Analysis of the competency standard of its graduates for the developing of physics e-book with tsunami theme

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Abstract: Tsunami threat preparedness is important to reduce the risk of disaster. Tsunami disasters can be used as themes in physics learning to support disaster mitigation education integrated into teaching materials in the form of e-books. Tsunami disaster mitigation efforts are closely related to student competencies, so it is important to do preliminary analysis. The purpose of this study is to analyze the competency standard of its graduates as a qualification criteria for the students' ability that is expected to be achieved. This study uses a quantitative descriptive method with the population being all high schools in Pesisir Selatan and the sample selected using a purposive sampling technique. The instrument used was a questionnaire that included several questions on aspects of attitude, knowledge, and skills. The results showed that the attitudes and skills competency were in less category with values of 75% and 72.44% respectively. The knowledge competency is in very less category with a value of 56.86%. These results indicate that the three competencies need to be further improved, especially the knowledge competency with the lowest percentage value.

1. Introduction
Indonesia's geographical condition is surrounded by three tectonic plates that are constantly moving, namely the Indo-Australina, Eurasia, and the Pacific Plates. This has made Indonesia known as a country prone to natural disasters. One of the regions in Indonesia, namely West Sumatra Province, has a very complex geological structure due to its location in the collision area of 2 tectonic plates. The negative impact of geology is that West Sumatra is an area that has the potential for natural disasters with a geological perspective in the form of tectonic earthquakes, both centered on land and centered at sea. Tectonic earthquakes centered on the sea, namely the western part of the Sumatra coast, are sometimes followed by sea level rise which is better known as Tsunamis [1]. At least it has been recorded in history that tsunamis have occurred twice in the west coast of Sumatra, namely in 1797 and 1833.

A tsunami disaster is a sudden occurrence of a large wave in the sea which has a large wavelength, period, frequency, wave propagation speed and energy caused by seismic or non-seismic events carrying a large amount of energy in its propagation towards the coast which can be causing damage and loss as well as casualties in the coastal areas, islands and its surroundings [2]. By looking at the magnitude of the impact of the damage caused by the tsunami, serious handling is needed to deal with it. In the event of a Tsunami in West Sumatra, several districts/ cities on the West coast that are directly facing the Indian Ocean will be affected. One of the districts that is potentially prone to disasters is the Pesisir Selatan Regency.
One of the strategies that can be implemented to reduce the risk of Tsunami disaster is by integrating disaster learning in the education curriculum [3]. This strategy is supported by article 27 of Law Number 24 of 2007 concerning Disaster Management requires everyone to carry out disaster management activities and also to provide correct information about disaster management to the community [4]. Efforts to reduce disaster risk in Indonesia have been carried out by many institutions (government), institutions, and world bodies. UNESCO (United Nations Agency) states support for international cooperation through education, science and culture in developing disaster preparedness materials as additional learning at the junior and senior high school levels. This activity is a way to increase students' fundamental knowledge of what a disaster is and how to reduce disaster risk [5]. Natural phenomena including these disasters are part of what is studied in physics. Physics is an interesting science because it studies how the world works [6]. In addition, physics is also a basic science in supporting the development of science and technology, so that it has a major role in supporting science and technology [7]. Therefore, the solution that can be given is by integrating disaster material according to the potential of the student's area into physics teaching materials.

Physics teaching materials in schools should be developed based on regional potential. This is in accordance with what has stated in Government Regulation Number 32 of 2013 article 77 B section 9 that the curriculum structure for secondary education units is one of which is general content which is potential and local wisdom. Local wisdom in the form of regional potential is a source of learning aimed at students so that they have the ability to know and understand regional characteristics [8]. If the content in the book is adjusted to the environment, students can learn easily because it is related to the environment and daily life. The learning process is very important because besides being able to improve students' cognitive, it can also improve students' affective and psychomotor aspects [9]. Analysis of the regional potential clearly states that Pesisir Selatan has the potential to be prone to tsunami disasters. Therefore, the appropriate disaster material to be integrated into the Physics teaching materials of students in Pesisir Selatan is the Tsunami theme material.

Along with that, education is currently trying to continue to take advantage of technology in the learning process that takes place continuously without time and space. This education is known as Revolution-based Education 4.0 or Education 4.0. The learning created is expected to help solve problems, find solutions, and make it possible to find new innovations. The era of the industrial revolution 4.0 required quality Human Resources (HR) to help face this competition in order to be able to keep up with the era of education 4.0 and be competent in a healthy manner in their field.

