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# Development of IMA-3D Based E-Learning on Vocational Education in the 4D (Define-Design-Development, and Disseminate) Instructional Design Model

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***Abstract*--***The ICT has become an important part of learning success in many countries. The addition of technology to learning online or mixed is more in demand by students in learning in vocational education. Previous researchers have developed the concept of interactive learning assisted by multimedia. However media research is limited in computer space and time of use. This study aims to develop interactive multimedia-AutoCAD 3D (IMA-3D) by measuring expert validation and user perception. The research method uses the 4D model approach (Define-Design-Development, and Disseminate). Expert validation consisted of media and language experts as well as material experts as considerations in the development in accordance with the context of vocational education media. As many as 34 respondents were involved in the use of IMA-3D with the characteristics of ± 18-20 years of age from various vocational schools with the organizers of the engineering curriculum. Data collection was carried out using a questionnaire with a measurement scale (RS. 1-5). Media and language validation results obtained an average of 79.20% (score. 99.00 from 125.00) in the agree category and validation of material experts obtained an average of 84.44% (score. 38.00 from 45.00) with a very agree category and both recommendations are valid. The user perception test results obtained an average of 72.16% (Score. 736 out of 1,020) with the category "Feasible or good". Interactive multimedia can increase new understanding and ease of learning, interests, talents, and motivation, learning more fun, and knowledge competency and practice are more directed at positive increases above 60%.*

***Keywords*--** *Interactive Multimedia, AutoCAD 3D, E-Learning, Vocational Education*

## I INTRODUCTION

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Learning in the 21st century has shifted and abandoned the habit of traditional learning concepts [1]. The paradigm shift in learning is influenced by information, computing, automation and communication [2]–[4]. Information is directed to encourage students to find out, while the old concept is to be told. Machine-assisted or technology-assisted computing is able to formulate a problem or ask not just to answer. Automation in routine work is directed at analytical thinking skills rather than mechanisms. Communication emphasizes collaboration and collaboration. Researchers in their studies related to the role of technology in learning, capable of producing high-quality, active and in-depth learning [5], [6]. However, the existence of technology as a function in helping learning needs to be controlled consciously, effectively and not become dependent.

Technology in learning, especially in vocational education is as a medium of learning in accelerating the learning process. There are many sources of information available and not all of them can be accounted for, so 21st century skills must be mastered. Trailing and Fadel, becomes a reference in vocational education to the skills that must be mastered, namely learning and innovation skills, information, media and technology skills, and life and career skills. Learning and innovation skills are related to critical thinking and problem solving, communication and collaboration, creativity and innovation [7]. Information, media and technology skills, namely developing literacy into habits [8], [9]. Life and career skills include flexibility and adaptation, initiative and self-regulation, social and cultural interaction, productivity and accountability, leadership and responsibility. The output of vocational learning is the ability to solve certain problems by building accountable literacy skills.

Learning in vocational education requires strategies, methods or models in developing good analytical concepts [10]. Vocational education is learning to work on specific occupations [11]. In the engineering education field, there are abstract competencies and difficulties in learning [12], [13]. Among them, the battery reaction, the concept of working steps of the machine, the concept of electricity [12], [14], and compelling 2D or 3D images [15], even many others. All of these competencies are abstraction skills which must be mastered into conceptual reasoning power. The process of events that cannot be observed in real terms, the learning approach must be used using appropriate media [16] to illustrate students' understanding [17]. This can reduce the damage to components that are high sensitivity [18], [19] and the basis for the ability of students more directed [20], [21]. However the role of the media as an innovation in learning, information and achieving vocational skills.

The accuracy of this innovative learning media [22], being able to convey information and being able to deliver learners' skills in certain jobs [23]–[25], is highly prioritized. This defines that it is not limited to the media, but must have a function on the achievement of competence. Three important aspects that influence the achievement of competence are learning models, multimedia, and student-oriented [26], [27]. The results of the study reinforce interactive learning multimedia increases interest, motivation, participation, stimulation [28]–[30], critical dimensions [31], which are able to increase competencies above 60% [32]–[34]. So that the role of educators will be greater in developing interactive multimedia based on needs and monitoring learning and ensuring learning information has been mastered.

