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Interactive multimedia using multiple-intelligences-based in the lesson of thermodynamics for high school

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Abstract. This research aims to develop interactive multimedia using multiple intelligences-based on in the lesson of thermodynamics which is valid, practical, and effective. The research method used was research and development by using Rowntree development model composed of 1) Planning stage; 2) development stage; and 3) evaluation stage by using Tessmer formative evaluation model which comprises five stages, i.e. (1) self evaluation; (2) expert review; (3) one-to-one evaluation; (4) small group; and (5) field test. Data collection techniques used were expert validation form, student response questionnaire, and learning outcome test. The research results that the product is very valid categorized by 93.11% while practicality is assessed through one-to-one and small group, with 98.46%, and 86.36% respectively. Therefore, the potential effect of the developed product measured in field test stage by 0.37 with medium categorized.

1. Introduction

On this globalization era, the existence of information and communication technology (ICT) in the education field is not merely as a teaching subject, but it has melded into every teaching subject by utilizing ICT in teaching processes [1]. Furthermore, teaching process is frequently faced with concepts and materials which are abstract and complex—exceed students' daily experience which furthermore, tend to be hard for the teacher to teach and hard for students to understand [2]. Technology advancement gives an opportunity for the educator in developing teaching technique[3]. By this, student's achievement might increase in terms of the academic result. Moreover, integrating ICT into the teaching process could make teachers deliver teaching materials easier.

Physics as part of science major provides the probability for technology-based media development. One of the technology-based media which is steadily growing in popularity in the education field is interactive multimedia (IM)[4]. IM is a combination of various learning media such as pictures, sounds, videos, animations, simulations, graphics, etc. which can be operated and controlled by the user themselves[5]. Therefore, IM utilization in physics learning might help students to understand abstract and complex concepts[6].

Nowadays, teachers' responses to the change in teaching technique by maintaining the learning progress. Teachers start to formulate learning objectives based on student's behaviour [7]. Regarding the experiences, meanwhile, teachers understand that students' learning styles are different; some students may learn faster and happier by using various type of learning media such as visual-type media, verbal-type media, and audio-type media[8,9]. This idea then leads to the concept of multimedia.

Several types of research regarding IM development and utilization already conducted previously. Meanwhile, some IM usually provide the same visualization for every user because it is assumed that all user characteristics are homogenous. Even though students are generally similar, partially they are essentially a unique individual—none of them are alike[10]. Thus, teachers should use methods and media properly and effectively by considering their students' diversity—intelligence, for instance[11]

According to Howard Gardner's in his theory regarding multiple intelligences, every human has eight types of intelligence with vary level combination[12]. These types of intelligence are visual-spatial, verbal-linguistic, logical-mathematical, musical, interpersonal, intrapersonal, kinesthetic, and naturalistic intelligence. Based on relevant research on multiple intelligences, it shows that the teaching process will reach optimum result if teachers realize their student's characteristics—multiple intelligences type which students behaved [13]. By this, to make the teaching process performs effectively, the teacher should be able to apply learning strategies which suitable their student's intelligence types. One of such strategies is integrating intelligence potential into instructional media such as interactive multimedia.

Based on the result of multiple intelligences test conducted on 31 eleven grade natural science students of Tanjung Batu 1 State Senior High School, it can be seen that every student has minimum one particular intelligence type with the highest score. The percentage obtained from the test result ranked from the highest score; 28% percent of students have visual-spatial intelligence, 19% verbal-linguistic intelligence, 13% interpersonal intelligence, 12% logical-mathematical intelligence, 10% naturalistic intelligence, 9% bodily-kinesthetic intelligence, 6% musical-rhythmic intelligence, and 3% intrapersonal intelligence. The pre-research test result also illustrates that three bits of intelligence are dominantly adapted during instruction activities; visual-spatial intelligence, verbal-linguistic intelligence, and interpersonal intelligence. However, IM usage tends to be self-paced, or in other words, it tends to serve individual and self-learning pace and satisfy learning modalities of each student[14]. Besides, physics materials contain many mathematical equations and demand reasoning and critical thinking abilities. By this, furthermore, multimedia usage is needed for presenting those contents. Regarding those explanations, only three dominant intelligence that would be developed in this research; verbal-linguistic intelligence, logical-mathematical intelligence, and visual-spatial intelligence.

