.30%; (including the language used in accordance with PEUBI, the language used communicative, and the simplicity of the sentence structure) reaches 83.30%, and the time span (the assessment includes the appropriateness of the allocation used and the time details for each learning stage) 87.50% . Then based on result criteria from Likert scale calculation show that RPP is very valid can be simulated class.

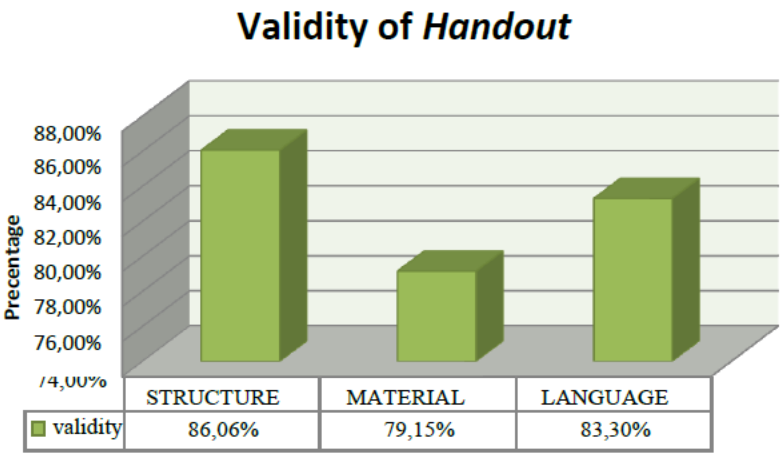

Figure 6. The validity of handout.

Based on the graph above, there are three domains in assessment aspect. Structural realm (assessment includes general presentation organization; general appearance is interesting, and consistent interrelationships between material language) reached 86.06%; the material realm (assessment includes material coverage, clarity, and sequence of material, material accuracy with SK, and linkage between issues with life/cognition context) l reached 79.15%; and language domain (assessment includes language used in accordance with PUEBI, language used communicative, and simplicity of sentence structure) reaches 83,30%. Improvements obtained when validation, including; the material is expanded and deepened; design made attractive possible for high school kids; the writing on the index is not yet appropriate, and the layout is less operational. Based on the result criteria from the Likert scale calculation, it shows that the valid handout can be simulated in the class.

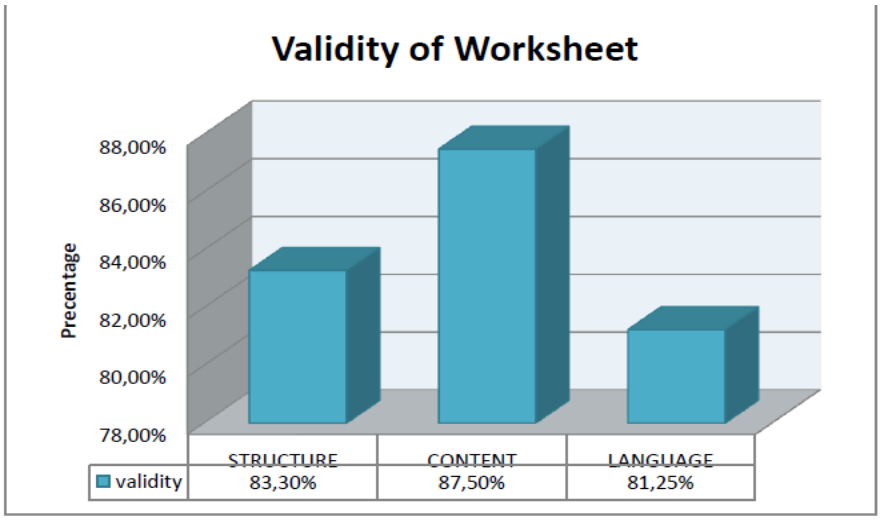

Figure 7. The validity of worksheet.

Based on the graph above, there are three domains in assessment aspect. Structure area reached 83.30%; the realm of material reaches 87.50%, and the language domain reaches 81.25%. Validator provides feedback to be repaired, such as: LKPD is detailed and operational, adjusts the circuit assembled with high school ability level, made LKPD for teacher and student's handling, picture clarified, the addition of comparison table of calculation results and measurements in experiment 4, using PUEBI guidance in writing, and the addition of barrier values to the manufacture graph of current to voltage on experiments 5 & 6. Then based on the results of the criteria of the calculation Likert scale indicates that a very valid LKPD can be simulated class.