In this case, educators must also have competence in order to guide students into the era of the 4.0 revolution, including competence to help students face difficulties and solve problems [10]. The challenge of education 4.0 can be answered by using the use of electronic-based teaching materials (E-books). E-books can provide fun learning because they are able to present interactive simulations by combining animation, video, images, audio, and navigation that make students more interactive. An e-Book can improve students' conceptual mastery [11]. Through an e-book that is integrated with the Tsunami theme in the Physics learning process, educators can provide material on tsunami disaster mitigation and assignments easily without being constrained by place and time. The development of an integrated physics e-book with Tsunami mitigation materials aims to improve the competence of students towards learning Physics and natural disasters. Therefore, an initial analysis of the competency standards of graduates from Pesisir Selatan schools is necessary.

Competency Standards for Graduates are criteria regarding the qualifications of graduates' abilities which include attitudes, knowledge and skills [12]. The analysis carried out on the competence of graduates is more focused on the study of the profile of the graduates as what is expected to be achieved after completing the study period, especially in terms of the competence of attitudes, knowledge, and skills. The results of this analysis are able to show which competencies are in the high, medium and low categories so that they can become a guide in the development of the Tsunami-themed physics e-book. This research is part of the development stage of Research and Development, precisely at the research stage. Therefore, the development of the e-book that will be carried out will
have a strong foundation for improving student competence in learning physics and in responding to the potential for Tsunami disasters in their environment.

2. Research Method
The quantitative descriptive method used in this research is to describe the problem under study through the related variables as well as the exploration and clarification of social reality phenomena. Based on the analysis of regional potential, the determined population is all high schools in Pesisir Selatan. Samples were taken using a purposive sampling technique. All schools in Pesisir Selatan were initially grouped based on the average score of the latest national exam scores (2019) into upper, middle, and lower groups. Then the researchers selected one school per each group so that SMAN 3 Painan, SMAN 1 Batang Kapas, and SMAN 2 Batang were assigned as research samples.

The instrument used was a questionnaire containing 44 statements in the form of positive sentences regarding aspects of the attitudes, knowledge, and skills of students in each school. This instrument is made in accordance with the competency standard of its graduate's analysis grid which is guided by Regulation of the Minister of Education and Culture Number 20 of 2016. Each statement will be responded to through the answer column with a liker scale which includes 4 alternative answers. Score 1 if "never", score 2 if "sometimes", score 3 if "often" and score 4 if "always" carry out activities on each statement. After the qualitative responses of respondents were converted into ordinal scale form, the scores were added up for each aspect and then expressed in percentage form with the following calculations.

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Percentage (P) = \frac{\text{total score}}{\text{highest score}} \times 100\%
\]  
(1)

The proportion value based on the calculation results of the calculation can use the criteria stated in Table 1 below.

| No | Category    | Value                      |
|----|-------------|----------------------------|
| 1  | Very Good   | $90 < P \leq 100$         |
| 2  | Good        | $75 < P \leq 90$          |
| 3  | Less        | $60 < P \leq 75$          |
| 4  | Very Less   | $P \leq 60$               |

3. Results and Discussion
Analysis of the competency standard of its graduates shows the achievement of graduate competencies by students in terms of attitudes, knowledge, and skills. Attitudinal competence can be explained through the spiritual attitudes and social attitudes of students. Knowledge competencies consist of factual, conceptual, procedural, and metacognitive knowledge. Meanwhile, skill competencies include 4C skills (critical thinking, creativity, collaboration, and communication) needed in education 4.0 as well as being productive and independent. An explanation of the results of Analysis of The Competency Standard of Its Graduates will be described for each aspect of attitudes, knowledge, and skills.

3.1. Analysis of The Competency Standard of Its Graduates for Attitude Competence
Attitudinal competence can be explained through the spiritual attitudes and social attitudes of students. The results of the analysis of the competency standard of its graduates for attitude competence can be seen in Table 2 below.
Table 2. Attitude competency