One of physics lesson that could be developed into physics instruction using interactive multimedia based on multiple intelligences is thermodynamics—material for high school grade 11. Thermodynamics is a physics lesson which provides several beneficial knowledge for daily life, but in fact, students still face difficulties in terms of understanding concepts and problem-solving[15]. The reason of this problem regarding the concepts analysis is thermodynamics lesson contained many abstract concepts and had high complexity. Therefore, interactive multimedia might help to visualize the concepts by using easy-to-understand animation, simulation display, and comprehensive content.

Meanwhile, inside thermodynamics consists of several mathematical calculations, graphics, and analysis activities which needs good comprehension in logic skill for solving problems related to the real example in daily life. Furthermore, thermodynamics teaching materials could be learned by explaining the concept using effective language, which it could be easily understood by students.

A research about IM utilizing on thermodynamics teaching materials has conducted by previous researchers, entitled Student Team Achievement Division (STAD)-type cooperative instruction model usage based on interactive multimedia on thermodynamics instruction contained significant influence on students' conceptual understanding [16]. Moreover, a research related to the theory of multiple intelligences application on physics instruction activities has conducted by another researcher, it is stated that through multiple intelligences-based instructions, students felt motivated in instruction activities and more directed in learning and understanding concepts [17]. Meanwhile, regarding the research about dominant multiple intelligences application in physics instruction in the class, it is mentioned that teachers should know students' intelligence types for planning purpose— an instructional strategy which suitable for students' intelligence types [18].

Based on the statements above, this research entitled" Developing Interactive Multimedia Using Multiple Intelligences-Based in Thermodynamics for high school aims to create thermodynamics interactive multimedia based on multiple intelligences on physics subject for grade 11 of senior high school which is valid, practical, and effective categorized.

2. Methods

The research method used is research and development by using Rowntree developmental model which consists of 1) Planning stage; 2) development stage; and 3) evaluation stage [19]. In terms to maintain the accountability of the research objectivity, in this research, furthermore, the used various methods of data collecting are outlined below.

2.1. Expert validation/ walkthrough form

The purpose of walkthrough form is for finding out the validity of developed thermodynamics interactive multimedia based on multiple intelligences by presenting it to validators. Walkthrough form is given to the experts on a Likert-type scale according to the assessment indicators. The final score of expert validation result (EVR) then matched with outlined categories in Table 1 [20].

Table 1. Expert validation result categories

Score (%)	Categories
86 ≤ EVR≤ 100	Very Valid
70 ≤ EVR< 86	Valid
56 ≤ EVR< 70	Less Valid
0 ≤ EVR <56	Invalid

2.2. Questionnaire

Evaluation questionnaire for the developed product is used for collecting students' opinion regarding thermodynamics interactive multimedia based on multiple intelligences which utilized during one-to-one and small group evaluation stage. The questionnaire is arranged by using the Likert-type scale for finding out the practicality of thermodynamics interactive multimedia based on multiple intelligences. The level of product practicality can be seen in Table 2.

Table 2. Practicality categories of one to one and small group stage evaluation result

Score (%)	Categories
86 ≤ EVR≤ 100	Very Practical
70 ≤ EVR< 86	Practical
56 ≤ EVR< 70	Less Practical
0 ≤ EVR <56	Impractical

2.3. Learning outcome test

Learning outcome analysis is used for finding out the effectivity of thermodynamics interactive multimedia based on multiple intelligences utilization. Collected students' test result data would be analyzed descriptively and qualitatively by using N-gain. N-gain on every group is measured through equation (1)[21].

$$< g > = \frac{(posttest)\, score - (pre-test}{score)(maximum\ score) - (pre-test)} \quad (1)$$

N-gain result, furthermore, would be categorized based on Table 3 [22].

Table 3. N-gain Categories

Categories	***N-gain***
High	$(< g >) \geq 0{,}70$
Medium	$0{,}70 > (< g >) \geq 0{,}30$
Low	$(< g >) < 0{,}30$

3. Result and Discussion

The result of this research and development is divided into three stages; planning stage, development stage, and evaluation stage.