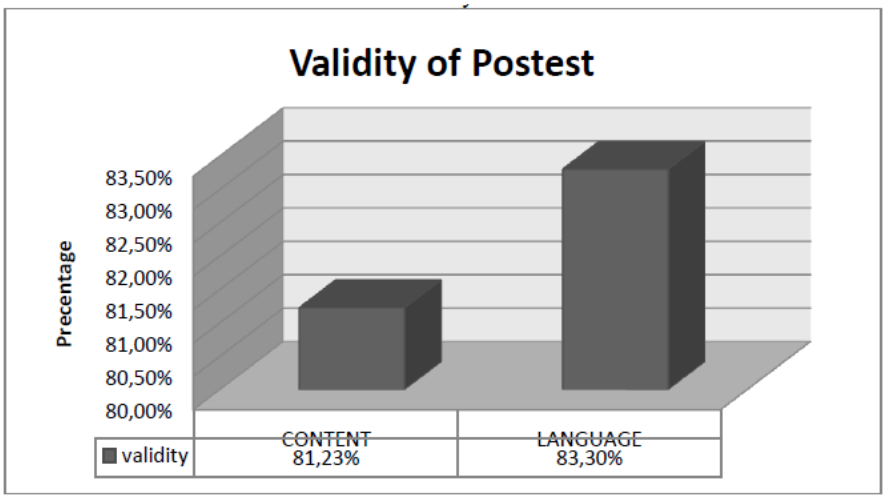

Figure 8. The validity of post-test.

Based on the graph above, there are two domains on the aspect of assessment. Structural aspects (assessment include: conformity with an indicator, conformity with learning objectives, problem difficulty level, and clarity of numbers) reaches 81.23%; language domain (assessment includes the use of language in accordance with PUEBI and simplicity of sentence structure) reaches 83.30%. Based on the result criteria from the Likert scale calculation, it shows that post-test is very valid and can be simulated in the class.

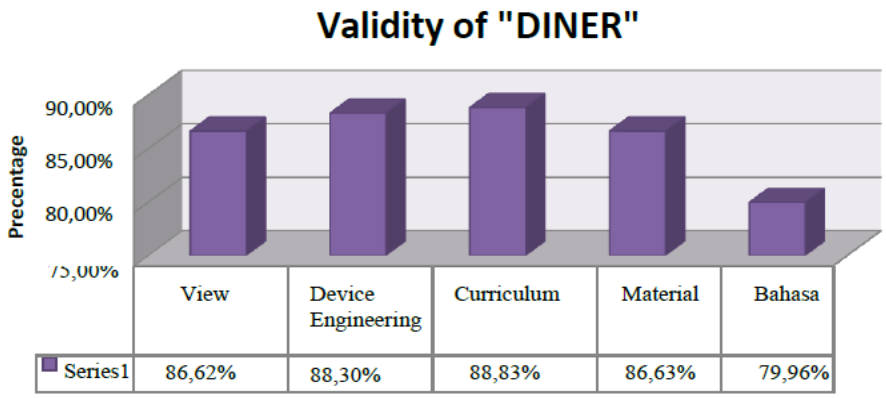

Figure 9. The validity of "Diner".

Based on the graph above, the assessment aspect of digital trainer learning media is five domains. The display area (assessment includes: description of components that facilitate the user in using media, presentation of early display of learning media that makes it easier for the students to understand, the clarity of components used and the material in learning media, suitability of component or interface layout and component layout, suitability of use of terminal color used, conformity of proportion of components mounted on instructional media, level of learning media flexibility used, difficulty level of material problem in learning media and suitability of design media with the level of users) reached 86.62%, the field of device engineering (assessment includes: creative in pouring ideas or ideas, ease and simplicity in operation, ease of component required, and the level of interactivity of media and students) reaches 83.30%: curriculum sphere (assessment includes: ease of learners in using and conformity with the material to be taught; the suitability of instructional media with core competencies and basic competencies; and through the learning media can facilitate learners to understand the material) to reach 88.83%, the material realm (assessment includes: the suitability of the material presented in the learning media with indicators and learning objectives, well-organized materials with digital trainer learning media, and the suitability learning media with the cognitive development of learners) reached 86.63%, and the language domain (assessment includes: use of communicative component description facilities, ease of understanding on the description of each component, and grammar on the description of components used in accordance with PUEBI) 79.96%. Media after validation has some improvements, such as: smoothing the cable under the kit, the addition of cable numbers to facilitate the circuit, the addition of circuit images, and need to be equipped multimeter. Then, based on the criteria of calculations like scale shows that the media learning digital trainer valid design get it, class.

Based on the result of device validation (syllabus, pp, handout, LKPD, post-test) and digital trainer instructional media by validator showed that valid for use in a learning activity. After the validation, revision and consultation process, the next step is learning simulation using digital trainer learning media to SMA Tongas students who take science program (Natural Science) by taking sample 1 class which contains 15 students. When learning takes place, physics teacher observes the activity simulated with the appropriateness of rpp then done the assessment according to the format proposed on the learning implementation sheet. The assessment result given by the observer is analyzed using the rating scale formula then the result is adjusted with the validation criteria.