Researchers have focused on vocational learning on AUTOCAD 3D competencies. The results of an FGD survey on industries or the world of work in the Tangerang-Indonesia recommend workers with the ability to draw designs. Factual competency of students is the difficulty of reasoning from 2D to 3D. If the learning process retains

the old concept of manual equipment, the process lasts quite a long time and is less effective. Based on factual, so far multimedia are limited to its application in computers in school laboratories. The right of access is obtained by students only, during learning hours. Therefore, media development based on the competency requirements for critical thinking on the concept of 3D integrated internet (E-learning) needs to be suggested. Students can access according to their needs and desires without being limited by space. So that learning becomes efficient, fun interesting and quality [35] [36].

AUTOCAD 3D expertise competencies include:

(1) Understanding the use of CAD (DDV Points, Plans, Primitive 3D Objects, Direct Modifications, EDGE and FACE Modifications, Territories, and Extrude);
(2) Able to draw technical (Isolines, FaceTress, Dillet, Chamfer, PolySolid, Revolve, Sweep, Helix, Subtract, Union); and
(3) Modification of 3D working images (UCS, Rotated 3D, 3D Mirror, 3D Array, Slice, Dynamic UCS, Imprint, PressPull) [37].

In drawing, 3D, the integration between multimedia development with AUTOCAD software requires a good relationship technologically and psychology of students. The failure rate is very high and not a few who fail. So the concept that is built must be adapted to the characteristics of students such as interest in appearance, instructions or navigation, structuring the material from simple to the next level, practice exercises, several other additional applications such as music, and others. An important part is the process of pouring competence needed a combination of sound, graphics, images with good resolution [38]. If all aspects have been considered, and running has been run, then testing the function is carried out. This research aims to:

1) Develop and validate Interactive multimedia on AUTOCAD 3D (IMA-3D) integrated with E-Learning; and
2) Testing the appropriateness of users, namely students in vocational education.

## II METHODOLOGY

Development of interactive multimedia, AutoCAD 3D (IMA-3D) using the 4-D development model approach by Thiagarajan [39]. This model is recommended by many researchers in the development of multimedia, worksheets, e-modules, worksheets related to education [40]. This development model consists of 4 stages, namely Define-Design-Development, and Disseminate to produce a valid 3D IMA and is suitable for use in learning in vocational education. Development has an important role in testing and improving a medium based on the construction of experts according to their fields. So that media acceptance is determined by media experts, material and language experts as validation of IMA-3D ability and students perceptions of IMA-3D. Conceptual framework of developing the IMA-3D model with the 4-D approach as follows:

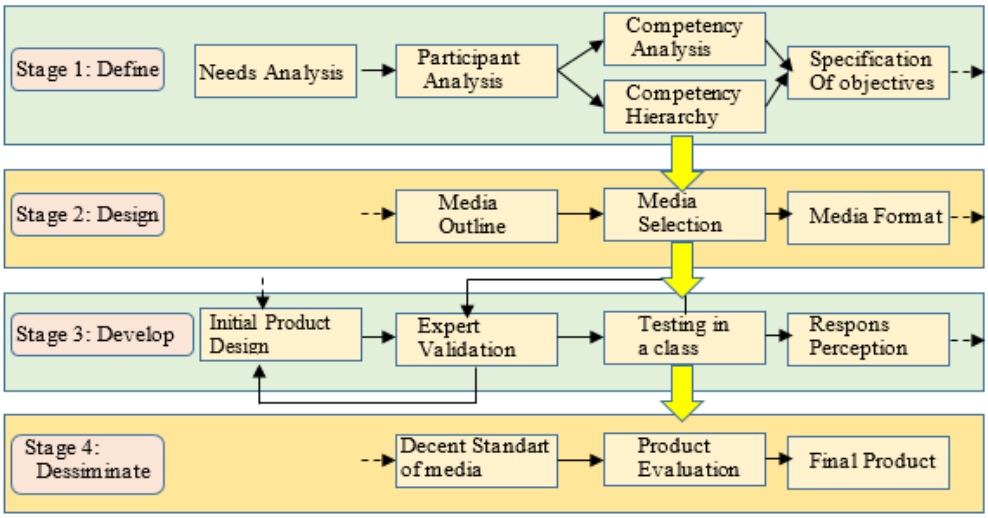



**Figure 1:** Development of IMA-3D with the 4D Model

The IMA-3D development procedure is clarified as follows:

a) Stage-Define, is the initial stage of development based on needs analysis, student analysis, competency analysis and competency mapping and specific objectives. The analysis was conducted from a combination of vocational education curriculum, education and training curriculum, and competency standards from KKNI. Important user characteristics are involved in media adjustment.

