Development of MBI$_2$ as interactive media in order to enhance scientific communication skills in global warming subject

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Abstract. The needs of technology-based learning media on physics subject is amplified in each year, although the learning media often not contextual with the learning subject since certain subject is more suitable with direct experiment. The purpose of this research is to develop media that integrated with the subject (MBI$_2$) in order to enhance scientific communication skills on subject that difficult to observe such global warming subject. This Research develop a media using Sherwoods developing model within the step is: Initiation, Specifications, Design, Production, Review and Evaluation, Delivery and Implementation. Thirty students in some middle school already participated in this research. The result approve that the students is encouraged to more communicative and showing a development with a normalize gain for writing scientific communication skills is 0.38 and for Oral Scientific communication skills is 0.24. With the conclusion is the utilization of MBI$_2$ could be used for further research that related with enhancement of scientific communication skills.

1. Introduction

Nowadays, science and technology advance swiftly. Technology growth has an influence on the development of learning approaches and media, predominantly in the usage of computer and the internet [1]. Computer and Internet Technologies are becoming indispensable components of the modern learning environment. These technologies are originating to be positioned in education institution for learning method. Through multimedia, teachers possibly will extant the information in an innovative manner and motivate the students to learn rapidly [2]. Bringing the subject by means of numerous media may well be way more effective than doing it over by a solitary media element. An effective multimedia necessitates cautiously uniting in well-reasoned ways that receipts advantage of apiece medium’s inimitable characteristics to epitomize the learning content [2,3].

There are numerous apparent advantages of interactive multimedia exceeding the traditional teaching methods. One of these is as an efficient alternative to individual or group, tuition, where such a device permits the provision of instantaneous and unswerving, or where the lessons is run as part of a distance education program. It correspondingly has the potential to extend further for advanced students and to support those who necessitate more attention through the opportunity to consist of various stages of complexity in one package [4].

Related to science course such Physics subject, there is imperceptible subject for the instance quantum physics or global warming which remain complex to represent and compare with tangible
phenomenon. Furthermore, one of simple material of physics but very hard to observe is global warming subject since it was fraction-less subject and easy to determine and discuss, but we cannot observe the phenomenon directly. For instance, there is specific material that students ought to know in global warming subject such greenhouse effect. It’s nearly impossible to show the students actual greenhouse effect wherever you are, even the students use special equipment such thermal camera which enabled temperature visioning, you still cannot see whole process of greenhouse effect. It way more efficient if the process of greenhouse effect that affect global warming is set up on media like picture, or simulation. Figure.1 show us an example of global warming process for educational purpose.

Figure 1. Global warming process.

Utilize representation of phenomenon by picture/simulation, students have their own perception about global warming process, it’s now a teacher job to explain and gather the opinion for concluding this process, media would increase the subject understanding magnificently. This is the basically why most of physics subject is requiring to represented by animation or simulation.

The simulations used in Physics teaching are computer programs that possess an implicit model of behaviour of a physical system. This permits the students to discover and to visualize graphic representation [5,6]. Learning through computer simulations is closely associated to a precise procedure of constructivist learning, namely scientific discovery learning. The students can interact with the system by altering the variable to the desired ones and perceive the outcome of those variations. Although simulations may well be considered as the fastest and the finest tool, however they cannot supersede real laboratory experiences, but can be used hand in hand with the intention of enhancing the understanding of certain concepts [5].

Whether using the actual experiment or simulation on physics subject, the students require to elucidate the outcome of their discovery. The way to deliver the experimental product called scientific communication. Another researcher discovered that some students exclusively in Indonesia have a lack of communication skills, particularly for the oral communication. Meanwhile, the scientific communication skills are essential in the way to be taught on physics subject for the reason that it capable to adjust the learning state into a good atmosphere within the societal presence between students or teacher [7].

Based on these contemplations, the purpose of this research is did the enquiry to develop multimedia that integrated with the subject that researcher called Multimedia Based Integrated Instruction (MBI2). For supporting the development and usefulness of MBI2 researcher trying to enhance the scientific communication skills with MBI2. Two aspect of scientific communication skills that this research will be focused is divided into two variable, that is Oral communication and written communication. it may be an extremely challenge to make an impressive multimedia with global
warming subject to enhance scientific communication skills since its very rarely to find and least amount of related research, nonetheless the research will accomplish and conclude the credits.

2. Methods
The methodology [8] sketched in this paper, therefore is, in result, a benchmark that will assist quality enhancement and amplified effectiveness in organizations involved, or proposing to involve, in the specification, design, production, evaluation and implementation of interactive resource-based education and training. The clear and detailed models of new/best practice, the integrated set of templates and the supporting tools provide developers with a model with which they can approach more systematically the design and development of multimedia products and systems [8].

Interactive multimedia products offer themselves to an enhancement procedure based on collaborative analysis and design, iterative and rapid prototyping. Small development groups comprised of specialists with advanced utensil sets, and project management based on prioritization. The methodology outlined in this research follows this procedure and emphases on six phases of multimedia development: Initiation, Specifications, Design, Production, Review and Evaluation, Delivery and Implementation.