3.1. Planning stage

Media planning criterion should be developed according to the desired outcomes, condition, and existing boundaries while taking into account the capacities and characteristics of the media. Based on syllabus analysis, thermodynamics could be seen as potential competency to be incorporated in interactive multimedia based on multiple intelligences. Furthermore, according to the concept analysis, thermodynamics is an abstract material which contains many physical variables, and mathematical equations. Meanwhile, the result of students' characteristics analysis shows that the majority of students (84%) are visual-spatial intelligence as their strongest intelligence, followed by 10% of students who are verbal-linguistic intelligence as their strongest intelligence, and 6 % of students who are logical-mathematical intelligence as their strongest intelligence. The complete data are illustrated in Figure 1. Therefore, the multimedia is developed and presented by considering the diversity of intelligence based on the teaching material and student characteristics—the three mentioned intelligence type. The interactive multimedia is developed for reaching instructional goals through gained benefits of instructional media, by this, students could understand more and might achieve instructional goals well [23].

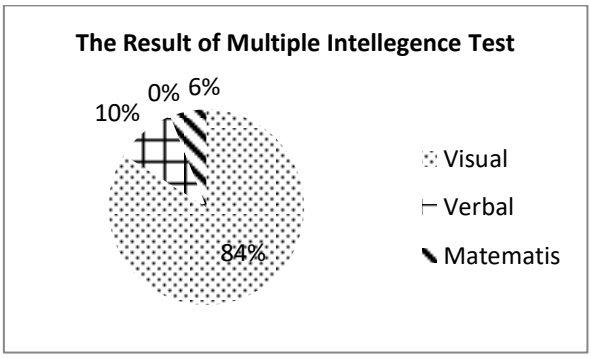

Figure 1. The Multiple Intelligences Test results of Students in Grade 11 SMA 1 Indralaya Utara

3.2. Development stage

From chosen competency, Derived Teaching Materials (DTM) and Multimedia Content Outline (MCO) that would be included in thermodynamics interactive multimedia based on multiple intelligences are compiled. Before creating multimedia, flowchart and storyboard are initially created as a guide in constructing multimedia. Flowchart creation showed that students are able to operate thermodynamics materials in accordance with students' dominant intelligence or their wish. On storyboard development, it could be shown that thermodynamics interactive multimedia based on multiple intelligences is presented by showing pictures, graphics, texts, videos, animations, simulations, etc. It is stated that the utilization of various representation in instruction could reduce the

abstract impression of physics contents [24]. On the multimedia creation process, computer programs are used for combining various multimedia aspects which enables auditory and visual senses usage by students when the instruction is given. It corresponds with the statement that multimedia instruction involved auditory and visual senses through text, still visual, moving visual, audio, and interactive media based on computer and information and communication technology (T) [25]. One of the application is physics instruction—by presenting pictures, graphics, texts, videos, animations, simulations, etc.

3.3. Evaluation stage

Evaluation method used is formative evaluation which aims to find out validity, practicality, and the potential effect of the usage of thermodynamics interactive multimedia based on multiple intelligences. The evaluation stage consisted of five stages; self-evaluation, expert review, one-to-one, small group, and field test.

3.3.1. Self-evaluation. On this stage, the self-evaluation process is applied to Prototype 1. Some faults and flaws are found, such as Navigation button function was not matched with an intended hyperlink; malfunctioned button; unattractive opening page; faults in the main page; unvaried music selection; and typographical error on some texts. Revision then performed to revise Prototype 1 before entering the expert validation stage.

3.3.2. Expert Review. The revised Prototype 1 through self-evaluation stage is submitted to 3 validators for validation. Validators checked, analyzed, and reviewed prototype 1. Validators give score and comments on provided validation forms. In Table 4, the result of thermodynamics interactive multimedia based on multiple intelligences validation from experts is presented. Based on comments and suggestions from validators, prototype 1 must be fixed. From validator assessment, the obtained total mean percentage is 93.11% and it is very valid categorized.