b) Stage-Design is the next stage consisting of media outline, material selection, and media format support. Storyboards and the outline of media content are of particular concern in determining media. The multimedia format is supported by other devices, namely Adobe Premiere Pro CC, CorelDraw X7, and Adobe Audition CC as editing processes.

c) Stage-Develop is the stage of ensuring that IMA-3D enters the validation and testing process. At this stage there is a process of mutual evaluation if recommendations for improvement are needed and even rearrangement if the results are not within the limits of media standards. A total of 5 media experts and language experts and 3 material experts was involved in the validation decision. As many as 34 users were tested in one of the vocational schools in the city of attack with the characteristics of class XI even semester with age ± 18-20 years. The results in the form of IMA-3D responses as media recommendations are used or not used in the learning process.

d) Stage-Disseminate is the final stage where the media meet the standard limits, then the product is evaluated before being used more generally and the fulfillment of the standard as the final of the IMA-3D product.

**Assessment aspect and category of IMA-3D**

The assessment aspects of the IMA-3D perception test of material experts include educational criteria, program display, and IMA-3D quality. Aspects of the IMA-3D perception test of media experts and language experts include the ease of using IMA-3D, clarity and function, user acceptance and error, and ease of use and language

clarity. While students' perceptions include understanding, ease, attraction, fun to learn, and competence and practice competencies [41], [42]. Measurements were made using a scale rating (RS) of 1-5 from Very Disagree / Very Unworthy to Very Agree / Very Feasible.

Furthermore, the acquisition of scores is grouped by RS, mean, SD and IMA-3D categories. The determination of the IMA-3D category is based on the following formulation:

**Table 1:** IMA-3D Assessment Criteria

| Criteria Formula | Media and Language Expert Assessment | Material Expert Assessment | User Perception Assessment |
|---|---|---|---|
| **RS (1-5)** | **R=5, Qi=5** | **R=3, Qi=3** | **R=34, Qi=6** |
| [a]C ≤ Mi-1.5 Sbi | 100-125 (Strongly agree) | 36-45 (Strongly agree) | 816-1.020 (Very Decent) |
| [b]Mi-1.5 Sbi <C ≤ Mi + (-0.5) Sbi | 83-99 (Agree) | 30-35 (Agree) | 680-815 (Feasible) |
| [c]Mi-0.5 Sbi <C ≤ Mi + 0.5 Sbi | 87-82 (Neutral) | 24-29 (Neutral) | 544-679 (Neutral) |
| [d]Mi + 0.5 Sbi <C ≤ Mi + 1.5 Sbi | 50-66 (Disagree) | 18-23 (Disagree) | 408-543 (Not Feasible) |
| [e]C> Mi + 1.5 Sbi | 25-49 (Strongly Disagree) | 9-17 (Strongly Disagree) | 204-407 (Very Unworthy) |

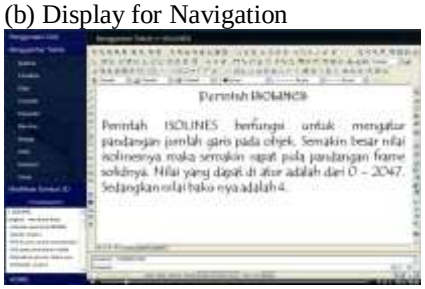
RS: Rating Scale
R= Respondents
Qi: Question Item
[a/b]Media decisions can be accepted and used (meet test requirements)

## III RESULTS AND DISCUSSION

### 1) Description of IMA-3D Development



(a) Display on the Main Page (b) Display for Navigation


(c) Display of the competency hierarchy (d) Display on the material menu and work area

(e) Display in the Field of Work


(f) Display on Competency Test

**Figure 2:** Display on the development of the IMA-3D project

The development product, IMA-3D, has passed various procedures and preparation processes. The AutoCAD application used is AutoCAD of the 2007 version. Consideration is chosen based on the lighter size, capacity compared to the latest version with many features. Although this version was chosen, students in learning to use various versions remain the same. The main reason is the only change in the appearance and completeness of the additional tools while the functions and shapes remain the same. The 2007 Version is easily installed on a variety of computer peripherals.