The following diagram, Figure. 2 outlines some of the tasks in each phase. Review by the expert and guidance are undertaken in most phases.

![Figure 2. Overview of the methodology and sample task in research.](image)

In addition to validate the media, this research conducts scientific communication enhancement. The scientific communication elements will be implemented on MBI\textsuperscript{2} to make sure both of media and scientific communication will give an effective and excellent way to learn. It will take around two meetings to accomplish the review and testing of MBI\textsuperscript{2}.

Scientific communication itself is divided into two different type, that is Oral communication and Written communication. The Written communication assessed when learning process is occur by worksheet in each meeting. Oral communication assessed when the discussion and presentation occurred in learning process while students finishing the worksheet by several observer who already qualified by the researcher group. This multimedia will be tested on seventh grader students from junior high school in Bandung. 30 students are take a part for this study preferred by purposive sampling seeing as the needs of requiring a lot quantity of computer, and the students which never study about global warming before.
3. Result and Discussion
The Result will explain further in two separated section, multimedia design progress result, and quantitative evaluation of scientific communication skills outcome. Scientific communication skills instrument based on adapting certain reference to measure [9,10] is divided into two parts, it will be Oral scientific communication and Written scientific Communication skills.

3.1. MBI\textsuperscript{2} development
MBI\textsuperscript{2} progress follows Sherwood [8]’s methodological design. Within the six phases to create the media under the supervision of several media and physics subject expert. The process will have explained on each phase.

3.1.1. Project initiation. The Initiation phase concentrations on the planning essential for the development of the media creation. Tasks consist of the determination of the inclusive strategy, the charges associated with copyright and rights consultations are incorporated into the scope of the risk management (business, technical and project risks) to be completed is recognized [8]. In these following phases, the researcher requires to find resourceful literature and journal to be a foundation of research. In addition, the research takes a step to sketch the idea of media concept and plan along with the timeline that have been scheduled. The result is the researcher find Sherwood [8]’s methodological design to create MBI\textsuperscript{2}. The main reason to create MBI\textsuperscript{2} with Sherwood [8]’s methodological design is it’s easy to understand as its follow the mostly Research & Design models, especially on 4D’s methodology, but it has their own term and additional step to perfectly finished the media.

3.1.2. Specification. In this phase, the viability of the project is reviewed. Exhaustive specifications of functional and, where proper, performance necessities, content and aims of learning outcomes are developed [8]. The researcher spends several weeks to decide which topic that fit to secondary students, and after the investigation, the researcher choose global warming subject in the means of the subject is imperceptible, it suitable to display whole process in media and also with its limited amount of resource or media especially in Indonesia. To support the development of media, Scientific communication skills development assist MBI\textsuperscript{2} in order to prove both quality to be a learning media. The further result will be explained in section 3.2.

3.1.3. Design. A foremost product of this phase is the Design Document which recognizes the human activity that the anticipated interactive multimedia system will maintain. It as well detects the people or users who will accomplish the activity and outlines the solution to the design problem [8]. Design document that researcher has been developed is Storyboard which consist the contextual subject about global warming that already implemented into grand design of interfaces and simulations. Furthermore, Flowchart will help the basic of construction of MBI\textsuperscript{2} which obtained from Storyboard. The expert will help the progress to supervise and review MBI\textsuperscript{2} progress along with scientific communication instrument accomplishment. Figure.3 give an example of Storyboard displayed pre-interface sketched by researcher with the Microsoft Power Point application.
3.1.4. Production. Within this phase, regulator of change is critical, as is attention to feature. Adherence to the specified technical aspects and formats are monitored and reviewed. Media acquisition is confirmed, and all rights and/or license negotiations should be complete. Production will be assigned to a professional to take part in making a MBI. Therefore, the content and animation in MBI will integrated with scientific communication skills that done by the researchers.

3.1.5. Review and Evaluation. This phase occurs throughout the iterative development process. At the end of each cycle of conceptualize, specify, design and produce, the product is critically examined before starting the next iteration. For products and systems, maintenance evaluation is conducted to examine their viability over time. The expert will review any details including the concept, and verbal text that used in MBI. The Enhancement of scientific communication will take part in this phase to validate the usefulness of MBI, so the researcher can direct the further purpose of MBI is created. The outcomes of scientific communication skills enhancement will be discussed in the next section.

3.1.6. Delivery and Implementation. The level of research support, performance support and ongoing maintenance is finalized with the professional. The overall conduct of the project is reviewed with corrective actions recommended.