Table 4. The result of Thermodynamics Interactive Multimedia Based on Multiple Intelligences Expert Validation on Expert Review Stage

Validator (*Expert*)	**Indicator / Scored Aspect**	**Score Mean**	**Percentage (%)**
Validator 1	Content Mean	3,57	89,87
Validator 2	Lay-Out Mean	4,00	100,00
Validator 3	Content Mean	3,57	89,87
	Lay-Out Mean	3,67	92,7
Multimedia Validation Total Mean Score		**3,70**	**93,11**

3.3.3. One-to-one. On this stage, prototype 1 is tested on three students of Grade 11 Natural Science 2 Class of Indralaya Utara 1 State Center of Excellence Senior High School with different capabilities, from low to high, based on the recommendation given by physics teacher who taught the class. On this stage, students are asked to do instruction using prototype 1. After instruction, students are asked to fill in the questionnaire for fixing prototype 1. The result of the students' response questionnaire could be seen in Table 5.

Table 5. The result of student response questionnaire on one to one evaluation stage

Student	Mean Score	Percentage (%)
Student 1	3,75	93,75
Student 2	3,75	93,75
Student 3	3,90	97,58
TotalMean Score	**3,80**	**94,86**

Based on data on Table 5, it could be concluded that the total mean score from the student response questionnaire regarding thermodynamics interactive multimedia based on multiple intelligences is 94.86% which is very practical categorized.

3.3.4. Small group. On this stage, prototype 2, the revised prototype 1, is tested on 9 students of Grade 11 Natural Science 2 Class of Indralaya Utara 1 State Center of Excellence Senior High School which are consisted of 3 low capability students, 3 medium capability students, and 3 high capability students based on recommendation from physics teacher who taught the class. Before doing the instruction, the students are asked to do multiple intelligence tests to determine dominant intelligence type on each student. Students furthermore are given instruction with guidance by researchers just like instruction on real class. After instruction, students are given questionnaire form to be filled. The result from the student's response questionnaire could be seen in Table 6.

Based on the calculation from the questionnaire filled by the students, total mean percentage of students response is 86.36% which very practical categorized. Total mean of the questionnaire from one to one stage and small group stage is 90.61%. That score showed that the developed thermodynamics interactive multimedia based on multiple intelligences is very practical categorized. This final product would be tested on the field test stage.

Table 6. Result of student response questionnaire on small group stage

Student	Response Mean	Percentage (%)
Student 1	3,38	84,61
Student 2	3,54	88,50
Student 3	3,46	86,50
Student 4	3,61	90,25
Student 5	3,77	94,25
Student 6	3,00	75,00
Student 7	3,46	86,50
Student 8	3,07	76,75
Student 9	3,80	94,80
Total Mean	**3,45**	**86,36**

3.3.5. Field test. On this stage, thermodynamics interactive multimedia based on multiple intelligences which are stated as very valid and very practical categorized is tested on the real class—with 31 students of Grade 11 Natural Science 1 Class of Indralaya Utara 1 State Center of Excellence Senior High School as the research subject. The time allocated for the test was 6 lesson periods (three times meeting), including meeting for preliminary test and final test. Based on students' learning outcome from normalized preliminary test score and final test score, the highest N-gain score is students with dominant logical-mathematical intelligence group with medium N-Gain categorized by mean of 0.49. In students with dominant visual-spatial intelligence group, obtained N-Gain mean is 0.37 and

medium categorized. The lowest N-gain mean is in students with dominant verbal-linguistic intelligence group with a score of 0.28 which is categorized as the low category.

Figure 2 shows that students with dominant logical-mathematical intelligence understand easier the material presented in the multimedia form and presented with some graphics and data categorizing which makes students learned easier. Similarly, it could be said that students with dominant visual-spatial intelligence might easily understand the material presented by using interesting visualization concepts. The students with dominant verbal-linguistic intelligence also interest with concepts explanation through words that are easy to understand by the students. According to Figure 2, it can be concluded that every student with their different dominant intelligence has a low potential effect on verbal-linguistic intelligence, medium effectiveness on logical-mathematical intelligence, and medium effectiveness on visual-spatial intelligence. Generally, N-Gain obtained is 0.37 and could be categorized as the medium on students' learning outcome improvement. Students' overall effectiveness after a preliminary test and the final test could be seen in Figure 3.