| No | Statement                                                                 | Value (%) | Criteria |
|----|---------------------------------------------------------------------------|-----------|----------|
| 1  | Students reflect an attitude of faith in God Almighty by praying seriously when starting learning | 83.33     | Good     |
| 2  | Students pray earnestly when they finish learning                         | 75.00     | Less     |
| 3  | Students show tolerance towards their peers.                             | 100.00    | Very Good|
| 4  | Students are able to obey the rules set by the school                     | 83.33     | Good     |
| 5  | Students follow teacher instructions in an orderly manner and finish on time in doing assignments | 83.33     | Good     |
| 6  | Students show a caring attitude towards the environment at school          | 75.00     | Less     |
| 7  | Students do not copy the work of other students                           | 66.67     | Less     |
| 8  | Students are active in participating in group discussion activities        | 75.00     | Less     |
| 9  | Students are actively involved and participate in activities held in the school environment | 75.00     | Less     |
| 10 | Students carry out individual tasks well                                  | 75.00     | Less     |
| 11 | Students have the courage to argue in public                              | 66.67     | Less     |
| 12 | Students have a polite attitude towards all school members                 | 83.33     | Good     |
| 13 | Students are able to adapt well                                           | 58.33     | Very Less|
| 14 | Students are able to assess their strengths and weaknesses (both physical and psychological) | 50.00     | Very Less|

Mean: 75.00 Less

Attitude competence is a very important competence in the learning process. Attitude competence in the learning process can be linked to spiritual and social values. Based on the results of the competency standard of its graduates’ analysis, the attitude competency is in a less category with a percentage of 75%. Based on Table 2, the best attitude shown by students in Pesisir Selatan is an attitude of tolerance towards their peers, so it is not a concern to be improved. Attitudes that need to be considered are those in the less and very less categories. Attitudes that are in the very less category include the attitude to adapt and the attitude to be able to assess one's own strengths and weaknesses.

In addition, attitudes that are in the less category also need to be improved, one of which is a caring attitude towards the school environment and the attitude to be actively involved and participate in activities that will be held in the school environment. The ability to adapt and care for the environment and to be active in their activities can be obtained directly when students learn about the potential for disasters in their environment through the teaching materials provided at school. Of the 14 statements given, only 5 attitudes have been achieved properly, while 9 of them are not optimal. Therefore, attitude competence still needs to be improved.

3.2. Analysis of The Competency Standard of Its Graduates for Knowledge Competence

According to Regulation of the Minister of Education and Culture Number 20 of 2016, knowledge is divided into factual, conceptual, procedural, and metacognitive knowledge. The results of the competency standard of its graduates’ analysis for high school knowledge competencies in Pesisir Selatan are as in Table 3 below.
Table 3. Knowledge competency

| No | Statement                                                                 | Value (%) | Criteria   |
|----|---------------------------------------------------------------------------|-----------|------------|
|    | Factual                                                                   |           |            |
| 1  | Students already know the facts that are important in learning Physics    | 58.33     | Very Less  |
| 2  | Students are able to recognize information about events related to the local environment | 75.00     | Less       |
| 3  | Students recognize information about events related to the international environment | 58.33     | Very Less  |
| 4  | Students are able to link their knowledge with related natural phenomena  | 50.00     | Very Less  |
| 5  | Students know the latest technology related to learning Physics           | 58.33     | Very Less  |
|    | Conceptual                                                                |           |            |
| 6  | Students understand the concept of physics as a whole                     | 50.00     | Very Less  |
| 7  | Students are able to classify general physics concepts                    | 33.33     | Very Less  |
| 8  | Students are able to explain theories / principles / laws related to physics | 66.67     | Less       |
| 9  | Students understand the concepts of Physics related to the latest technology | 58.33     | Very Less  |
|    | Procedural                                                                |           |            |
| 10 | Students are able to explain Tsunami disaster mitigation steps            | 50.00     | Very Less  |
| 11 | Students are able to solve problems with correct scientific steps         | 58.33     | Very Less  |
| 12 | Students use certain techniques to find solutions or problems             | 58.33     | Very Less  |
| 13 | Students examine the use of problem solving methods                       | 58.33     | Very Less  |
|    | Metacognitive                                                             |           |            |
| 14 | Students know physics material that they do not understand                | 58.33     | Very Less  |
| 15 | Students examine their own ability to perform certain tasks              | 58.33     | Very Less  |
| 16 | Students are able to make personal decisions about the benefits of an assignment | 58.33     | Very Less  |
| 17 | Students are able to provide arguments / reasons that support their thinking in learning physics | 58.33     | Very Less  |
|    | Mean                                                                      | 56.86     | Very Less  |

Based on Table 3, it can be seen that the average value of knowledge competency is 56.86% in the very less category. Overall competencies for the four types of knowledge are in the very less category. This is of course an important part to note to be improved. Although all knowledge needs to be improved, factual knowledge has the highest value among other types of knowledge at 60%. From Table 3, it can be seen that students do not know enough facts that are important in learning physics, are not able to relate their knowledge to natural phenomena, and do not yet know enough about the latest technology that is related to learning physics. However, students are sufficiently informed about
events related to the international environment. This can mean that students are more familiar with the external environment than their own environment and experience difficulties if this knowledge is related to learning Physics. By using the Tsunami themed e-book later, it is hoped that students will be more familiar with their environment, natural phenomena around them, it is easier to understand physics in a contextual manner, and even know which technology can be utilized in relation to the knowledge they already have.