3.2. Scientific communication skills result
Learning global warming by using MBI was implemented in two sub-concepts that should be discussed: the greenhouse effect and factors of global warming, and global warming impact and solutions. The results of the normalized gain analysis of each topic are presented in Table 1.
Table 1. The result of normalized gain of scientific communication skills on each sub-concept.

| SCS - Categories | Average score of meeting | g | Categories |
|------------------|--------------------------|---|-----------|
|                  | 1st                      | 2nd |            |
| Oral             | 2.04                     | 2.50 | 0.24 | Low |
| Written          | 2.39                     | 3.01 | 0.38 | Moderate |

Based on Table 2, there is a gradually enhancement in students’ scientific communication skills, at respectively meeting through similar normalized gain scores, students’ oral communication included in the low category [9]. Those studies also present related result that learning with computer multimedia enable to enhance students’ scientific communication skills in physics subject [1,5,10,15]. The rationale of this result is the utilization of multimedia computer in the learning course will initiate students to conduct their investigation on the way to comprehend new information based on data and simulation in MBl2. It means MBl2 emerge a new problem that must be solved together, so that students will be encouraged to communicate each other in a discussion along the learning process. There is increasing inclination for both type of scientific communication skills, there is gradual improvement in oral communication with N-gain score is at 0.24 that included in low category, and also in written communication the result of N-gain score is at 0.38 that included in moderate category. Scientific communication consists some aspect on both type. Figure 4 and Figure 5 show N-gain on each aspect of scientific communication skills.

![Figure 4](image1.png)  ![Figure 5](image2.png)

3.2.1. Written Scientific communication. There are four aspects that adapted from certain reference [11,12] of written communication there are context, scientific words, data gathering, and graphing. The highest N-gain increase is on Scientific reasoning skills with N-gain score 0.65. Scientific reasoning assessed as ability to answer a question based on scientific properties such hypothesis, purpose of learning, data, and drawing a conclusion [11]. On the first meeting, students are not acquainted to using scientific properties as derivation of their answer, after a correction and review from teacher, it increases magnificently since they previously recognize the procedure, beside that...
MBI$_2$ also take a part to enhance this aspect like display some animation and video that have to be analyzed and interpreted to an answer.

In contrary, the lowest N-gain increases with 0.05 and 0.09 score is data gathering and graphing. The researcher set a low standard for these criteria at the basic level [13], most of students by now understand how to take and generate data and also transform it into graph or table. MBI$_2$ also trying to increase this aspect such put a variation form of data, and instructed to draw a good graph, but it still does not affect impressively. Figure 6 and Figure 7 give an example of MBI$_2$ display in order to encourage students written scientific communication skills.

**Figure 6.** MBI$_2$ shows various form of data and graph, in addition give extra learning by concluding an answer based on data or graph.

**Figure 7.** Carbon steps calculator on MBI$_2$, allowing the students to count their CO$_2$ emission. so, students gather data based on their activities and students have to give their opinion.

### 3.2.2 Oral scientific communication

There are also four aspects on this type of communication, namely Asking Question, Contextual Explaining, Data Presentation, and Scientific Words [11,12]. The highest gain reached on Oral communication is Asking Question. Asking Question does not mean every single question that students ask will be considered as additional score for students, but it depend on the context and how it related to material or not. With N-gain score barely on low category, learning with MBI$_2$ that explain much thing trigger the students to asking something that related to subject, on first meeting the students does not seems understand what they have to ask, because they also still not understand the learning process, and some method like writing and answer based by procedural scientific progress. Basically, they are not understood how to operate the MBI$_2$ properly, so they focused on technical issue rather than the concept itself. That’s why big lead of N-gain is happened on the second meeting which they already get used to understand how MBI$_2$ works, so they start to notice what is their real problem is. with the score of N-gain 0.31, it is included as moderate category, lead all the other raising aspect which only get low category.

On the other hand, the lowest increase occurred in the Scientific Words category with the score of N-gain is 0.09. This reasonable score is occurred because it makes an enormous effort to create scientific atmosphere only in two meetings. According to previous research about scientific attitude, the lowest N-gain increased is also on communication skills [1]. In this case, more specifically scientific word is the way students communicate each other while using certain words and based on facts / data they already found/count [11,14]. Scientific word is learned in MBI$_2$ implicitly, the feature and display of MBI$_2$ already give a hint for students to use data or graph as the reference of their discussion, but it still hard to observe because students are concerning what they think and other think about the problem. N-gain not raise properly since there are no significant change of the way they communicate each other in two meetings.
4. Conclusion
Based on the research that has been conducted, it was concluded that the use of multimedia computer in global warming subject for junior high school students is capable to enhance scientific communication skills on each type, Oral communication with low category and Written with moderate category in normalized gain score on each sub-concept learnt. The development of scientific communication skills is also found in each indicator with the highest increase in Scientific Reasoning and Asking Question skill indicator, while the lowest increase is on Data gathering, Graphing, and Scientific Words.

In practical terms, the use of computer MBI2 can be used as further research to improve students' scientific communication skills. However, it has not been optimized to improve data gathering, graphing and scientific Word as well. It is supported by the results of this research which shows that the normalized gain scores are still low. So, to improve these skills, the aspect must be learned by computer multimedia, and set the appropriate standard for the rubric. MBI2 can only be used as the media that supports learning process. For further research, it would be better if the tests are conducted using an additional meeting in order to access more detail information of students' scientific communication skills in answering questions based on scientifically frame.

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