The results of the IMA-3D product development are shown in Figure 2 (a) in the form of initial display information and competency achievement goals. Competency objectives are carried out in a structured way from introducing tools, tool's functions and simple work, as well as running in the work area by making 3D objects. Figure 2 (b) is in the form of information from the navigation panel that explains the menu functions in IMA-3D. This helps students to operate, especially beginners. Figure 2 (c) is a display of the competency hierarchy to be achieved. However, the level of users other than beginners can start the project according to their choice. Figure 2 (d) informs the menu and work area display on the right. The menu is constructed from simple levels. When the menu is selected information from the menu will appear on the right side. Specific menus in the work area are shown in Figure 2 (e) at a high level, namely building 3D images that are done directly with the Video approach in the AutoCAD 2007 software. This is intended to be easy for students to follow with consideration of the same media used, namely AutoCAD 2007 with video packaging equipped with sound and text. The advantage of the chosen video format is the equalization of the speed version of the varied learners. This means that the video can be stopped for a moment if the information is left behind or confused in the understanding of the material. Furthermore, students who have been able or proficient can pass the self-testing in Figure 2 (f). IMA-3D is important to do by paying attention to the characteristics of students. IMA-3D is integrated with E-learning, intended to provide learning flexibility as needed.

### 2) Results of IMA-3D validation by media and language experts

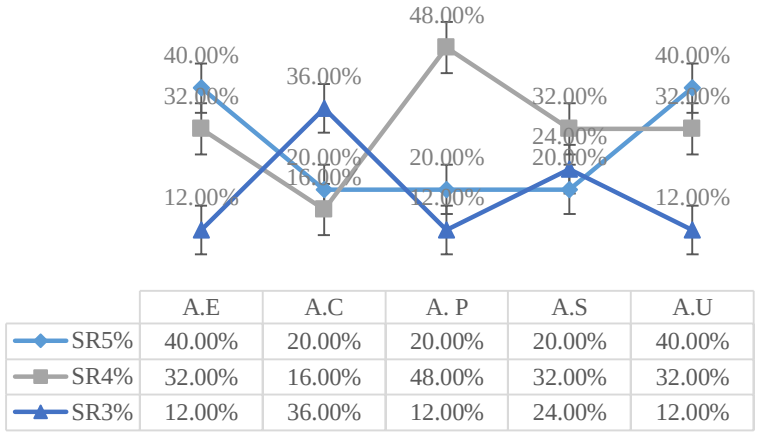
Five media experts were chosen to contribute to the IMA-3D media decision. Experts are selected based on learning experience using technology for more than 10 years, and functional experts as Associates or Associate Lectors (senior lecturers). The five media experts assessed 5 aspects with the results presented in the following table:

**Table 2:** Learning Media Evaluation Result by IMA-3D Media and Language Experts

| No | Evaluation Aspects | RS 5 | RS4 | RS3 | Total | Mean (1-5) | S.D | C |
|---|---|---|---|---|---|---|---|---|
| 1 | Ease of using the navigation key and main menu button (A.E) | 10,00 | 8,00 | 3,00 | 21,00 | 4,20 | 0,75 | VA |
| 2 | Clarity and function of buttons on other pages (A.C) | 5,00 | 4,00 | 9,00 | 18,00 | 3,60 | 0,80 | A |
| 3 | The presence or absence of error level that is acceptable to the user (A.P) | 5,00 | 12,00 | 3,00 | 20,00 | 4,00 | 0,63 | VA |
| 4 | Ease of material structure (A.S) | 5,00 | 8,00 | 6,00 | 19,00 | 3,80 | 0,75 | A |
| 5 | Usage of simple and clear language (A.U) | 10,00 | 8,00 | 3,00 | 21,00 | 4,20 | 0,75 | VA |
| | **Average all aspects** | **99,00** | | | | **3,96** | **0,74** | |
| | **Aspect Category from Media and language Experts Evaluation** | **83-100 (A) and 101-125 (VA)** | | | | | | **A*** |