The type of knowledge that has the lowest value of 52.08% is conceptual knowledge, especially in the difficulty of students classifying physics concepts in general because the statement gets the lowest score of the lowest. In addition, students have not been able to understand and explain the concept completely and relate it to the latest technology. Therefore, explanations for understanding the concept of physics receive more attention to be improved by emphasizing important explanations in the e-book that will be developed.

Students' procedural knowledge only reached 56.25% of all knowledge competencies. In connection with the research objective, namely the development of the e-book Physics with the theme of Tsunami, the ability of students to explain disaster mitigation measures had the lowest score among students' procedural knowledge. This certainly strengthens the purpose of developing the e-book on Physics with the theme of the Tsunami. The mitigation knowledge provided includes actions that can be taken before a disaster occurs (pre-disaster), when a disaster occurs, and after a Tsunami disaster (post-disaster). Before that, students must first understand what a Tsunami is and how it relates to the physics theory that will be studied. If all this knowledge has been given and understood by students, then the Tsunami disaster mitigation steps will be easy to apply.

Metacognitive knowledge is about one's own strengths and weaknesses and uses it in studying technical, detailed, specific, complex, contextual and conditional knowledge with respect to science, technology, art, and culture related to the surrounding community and natural environment, nation, state, regional area, and international. Metacognitive high school students in Pesisir Selatan still reach a score of 58.33%. This means that students have not been able to understand themselves about what they have mastered, what difficulties they face, how to express their thoughts, and what decisions they will give when they face a problem. The statements on metacognitive knowledge have a close relationship with disaster mitigation, because in the face of a disaster, at least a person knows how he is at that time, what dangers he faces, and what actions he can take before the Tsunami disaster occurs, during the Tsunami, was going on, and after the Tsunami it was over. Therefore, students' metacognitive knowledge also needs to be improved.

Based on the results of the competency standard of its graduates' analysis of each type of knowledge, the conceptual knowledge competency has the lowest score. However, factual, procedural, and metacognitive knowledge also has a low value. Thus, overall it can be concluded that knowledge competence really needs to be improved.

3.3. Analysis of The Competency Standard of Its Graduates for Skills Competence

Skills competencies according to Regulation of the Minister of Education and Culture Number 20 of 2016 include creative, productive, critical, independent, collaborative, and communicative thinking and acting skills. The results of the competency standard of its graduates’ analysis for skills knowledge can be seen in Table 4 below.

Table 4. Skills competency

| No | Statement                                                                 | Value (%) | Criteria |
|----|---------------------------------------------------------------------------|-----------|----------|
| 1  | Students estimate the tools and materials in conducting demonstrations / practicum activities provided | 58.33     | Very Less|
| 2  | Students display the steps according to the sequence of practicum activities | 66.67     | Less     |
| 3  | Students can communicate verbally and in writing                           | 75.00     | Less     |
| No | Statement                                                                 | Value (%) | Criteria |
|----|---------------------------------------------------------------------------|-----------|----------|
| 4  | Students carefully observe practical / demonstration activities in the learning process | 83.33     | Good     |
| 5  | Students measure a quantity accurately                                    | 75.00     | Less     |
| 6  | Students are able to provide explanations related to the practical results obtained | 66.67     | Less     |
| 7  | Students are skilled carry out experiments to prove natural phenomena around | 66.67     | Less     |
| 8  | Students are able to solve the problems given in the learning process      | 66.67     | Less     |
| 9  | Students are able to make their own conclusions from the practical results they have carried out | 66.67     | Less     |
| 10 | Students are able to do self-criticism and assessment                       | 75.00     | Less     |
| 11 | Students use practicum equipment to obtain data in groups                  | 75.00     | Less     |
| 12 | Students are active in group practicum activities                         | 83.33     | Good     |
| 13 | Students give and listen to opinions in group work in class               | 83.33     | Good     |

| Mean | 72.44 | Less |

The skill competence of high school students in Pesisir Selatan is in the less category with a percentage of 72.44%. The lowest ability is that students have difficulty estimating the tools and materials in carrying out the demonstration/practicum activities given. It is assumed that the teaching materials used for practicum activities have not fully provided supporting explanations that are easy for students to understand. This can be expressed because students who are active in practicum activities and their ability to observe demonstrations, hear and give opinions in the group are good, so it can be said that meaningful problems only arise when starting the practicum.

