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Analysis of compatibility of tornado material with physics material of grade xii senior high school

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Abstract
One way to increase disaster knowledge is integrate disaster material into physics learning in schools. For tornado material to be easily raised in the physics learning process, learning resources are needed such as physics textbooks that are integrated with tornado material. However, not all physics materials can be integrated with tornado materials. So, it is necessary to first analyse the level of compatibility of tornado materials with physics materials in senior high school. This research is descriptive research with a qualitative approach. Research data is primary data collected through documentation studies. The primary tool used in this research is an analysis table of the compatibility of tornado material with physical material. The result of this research is the compatibility of tornado material with Senior High School physics learning material class XII semester 1 with a value of 0.316 and class XII semester 2 with a value of 0.348. In class XII semester 1, only 1 of 5 subject matter has compatibility to be integrated with tornado material, namely static electricity material with a compatibility value of 0.58. In class XII semester 2, there are 2 out of 6 subject materials that have a compatibility to be integrated with tornado material, namely electromagnetic radiation, and technology material with a compatibility value of 0,67 and 0,42. The research's finding is that physics material for class XII in semesters 1 and 2 is less compatible for integration with tornado material.
Keywords: disaster; physics material; tornado material

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1. Introduction

Tornadoes are the most frequent natural disasters in Indonesia. According to Utomo (2016), a tornado is defined as a strong wind that comes suddenly, has a centre, moves in a circle resembling a spiral at a speed of 40–50 km/hour until it hits the earth's surface, and will disappear in a short time (3-5 minutes). Supriono (2015) also stated that a tornado is a strong wind with a speed of more than 63 kilometres per hour that comes suddenly, has a centre or base, and rotates in a circle like a spiral until it touches the earth's surface. Based on Geoportal Data Bencana Indonesia from Badan Nasional Penanggulangan Bencana (BNPB) in 2023 for the last 10 years (2013-2022) there have been tornado disasters with a total occurrence of 10,187 or 31% of the total 32,959 natural disaster events in Indonesia. The west monsoon and east monsoon caused by Indonesia's geographical position and the instability of air masses caused by a tropical climate with humidity above 75% can affect the occurrence of tornadoes (Nurjani *et al.*, 2013). In addition, tropical climate conditions make Indonesia only have two seasons. So that at every change of season, there are often tornadoes.

Tornadoes are natural disasters that take many victims and cause many losses. Data on tornado disaster events in Indonesia in 2018-2022 can be seen in Table 1.

Table 1. Data on tornado disaster events in Indonesia 2018-2022

No	Year	Number of Incidents	Fatalities		Broken House
			Died & Lost	Injuries	
1	2022	1113	17	162	14.105
2	2021	1817	33	239	21.536
3	2020	1.485	30	193	20.938
4	2019	1.393	21	291	34.212
5	2018	1.137	36	197	18.134
Total		6.945	137	1.082	108.925

(Geoportal Data Bencana Indonesia BNPB. 2023)

Based on the data in Table 1. The year 2021 had the most tornado incidents in the previous five years (1,817 incidents). In addition, the highest number of deaths and injuries and damage to homes by tornadoes was in 2019. The number of fatalities caused by tornadoes is not only found in one region, but in various regions in Indonesia. This is because 80 percent of Indonesia is prone to tornadoes (Supriono, 2015; Hadi, 2020). Therefore, as people living in disaster-prone areas, people should have more knowledge about disaster mitigation to decrease the effects of the disaster. Currently, public knowledge about disaster preparedness in Indonesia is still lacking (Kurniawati & Suwito, 2017; Ayuningtyas *et al.,* 2021; Tanesab, 2020). Lack of public awareness about disaster vulnerability and mitigation efforts results in many casualties when disasters occur (Kurniawati & Suwito, 2017). Even though knowledge with preparedness behavior possessed by a person shows a strong relationship and a positive pattern (Hayudityas, 2020). Where the more knowledge about disasters, the higher the preparedness behavior. Therefore, disaster mitigation efforts are needed to increase public knowledge about disasters.

One of the efforts that can be made so that knowledge about disasters can be known and understood by the surrounding community is through learning and education in schools. This is supported by Peraturan Pemerintah Republik Indonesia No. 21 (2008) pasal 14 which explains that disaster mitigation can be organized by local governments in the form of formal education, non-formal education and informal education. Formal education is education that is taken in a structured manner and is taken in schools in general, starting from elementary school, middle school, and university.

School is an effective learning tool to increase knowledge about disasters. Moreover, currently students' knowledge and readiness are also still low in facing disasters (Elfina *et al.*, 2021; Sulistiowati *et al*., 2019; Syam & Arif, 2019). Disaster education in Senior High Schools enables youngsters to play a crucial part in saving lives and protecting community members during disasters (Pahleviannur, 2019). Senior High Schools students can also help people to control their emotions before, during and after disasters. In addition, Senior High Schools students can be an extension to inform the wider community about disaster knowledge. This is in accordance with UU No.24 (2007) pasal 27 concerning disaster management, which states that everyone is obliged to maintain a harmonious social life of the community, maintain balance, harmony, harmony, and preservation of the functions of the living environment, carry out disaster management activities and provide correct information to the public about disaster management. Therefore, providing knowledge and understanding about disasters in schools is one of the right efforts to increase the knowledge of students or the community about disasters.