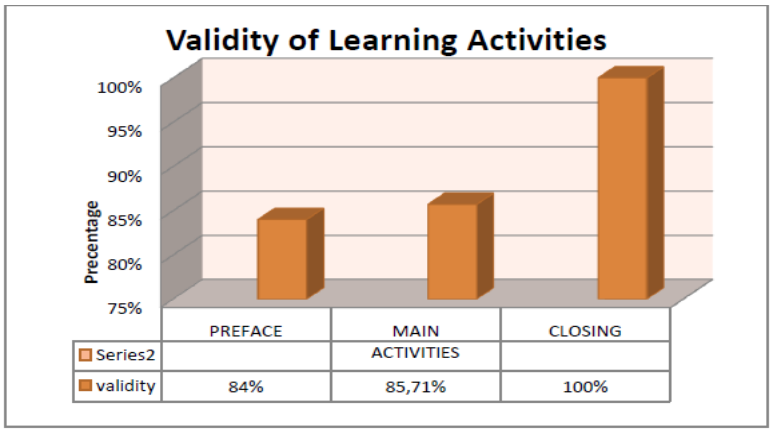

Figure 10. The validity of learning activities.

Based on the graph above, the assessment aspect there are three phases. The assessment opening phase includes: the teacher provides a pre-test of the material; motivate learners; convey the Learning Objectives; the teacher gives the phenomenon and asks the phenomenon, and provide opportunities for learners to think the phenomenon that occurred. The calculation result is 84%. The activity phase includes; teachers explain about practicum using digital trainer learning media; teachers divide the lab group; the teacher gives a problem; teachers guide groups in preparing hypotheses; teachers guide groups in the lab; teachers guide groups in data analysis, and the teacher asks the learners to present the experimental results. The calculation result is 85.71%. The closing phase includes; teachers ask learners to deduce learning outcomes; and teachers share learning evaluation questions. The calculation results reach 100%. Therefore, the analysis results show that the learning activities performed very well.

Further analysis is the understanding of learners' concepts that are shown from the learning outcomes. Learning outcomes can be seen from the increase of pre-test to posttest. Because of limitations assessment, the cognitive domain, psychomotor and affective domains are not assessed. This is because of the difficulty to facilitate in analyzing the results and inability to reach aspects of psychomotor and affective assessment within 4 months. Time is consumed in the making of instructional media, so the simulation schedule should adjust to school activities and researchers. There are 15 items in the pre-test and post-test. Pre-test problem is given in the same realm but pre-test is given before treatment and post-test is given after treatment in the form of simulation of class learning on dynamic electrical material using the digital trainer.

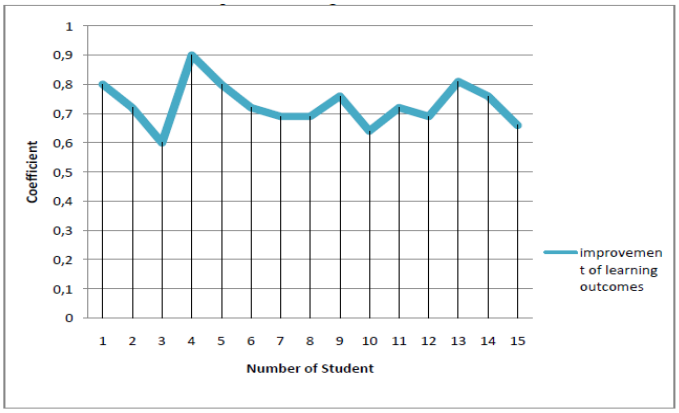

Figure 11. Improved learning outcomes of learners.

Based on the analysis of the N-gain test, the interpretation of improving learning outcomes learners (cognitive domain) states that 60% the improvement in learning outcomes of learners achieve has a high interpretation and 40% of moderate interpretation. It shows that media digital trainer learning can increase learners' understanding of dynamic electrical materials.

To know the impression of learners on learning activities using a digital trainer, a questionnaire is given. The result of the student response shows that 46.67% of the students strongly agree that the design of the digital trainer learning media is interesting. 73.33% agree that the design of the Diner is practical and unique, so interested in trying to use it. 53.33% agreed that the circuit scheme helps to understand the designed circuit experiment. 73.33% agree that a transparent form on digital trainer learning media helps to understand the components used in the lab. 53.33% strongly agree with the existence of measuring instrument digital on DINER makes it easy to get accurate results. 66.67% agreed to the media Digital trainer learning makes it easy to distinguish between series and series-parallel. 53.33% agree if using digital trainer learning media help to understand Kirchoff's legal concepts. 80% agree that the media of digital trainer is very good required by learners and teachers to support dynamic electrical material learning. 53.33% agree if Dynamic Electric will be easily understood with practice using learning media digital trainer.

4. Conclusion and Suggestion

4.1. Conclusion

Based on the presentation of the results of the discussion as described, it can be concluded that in terms of the validity of the device and the digital media trainer declares a digital trainer worthy of being used as a learning medium. Judging from the implementation of learning states Digital trainers are also worthy of a digital trainer worthy of use as a medium of learning. Besides, digital trainer as a learning medium on dynamic electrical material showed effectiveness in increased learning outcomes of learners.

4.2. Suggestion

For the suggestion, the domain of assessment of learning outcomes of learners also includes affective and psychomotor. Digital trainers can also measure the critical level of critical thinking of the participants educate. In addition, it can also be used as a science literacy in physics learning. A digital trainer can also be applied in high school majoring in electrical engineering majors and colleges. The components used in the digital train can be increased or reduced as needed, for example for learning on electromagnetic materials, magnetic electricity, and basic electronics.

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