In addition, some statements in the less category also need attention. Student skills such as displaying steps in sequence, polite oral and written communication, measuring accurately, carrying out experiments to prove natural phenomena around them, solving problems, making conclusions, and so on also need to be improved. Experiments to prove natural phenomena can be improved if students know in advance what natural phenomena are related to the physics material being studied, especially natural phenomena that have the potential to occur in their environment. This becomes important because what students can see or imagine clearly can make it easier for students to express them in detail and confidently so that the experiments to be carried out are easily completed. Thus, several things need to be improved to achieve the expected skill competency standards.

The results of analysis of the competency standard of its graduates are useful in ebook development because the information provided is used to modify the currently used teaching materials, and how to improve the quality of the teaching materials to be better and effectively used so that competence in each aspect can be improved. The integrated learning of tsunami material will have a direct effect on increasing students' knowledge of natural phenomena, students' attitudes in responding to natural phenomena around their homes, and honing students' skills in solving difficulties they experience. Analysis of the competency standard of its graduates for the developing of physics e-book with Tsunami theme is the first step in efforts to mitigate the risk of a tsunami disaster with a large potential to occur in coastal areas such as Pesisir Selatan and other Tsunami-prone areas.

4. Conclusion
The conclusion in this research is that all competencies, both attitudes, knowledge, and skills of high school students in Pesisir Selatan need to be improved. Based on the results of the analysis, knowledge
competence is in less category with a value of 75%. Knowledge competency gets the lowest achievement score of 56.86% in the very less category, so it needs to be the biggest concern for improvement. Meanwhile, skills knowledge obtained a score of 72.44% in the less category. These three competencies need to be improved to meet the demands of education 4.0. By taking the results of the competency standard of its graduates' analysis of high school students in Pesisir Selatan, it is hoped that the physics e-book with Tsunami theme that will be developed will be a valid, practical, and effective product.

References

[1] BNPB 2019 Rencana Kontinjensi Menghadapi Bencana Tsunami Provinsi Sumatera Barat.
[2] Fauzi A 2013 Fisika Bencana Alam (Padang: Universitas Negeri Padang) p 38
[3] UNISDR 2018 Asian Ministerial Conference on Disaster Risk Reduction 2018 Retrieved Juli 20, 2018, from https://www.unisdr.org/
[4] Undang-Undang Nomor 24 Tahun 2007 tentang Penanggulangan Bencana
[5] Selby D and Kagawa F 2012 Disaster Risk Reduction in School Curricula: Case Studies from Thirty Countries (UNICEF: Geneva, Switzerland/ Paris, France).
[6] Halliday D, Resnick R and Walker J 2011 Fundamental of Physics 9th Editionn (United States of America: John Wiley & Sons, Inc)
[7] Mufit F, Asrizal, Hanum S A and Fadhilah A 2020 IOP Conf. Series: Journal of Phys: Conf. Series 1481 1 012041 doi:10.1088/1742-6596/1481/1/012041
[8] Peraturan Pemerintah Nomor 32 Tahun 2013 tentang Standar Nasional Pendidikan
[9] Asrizal A, Desnita D and Darvina Y 2020 Journal of Phys Conf. Series 1481 1 p 012123 doi: 10.1088/1742-6596/1481/1/012123
[10] Asrizal A, Amran A, Ananda A and Khairani S 2018 Journal of Physics Conference Series 1006 1 p 012031 doi: 10.1088/1742-6596/1006/1/012031
[11] Harjono A, Gunawan G, Adawiyah R and Herayanti L 2020 International Journal of Emerging Technologies in Learning (iJET) 15 5 pp 40-49 https://doi.org/10.3991/ijet.v15i05.10967
[12] Peraturan Menteri Pendidikan dan Kebudayaan Nomor 20 Tahun 2016 tentang Standar Kompetensi Lulusan Pendidikan Dasar dan Menengah
[13] Arikunto S 2013 Prosedur Penelitian: Suatu Pendekatan Praktik (Jakarta: Rineka Cipta)