Textbook design based on multiple intelligences with the theme of earth protector

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Abstract. This study aims to describe the design of teaching materials of earth and space science subject on theme of Earth protector-based on multiple intelligence for high school students. The whole process consist of three steps, namely Define, Design and Develop. Our work will focus on design stage that consists of four tiers: constructing criterion-referenced, media selection, format selection and initial design. Our teaching material product is accommodating two integrated models, which are webbed and threated model. The webbed model is built based on twenty-eight Basic Competencies in the 2013 curriculum with theme on Earth Protector. Meanwhile, threated model underlies the meta-cognitive arrangement of book with that accommodate multiple intelligences. This teaching material integrates five subjects, namely Natural Sciences, Social Sciences, Mathematics, Islamic Education and Bahasa.

1. Introduction
Teaching materials are materials or subject matter that are arranged systematically, which were used by teachers and students in the learning process [1]. Teaching materials contain content that needs to be studied by students in the form of print or facilitated by the teacher to achieve certain goals [2]. Instructional materials contain content that is either written, mediated, or facilitated by an instruction that students use to achieve the objective as well as include information about the learners who will use to guide the progress [3]. Textbooks are instructional texts written to teach their users. As such, textbooks have some similarity to the course of a classroom lessons, without being used for actual learning.

Success in the learning process can not be separated from three elements, namely: curriculum, learning model approach, and teaching materials. Often teaching materials are used as the basis for making classroom learning models. One ideal teacher is those who prepare teaching devices and teaching materials effectively. Without the complete teaching materials, the teacher will experience difficulties in increasing effectiveness in the learning process. Likewise, for students, they will experience learning difficulties without teaching materials. Especially if the teacher explains the teaching material too quick and unclear. The need for teaching materials is important to improve the quality of learning. Teaching Earth and Space Science material in schools whether in science or social studies teachers often depends on an available textbook. However, the book does not meet the criteria...
of a good book according to Puskurbuk of the Ministry of National Education. In addition, the design does not pay attention to student's initial abilities, learning resources, conditions and available facilities, the lack of link between subject and real world, the level of language that is still difficult for some students to understand and the lack of development of student's multiple intelligence [4]. In addition, teaching materials can give students complete autonomy and independence to carry out their own learning activities [5].

Starting from the problems described, it is necessary to develop teaching materials that can integrate several subjects with also covers student's multiple intelligence. Teaching materials that are in accordance with the direction of the 2013 curriculum, namely by developing integrated learning models that are integrated with a focus not only on embed concepts but also multiple intelligence. IPBA lesson so far only accommodates a number of intelligences such as linguistics and logical-mathematical [6,7]. Even though every child have a diverse intelligences. We tend to only respect people who are experts in logic (mathematics) and language skills. We must give a balanced attention to the people who have gifts in other types of intelligences such as artists, architects, musicians, naturalists, designers, dancers, therapists, entrepreneurs, etc. [8]. Therefore, there is a need for innovation in learning that can equip students with Earth and Space Science (ESS) textbook material that accommodate a variety of intelligences for each student [9-11].

2. Methods

The design of this teaching material considers the interrelationship between material characteristics with each multiple intelligence. The design of integrated teaching materials based on multiple intelligence are made using four stages that consist of four tiers: constructing criterion-referenced, media selection, format selection and initial design [12]. The design phase of the teaching material consists of four steps, namely:

2.1. Constructing criterion-referenced tests

This process is an important phase that must be completed before heading to the selection of media and format phase. This text's reconstruction needs to adjust to the language style of middle school / equivalent age. But the criteria or indicators need to be set in advance. The development of indicators at this phase is used at the selection of media and format phase. Words selection conducted at this phase aims to make teaching materials easy to understand for students with very low linguistic intelligence.

2.2. Media selection

The selection of media is adjusted to the material characteristics and endeavored to conduct experiments. But if it can't be achieved then it will be supported by media simulation. Besides that, every concept given to teaching materials is minimally supported by media images. This is to support students who have a dominant visual intelligence. The selection of media through experiments can develop all multiple intelligences compared to using simulators.