Note: * Relationships are high or near the top level

The results of media expert validation show that the clear Usage of simple and clear language (AU) in the highest acquisition of 84.00% is equivalent to the Ease of using the navigation key and main menu button (AE), followed by the aspect of the presence or absence of error level that is acceptable to the user (AP) that is 80.00%. On the Ease of material structure (U.S) criteria, it was obtained 76.00% and followed by a Clarity and function of buttons on other pages (A.C) of 72.00%. All validation aspects of the above criteria Mi + 0.5 Sbi <X ≤ Mi + 1.5 Sbi (17.00) means that there is no aspect value below "A" and it is stated that IMA-3D has fulfilled the validation aspect. Overall results in the A* criteria are assumed that the value of 99.00 is approaching the 100.00 limits (100.00-125.00 in the VA category). Thus IMA-3D is critically included in the basic level VA decision. More details on the acquisition of validation by media experts and linguists based on the criteria and rating scale (RS) obtained are shown in the following graph:




| | A.E | A.C | A. P | A.S | A.U |
|---|---|---|---|---|---|
| SR5% | 40.00% | 20.00% | 20.00% | 20.00% | 40.00% |
| SR4% | 32.00% | 16.00% | 48.00% | 32.00% | 32.00% |
| SR3% | 12.00% | 36.00% | 12.00% | 24.00% | 12.00% |

**Figure 3:** Distribution of Rating Scale (RS) against the assessment criteria of media and language experts

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The rating scale chosen by the validation of media and language experts in the range 3-5. Figure 3 shows that the RS acquisition in sequence from the highest acquisition was SR4, SR5, and SR3.

### 3) Results of IMA-3D validation by material experts

A total of 3 material experts was involved in the validation of the IMA-3D product. Consideration of the choice of experience in vocational education of more than 10 years in technical drawing material. Educational material in vocational is different. According to the needs. The results of the material expert validation are presented in table 2 below.

**Table 3:** Learning Media Evaluation Result by IMA-3D Material Experts

| No | Evaluation Aspects | RS 5 | RS4 | RS3 | Total | Mean (1-5) | S.D | C |
|---|---|---|---|---|---|---|---|---|
| 1 | Educational criteria: material content, interaction, feedback (B.E) | 5,00 | 4,00 | 3,00 | 12,00 | 4,00 | 0,82 | VA |
| 2 | Program Display Criteria: colorings, grammar, interactive buttons, images, animation, sound, buttons, interface design (B.P) | 5,00 | 4,00 | 3,00 | 12,00 | 4,00 | 0,82 | VA |
| 3 | The technical quality criteria: program operations, usage and security, errors and facilities (B.T) | 10,00 | 4,00 | 0,00 | 14,00 | 4,67 | 0,47 | VA |
| | **Average all aspects** | **38,00** | | | | **4,22** | **0,70** | |
| | **Aspect Category from Material Experts Evaluation** | **30-35 (A) and 36-45 (VA)** | | | | | | **VA** |

The three aspect showed that IMA-3D had fulfilled the highest criteria (VA). All scores obtained above the average are 36-45. The level of quality criteria is based on the following aspect code B.T is 93.33%; B.P and B.E obtained 80.00%. Thus the material experts have stated the validity of IMA-3D in language meets aspects of the needs of students. More detailed acquisition of material expert validation based on the criteria and rating scale (RS) obtained is shown in the following graph:

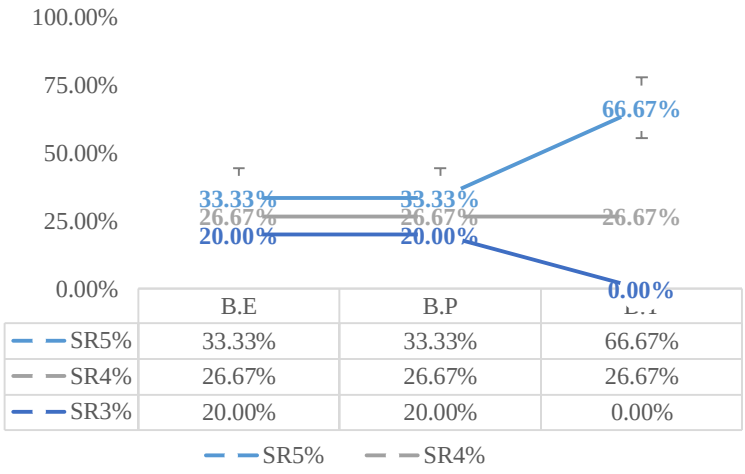

**Figure 4:** Distribution of Rating Scale (RS) against the assessment criteria of material experts

The rating scale chosen by the validation of media experts is in the range of 3-5. Figure 3 shows that the RS acquisition in sequence from the highest acquisition was SR5, SR4, and SR3. It can be interpreted that the SR 5 aspect represents an expression that states IMA-3D has very good validity.