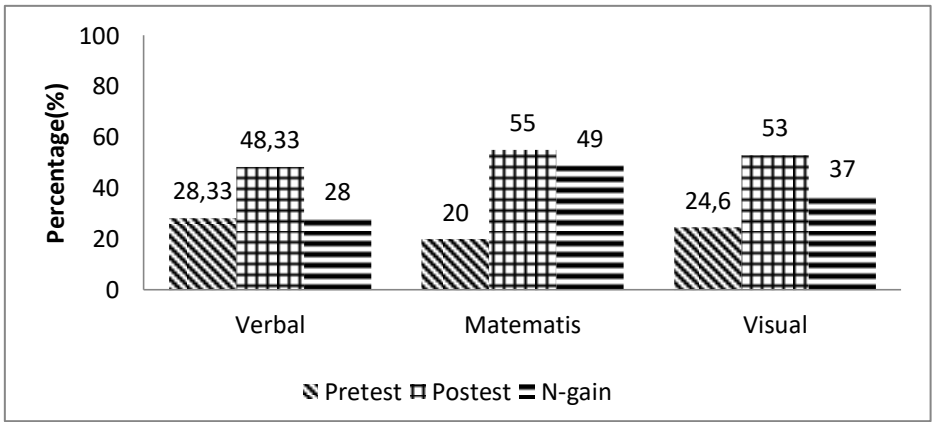

Figure 2. Obtained Score Results

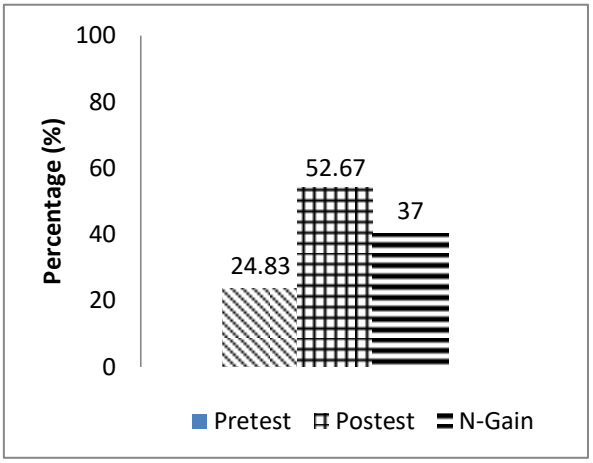

Figure 3. Overall obtained score results

According to research conducted by [26], it reveals that using several interactive learning media such as games and simulation might increase students levels in terms of motivation. Moreover, by using this instructional media tends to enhance the participation level of involved students in the learning activity. Moreover, regarding the performed research by [27], shows that educational technology also supports the instructor to be more creative in innovating learning media for students which more

interactive and well-suited for active, collaborative student's centered learning that multimedia intelligence featured. By this, student's skill might increase as a result of applied learning media. Research conducted by [28,29], for instance, that shows teacher might influence the learning cognitive skill through learning activity with multimedia intelligence approach. Furthermore, it also appears the fact that the multimedia-intelligences-based media might develop student's logic-mathematics skill. Another beneficial impact through MI-based media is the provided convenience for the users and flexibility to be administered for a large group of students [30]. The advantages of thermodynamics interactive multimedia based on multiple intelligences for grade 11 senior high school students are outlined as follow: (a) the instruction is student-centered type; (b) students have facilities to repeat the instruction, if it is needed, and students would be able to develop their creativity during repetition; (c) it could be adjusted to students' learning capability; (d) the learning materials presented are varied and supported every dominant intelligence; (e) there is interactive virtual lab for understanding gas conditions during some process that could not be seen directly; (f) interactive evaluation could show students evaluation result directly, including whether they passed the subjects or not.. Meanwhile, the disadvantages are: (a) It is usable only in schools with computer facilities; (b) it would be difficult to use by students who are not used to operate the computer.

4. Conclusions and Suggestions

The developed thermodynamics interactive multimedia based on multiple intelligences on physics subject for grade 11 of senior high school are: categorized as very valid with the percentage of 93,11%; categorized as very practical with mean percentage of 90,61 %; and categorized as having medium effectivity with N-gain score of 0,37.