2.3. Format selection

The selection of learning formats that is adjusted to the media available in the previous stages, namely the stages of media selection. The choice of format must support learning with multiple intelligence that can be supported in one activity. The needs in selecting format for this media can be see again in the previous stage that is media selection.

2.4. Initial design

In learning, thematic or integrated learning is difficult to achieve. Therefore, it is necessary to place material and divide competencies in each topic raised. This is very important considering that in the standards set by the National Education Standards Agency (BSNP) and the Center for Curriculum and Books (puskurbur) requires the balance of material in the chapter in writing a book. It also involves structuring various learning activities such as reading texts, conducting interviews with special education personnel, and practicing peer teaching skills when making long-term product designs.
3. Result and Discussion

3.1. Constructing criterion-referenced test

In teaching materials that refer only to the Content Standards, the process of identifying indicators is carried out after the determination of basic competencies. But in the development of Earth Protector theme, development is carried out after the establishment of activities. In addition to being able to clarify competencies that can be achieved, the indicators that are not found in KD will be made. This indicator can be used by the teacher especially to pick and choose the material that corresponds to the material being taught. In addition, this indicator can be used as the basis for preparing the Learning Implementation Plan if indeed the learning design is fully in accordance with the teaching materials of the Earth Guard book. The following is an example of a list of indicators on the Earth Guard book teaching material.

Table 1. List of Indicators for Earth-Protective Teaching Materials.

| Sub CHAPTER                                | Indicators                                                                 |
|--------------------------------------------|---------------------------------------------------------------------------|
| Earth's Electromagnetic Protective Layer    |                                                                           |
| Invisible Light                            | Registering types of electromagnetic waves based on energy levels         |
|                                            | Registering the application of the type of electromagnetic wave technology|
| Layer of Sun                                | Registering the interior and atmospheric layers of the Sun.               |
|                                            | Explaining the phenomenon that occurs in the layers of the Sun.           |
|                                            | Explaining the influence of electric current on a magnetic field          |
|                                            | Explaining the differential effect of rotation on the appearance of a sunspot|
| Sun’s atmosphere                           | Explaining the phenomena that occur on the chromosome                     |
|                                            | Draw a circle from juring                                                |
|                                            | Determining the scale of comparison of maps and objects                  |
|                                            | Explaining the direction of the comet's tail                             |
| Layer of earth                             | Registering the interior layers of the Earth                              |
| Magnetosphere                              | Describing Earth's mantle convection causing the Van Allen Belt           |
|                                            | Registering animals that have magnetoreceptors                           |
| Ionosphere                                 | Distinguishing between positive ions and negative ions                    |
|                                            | Explaining the characteristics of the ionosphere in reflecting radio waves|
| Aurora                                     | Explaining the process of the occurrence of Aurora from a solar storm      |
|                                            | Restate Bohr's rules in hydrogen gas emissions                           |
|                                            | Explaining the appearance of aurora colors with the concept of gas emissions|
|                                            | Explaining the influence of magnetic fields on the emergence of electric currents|
|                                            | Explaining the impact of the aurora phenomenon by electromagnetic induction|
|                                            | Judging science issues in society                                        |
|                                            | Arranging an explanatory text about aurora phenomenon                     |
|                                            | Rewriting the main ideas of a paragraph                                   |
| Atmospheric Layer                          |                                                                           |
| Exosphere and Thermosphere                 | Registering the layers of the atmosphere                                 |
|                                            | Registering the artificial satellite and its functions                   |
| Mesosphere                                 | Explaining the effect of heat on expansion                                |
|                                            | Registering the expansion phenomena in everyday life                     |
3.2. Media selection

The media used in teaching materials uses a variety of media. Many use media when experimenting. Experiments are learning methods that are able to accommodate many multiple intelligences. In addition, experiment can be developed by the teacher to cultivate many characters. The following is a list of experiments developed on the Earth Protector theme:

| Name of activity                           | Materi                  |
|--------------------------------------------|-------------------------|
| Earth Electromagnetic Protector            | Invisible Light         |
| Detect Invisible Light                     | Invisible Light         |
| Making Magnets with Electricity            | Magnetosphere           |
| Measuring the Sun’s Fire                   | Sun’s atmosphere        |
| Making Earth’s Magnetic Field              | Magnetosphere           |
| Domestic and International Radio Broadcasts| Ionosphere              |
| Making electricity from a magnet           | Aurora                  |
| Atmospheric Layer                          |                         |
| Hot Competition                            | Meteor                  |
| Broken Alone                               | Meteor                  |
| Drawing with Light                         | UV radiation            |