### 4) Respond to users perception in using IMA-3D

A total of 34 students was involved in using IMA-3D after it was recommended to be valid. Users in the perception test assessor consist of several vocational schools that provide expertise in AutoCAD in their curriculum. Perception statements represent the user's expression or feeling after using IMA-3D. The results of students' perceptions are shown in the following table:

**Table 4:** Users Perception Result after Using IMA-3D

| No | Evaluation Aspects | RS 5 | RS4 | RS3 | RS2 | RS1 | Total | Mean (1-5) | S.D | C |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | I feel that learning with interactive multimedia enhances new understanding and ease of learning AutoCAD 3D (C.A) | 35,00 | 40,00 | 42,00 | 2,00 | 2,00 | 121,00 | 3,56 | 1,03 | F |
| 2 | I feel that this interactive multimedia make it easy for me to understand functions to make other machine products (C.B) | 40,00 | 40,00 | 30,00 | 10,00 | 1,00 | 121,00 | 3,56 | 1,09 | F |
| 3 | I feel that interactive multimedia can increase my interest, talent, and motivation in using AutoCAD 3D (C.C) | 20,00 | 52,00 | 51,00 | 0,00 | 0,00 | 123,00 | 3,62 | 0,69 | F |
| 4 | I feel that interactive multimedia is easy to understand and can be used any time (C.D) | 25,00 | 32,00 | 54,00 | 4,00 | 1,00 | 116,00 | 3,41 | 0,91 | F |
| 5 | I feel that interactive multimedia is fun to learn (C.E) | 50,00 | 20,00 | 54,00 | 0,00 | 1,00 | 125,00 | 3,68 | 0,99 | F |
| 6 | I feel that interactive multimedia enhances knowledge and practice competencies (C.F) | 70,00 | 24,00 | 27,00 | 8,00 | 1,00 | 130,00 | 3,82 | 1,17 | F |
| | **Average all aspects** | **121,00** | | | | | | **3,61** | **0,98** | |
| | **Aspect Category from Users Perception Response Evaluation** | **113-135 (F) and 136-170 (VF)** | | | | | | | | **F** |

The highest score is the category C.F which states that students after using IMA-3D are able to improve the competence of knowledge and practice. Overall criteria in the moderate feasible category. This perception indicates that IMA-3D has good reception and can be generalized to students in the same competence. Based on the results of the distribution of the RS, it was found that all the items (1-5) were selected. This gives the meaning that RS is functioning properly.

### 5) Discussion and limitations

The results of students' perception test on the use of IMA-3D provide several perceptions that IMA-3D is able to increase new understanding and ease of learning, increase interest, talent and motivation, facilitate understanding, learning is more enjoyable and competence of knowledge and practice is more directed. The results of observing the data as a whole range of values obtained do not indicate greater distances. This means that students' perceptions are evenly equal and it is assumed that AutoCAD 3D interactive multimedia with integrated E-learning has a positive contribution to the achievement of drawing competence. In line with studies conducted [43], [47], on cognitive load is more positive, other things lead to higher motivation and metacognition of students. Park et al., support this statement through the results of studies that state that media technology positively influences users' perceptions of learning interest [44], [45]. Researchers agree that the role of media technology combined with online [46] and mixes make a positive contribution to learning.

The researcher concludes that future learning is oriented to the use of online-based media. This consideration is reinforced that the use of mobile devices as a learning function is more desirable. However, the developers and researchers must adjust the characteristics of students. Even the competency characteristics which will be taught.

This study has limitations and further research can be done, namely the effectiveness test of the competencies packaged in IMA-3D in class experiments and action research. An empirical effectiveness test is carried out to see the effect of the competency to be achieved. On the other hand, IMA-3D based E-learning is difficult to control and all visitors have the same access rights.

## IV CONCLUSION

Development research in the form of IMA-3D products with online technology has been declared valid by media experts and linguists as well as media experts by averaging 79.20% (score. 99.00 from 125.00) while material expert validation is obtained by averaging 84.44% (score. 38.00 from 45.00). The second result is validation in the "Agree" and "Very Agree" categories. While the students' perception test obtained an average of 72.16% (Score. 736 out of 1,020) in the "feasible or good" category. Recommendations testing the user's perception have been made. The overall IMA-3D perception enhances new understanding and ease of learning, interests, talents, and motivations, learning is more enjoyable and competence of knowledge and practice that is more directed towards positively increases. The overall positive impact contribution is above 60%, interactive multimedia based on E-learning improves the learning process.

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