Furthermore, some suggestions that could be stated regarding this research. First, the school may integrate ICT into instruction activities as instruction tools to help to improve and optimize students' learning quality. Second, the teacher may use this interactive multimedia as one of the alternative instructional media that could be utilized in the instruction process to improve students' learning motivation while observing students' diversity. Third, other researchers may develop other interactive multimedia based on multiple intelligences on other teaching points while using other types of intelligences.

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References

[1] Tondeur J, Van Braak J, and Valcke M 2007 *Br. J. Educ. Technol.* **38** 962
[2] Dreyfus B W, Geller B D, Meltzer D E, and Sawtelle V 2015 *Am. J. Phys.* **83** 5
[3] Henderson M, Selwyn N, Aston R 2017 *Stud. High. Educ.* **42** 1567
[4] Poli A, Gambini A, Pezzotti A, Broglia A, Mazzola A, Muschiato S, et al 2018 *Digital Diorama: An Interactive Multimedia Resource for Learning the Life Sciences. In Optimizing Human-Computer Interaction With Emerging Technologies* (IGI Global) p 52
[5] Turel V and McKenna P 2015 *Design of Multimedia Listening Software: Instructions, Tasks, Texts, and Self-Assessment Tests. In Intelligent Design of Interactive Multimedia Listening Softw*are (IGI Global) p 142
[6] Hakim A, Liliasari L, Setiawan A, and Saptawati G A P 2017 *J. Pendidik. Fis. Indones.* **13** 33
[7] Luiselli J K, Putnam R F, Handler M W, and Feinberg A B 2005 *Educ. Psychol.* **25** 183
[8] Wilson J D 2018 *Student learning in higher education* (Routledge)
[9] Rogowsky B A, Calhoun B M, and Tallal P 2015 *J. Educ. Psychol.* **107** 64
[10] Douglas S 2015 *J. Thoughts* 261
[11] Mertens D M 2014 *Research and evaluation in education and psychology: Integrating diversity with quantitative, qualitative, and mixed methods* (Sage publications)

[12] Azarmi B, Jahangard A, and Movassagh H 2012 *Brain-Broad Res. Artif. Intell. Neurosci.* **3** 51
[13] Sulaiman T, Abdurahman A R, and Rahim S S A 2010 *Procedia - Soc. Behav. Sci.* **8** 512
[14] Chachil K, Engkamat A, Sarkawi A, and Shuib A R A 2015 *Procedia - Soc. Behav. Sci.* **167** 267
[15] Georgiou H and Sharma M D 2015 *Eur. J. Phys.* **36** 1
[16] Jamuri, Kosim, and Doyan A 2015 *J. Penelit. Pendidik. IPA (JPP IPA)* **1**123
[17] Purnamasari W and Admoko S 2015 *Inov. Pendidik. Fis.* **04** 98
[18] Aryani A D, Sudjito D N, and Sudarmi M 2015 *EDUSAINS* **06** 1
[19] Riandry M A, Ismet I and Akhsan H 2017 *Proc. IOP Conf. Series: Journal on Physics* (IOP Publishing) p 012047
[20] Wiyono K 2015 *J. Inov. dan Pembelajaran Fis.* **2** 123
[21] Meltzer D E 2002 *Am. J. Phys.* **70** 1259
[22] Hake R R 1998 *Interavtive engagement vs traditional methods*
[23] Santyasa I W 2007 *Model-Model Pembelajaran Inovatif* (Jakarta: Raja Grafindo Persada) p 1
[24] Ismet I 2012 *In: Prosiding Seminar Nasional Pendidikan IPA 2012* p 109
[25] Asyar R 2011 *Developing creative learning media* (Jakarta: Gaung Persada
[26] De Freitas S 2006 *Learn. Media Technol.* **31** 343
[27] Schrand T 2004 *Tapping into Active Learning and Multiple Intelligences With Interactive Multimedia* (Prince)
[28] Delgoshaeia Y and Delavaria N 2012 *Procedia - Soc. Behav. Sci.* **32** 361
[29] Li J, Ma S, and Ma L 2012 *Phys. Procedia* **33** 1749
[30] Chen X and Soldner M 2013 *Natl. Cent. Educ. Stat.* (Statistical Analysis Report. NCES 2014-001) 102