The use of experimental methods is not a single choice because it is very effective in covering multiple intelligence’s domains. However, if it is felt that the type of experiment is difficult and the media used is difficult to obtain, then the next choice is a simulator. This type of experiment is limited to science teaching material in schools and household items that can be easily obtained by students. The simulations are available free of charge. The following simulator is used in teaching materials:

| Nama Kegiatan                  | Materi     | Sumber             |
|--------------------------------|------------|--------------------|
| Earth Electromagnetic Protector| Bohr’s Rules| pHet               |
| Photoelectric game             |            |                    |
| Atmospheric Layer              | Meteor     | down2earth.eu     |
| Measuring Meteorite Hazards    | Meteor     |                     |

Table 2. List of Practicum Experiments.

Table 3. List of simulators in teaching materials.
3.3. Format selection
The Earth Protector Book demands that as an integrated book that accommodates various domains of multiple intelligences and cultivation of character. Therefore, activities must be diverse in order to accommodate the demands of the book. The following are the types of activities in the Earth Protector book.

3.3.1. Coba-coba (Try This). This content is experimental content that can be done either at school or at home. Experiments that students can do is quite a lot. This is because in this book every major concept that is built, must go through experiments. Although it has been explained through text.

3.3.2. Coba Pikir (Try to Think). This column invites students to enjoy thinking with phenomena that occur in the environment. The main purpose of this column trains students to get used to problem solving.

3.3.3. Coba Ekplorasi (Try Exploration). This column contains homework to explore the surrounding environment or to find information related to natural phenomena. So that students will be familiar with integrated learning that used by the teacher in the class.

3.3.4. Coba Bermain Logika. This column contains practice questions. The main goal is for students to get used to solving problems independently.

3.3.5. Coba Simpulkan. This column is usually found after coba-coba (Experiments). The goal is that students are guided in making concluding sentences after each experiment.

3.3.6. Coba Gambar/Menyanyi. This column is in addition so students can strengthen the concept and remember the material learned.

3.3.7. Info Ilmiah, Telisik Sains. This column is additional knowledge for students outside the material taught. The goal is to increase student's insight.

3.3.8. Telisik Bahasa. This column is intended so that students continue to learn the creation of several types of texts that are learned in Bahasa subjects according to the Content Standards.

3.3.9. Rehat Sejenak. This content is a competency test for each chapter that is uniquely wrapped with different types of questions so that the teacher can provide a more diverse and interesting competency test.

3.4. Initial Design
The list of activities that accommodate multiple intelligence’s domains at the stage of task analysis and special purpose instrument is now merged with the media and the format of the creation of the teaching materials. Every multiple intelligence is included in activities in the Earth Protector teaching material. The following is a list of activities in accordance with the domain of multiple intelligences that can be developed through Earth Protector theme.

| Multiple Intelligence               | Activity                                           |
|-------------------------------------|----------------------------------------------------|
| Electromagnetic Waves Protectors    |                                                    |
| Visual/Spatial Intelligence         | William Herschel's experiment                      |
|                                     | Study of electromagnetic waves                     |
|                                     | Bar’s magnetic field experiments                   |
|                                     | Study of radio reflection                          |
|                                     | Electron excitation simulator                      |
| Logical/Mathematic Intelligence     | Calculating the density of the Sun's core          |
|                                     | Study of the emergence of sunspot                  |
|                                     | Study of comet’s tails                             |
| Bodily/Kinesthetic Intelligence     | William Herschel's experiment                      |
|                                     | Magnet coil experiment                             |
|                                     | Electric force motion induction Experiment         |
| Interpersonal Intelligence          | William Herschel's experiment                      |
|                                     | Electromagnetic magnets experiments                |
| Multiple Intelligence     | Activity                                                                 |
|--------------------------|--------------------------------------------------------------------------|
| **Verbal/Linguistic**    | Study of various electromagnetic waves                                   |
| **Intelligence**         | Study of sun layer                                                       |
|                          | Study of earth layer                                                     |
|                          | Study of Bohr's rules                                                    |
| **Intrapersonal Intelligence** | The task of looking for types of waves that are harmful to health      |
|                          | Looking for issues related to 2012 doomsday                             |
| **Naturalist Intelligence** | The task of finding animals with navigation capabilities               |
| **Musikal/Rhythmic**     | Bridges of donkeys of electromagnetic waves                               |
| **Intelligence**         |                                                                           |
| **Atmospheric Layer**    |                                                                           |
| **Visual/Spatial**       | Meteor simulator                                                         |
| **Intelligence**         | Video of a meteor falling                                                |
| **Logical/Mathematical** | Calculating the expansion of the length of                                |
| **Intelligence**         | an object                                                                |
|                          | Calculating the amount of heat                                            |
| **Bodily/Kinesthetic**   | Expanding object experiment                                              |
| **Intelligences**        | Glass break by water experiment                                          |
|                          | Burning with magnifying glass experiment                                 |
| **Interpersonal Intelligence** | Expanding object experiment                                           |
|                          | Saltwater distillation experiment                                        |
| **Verbal/Linguistic**    | Study of thermosphere and exosphere                                      |
| **Intelligence**         | The task is to find the name of the satellite in the exosphere          |
|                          | Study of railroad expansion                                              |
|                          | Study of various hydrological cycles                                     |
|                          | Drama of the story of Salty Sea Water                                    |
| **Intrapersonal Intelligence** | Meteor simulator                                                          |
|                          | Registering environmentally friendly behavior                            |
|                          | UV light hazard assessment                                               |
|                          | Quran verse study                                                        |
| **Naturalist Intelligence** | Study of the hydrological cycle processes                         |
| **Musikal/Rhythmic**     | Drama of the story of Salty Sea Water                                    |
| **Intelligence**         |                                                                           |

3.5. **Discussion**

Earth and Space Science (ESS) is a discipline with a very broad scope with natural phenomena on Earth or Space as teaching material [13]. With a wide range of material, ESS can be used as the main topic in building integrated teaching materials. The Integrated Webbed Model [14] with the main topic of the Earth Protector are the main design of this teaching material. Earth protector theme is built from 28 Basic Competencies in the 2013 Curriculum Content Standards which cover five subjects, namely: Science, Social Sciences, Bahasa, Mathematics and Islamic Education and covers many other disciplines, including: Anthropology, Astronomy, Bahasa, Biology, Physics, Geography, Chemistry, Mathematics, Islamic Education, Environmental Education, Sociology, Fine Arts, and Communication Information Technology.
Accommodation of multiple intelligence’s domains usually in one scientific discipline can only accommodate one multiple intelligence. For example, that in mathematical disciplines can only accommodate the domain of mathematical intelligence. Besides that, the cultivation of characters in the curriculum is entrusted to each discipline accordingly. The breadth of material possessed by Earth Protector theme and its foundation as material that discusses natural phenomena makes this theme able to accommodate many multiple intelligences and cultivation of characters in it [15]. The Threated model as a meta-cognitive foundation in the Earth Protector book develops multiple intelligences and the cultivation of characters in the creation of Earth Protector material. As a meta-cognitive basis the Threated model is usually sequential with each stage of cognitive achievement. But in accommodation of multiple intelligences and the cultivation of characters, all intelligences and all characters have the same position. Therefore, visualization of integrated models as a meta-cognitive foundation in the form of a large circle surrounding the Webbed integrated model [16].

4. Conclusion
The design of Earth Protector teaching materials is teaching material with two integrated models. The first is Webbed model that was built from 28 Basic Competencies in the 2013 curriculum with the Earth Protector as a theme, covers thirteen disciplines. The second is Threated model, Threated model are models that underlie meta-cognitive compilation of books with the foundation of accommodation of multiple intelligences. The diversity of all activities in teaching materials can accommodate multiple intelligences.

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