Integrating disaster information into school curricula is one way for providing knowledge and understanding of major events through education. This is supported by Regulation of the Minister of Education and Culture No. 81 A (2013) concerning the implementation of the 2013 curriculum, the curriculum is developed in accordance with the characteristics, potential, excellence, local wisdom, and regional needs/demands. Thus, the learning process must be in accordance with local wisdom/regional potential. The potential of the area can be in the form of disasters that threaten the area, namely tornado disasters.

Students can understand and recognize the potential of their area through learning physics. Recognition and understanding of nature and every event such as a tornado can be done through physics, because physics is a study that investigates every natural phenomenon. The potential for tornado disasters can be used as a source of learning as a fact that can be studied using physical concepts and principles to determine the characteristics of tornadoes. This characteristic of tornadoes can be used as mitigation efforts. The characteristics of tornadoes will also form the character of disaster preparedness for students. With this consideration, integrating tornado disasters in the physics learning process needs to be done.

This tornado material can be easily raised in the physics learning process if there are physics learning resources that have been integrated with tornado material. One of the learning resources that can be used is textbooks. This is because Regulation of the Minister of National Education No. 11 (2005) states that textbooks are mandatory reference books for delivering learning materials in schools. However, until now there has been no textbook that integrates tornado disaster material into physics material for at least one semester. Therefore, efforts are needed to develop integrated physics textbooks for at least one semester so that this tornado material can be easily raised in physics learning and learning can be more contextual.

Before developing a physics textbook that is integrated with tornado material, it must first be known what semester material is compatible for integration with tornado material. This is because not all physics material in each semester can be integrated with tornado material. So, it takes an analysis of the level of compatibility of tornado material with physics material every semester which is the initial research of the development of integrated physics textbooks for tornado disasters. So that the integrated disaster material is in accordance with the teaching material to be learned by students. Thus, the implementation of learning can achieve the goals and objectives to be achieved. However, until now it is not known the level of compatibility of physics material with tornado material for each semester.

The effectiveness of tornado mitigation magazine learning medium related with Qur'anic verses was examined by Azhar (2020) in her research. Furthermore, research conducted by Desnita (2016) aims to develop a tornado knowledge enrichment book as a source of physics learning that is compatible for use. Research conducted by Riyatningtyas (2016) shows that the development of learning resources for physics based on the *Problem Based Learning (PBL) learning model with a* guided inquiry approach on dynamic fluid material integrated with hurricane disasters is in the category of very valid, very practical and effective. All three studies have integrated tornado material in dynamic fluid material, but research that integrates tornado material with physics material as a whole for all Basic Competence (BC) has not been conducted. Research conducted Sasma and Fauzi (2020) looked at the level of compatibility of physics materials to be integrated with earthquake materials in Senior High School physics textbooks classes X, XI, and XII. This study has seen the level of compatibility of physical materials to be integrated with earthquake disaster material for each semester. However, research to see the level of compatibility of integrated physics material for tornado material for each semester has not been conducted.

Researchers are interested in conducting study analyzing the compatibility of Senior High School physics material with tornado material per semester based on the issues and also prior research that has been discovered. This research was conducted by analyzing material based on the field of knowledge, namely factual, conceptual, and procedural knowledge of physical materials and tornado materials so that compatibility physical materials were obtained to be integrated with tornado materials. So, this study analyzes the compatibility of tornado material with Class X, XI and XII Senior High School Physics Learning material to get a semester that is particularly compatible with tornado material.

2. Methods

This study employed descriptive research with a qualitative approach to the presentation of research findings. The goal of descriptive research was to describe and interpret objects exactly as they are (Cresswell, 2007), while qualitative approaches resulted in descriptive data in the form of people's spoken or written words and observed behaviour (Margono, 2010).

This study's population is the physics material from the 2013 curriculum for Senior High School classes X, XI, and XII. The non-probability sampling approach, a saturation sampling type in which all members of the population are employed as samples, was used by the authors to collect samples for this study. The variables of this study are Senior High School physics learning materials Class X, XI and XII semester 1 and semester 2 as well as earthquake material. This study only analyzes the suitability of a tornado with physics material for class 12 high school. This is because the material in grade 12 is more relevant to the tornado disaster than grades 11 and 10.

In this study, the research procedure was divided into three stages, namely the preparation stage, the implementation stage, and the completion stage (Nurhaliza & Fauzi, 2022). Some procedures carried out at the preparation stage are 1) preparing a research design, 2) determining the subject and object of research, 3) preparing instruments, 4) testing the validity of instruments, 5) analyzing the results of validity tests, 6) improving instruments. Some procedures carried out at the implementation stage are collecting data by analyzing the compatibility of physics material with tornado material. Some of the procedures carried out at the completion stage are 1) processing data, 2) drawing conclusions, 3) reporting research results.

Instruments are researchers' tools for measuring natural and social phenomena that researchers focus on (Hikmawati, 2018). The instrument used in this study is an analysis sheet of the compatibility of tornado material with Senior High School physics material. The analysis sheet is in the form of a table, with scaled scores of 1,2,3, and 4. Each indicator has a highest score of 4 and a lowest score of 1. Assessment of instrument validity uses 3 components, including the accuracy of the instrument with the data to be measured, the adequacy of items and the use of language. The overall validity test uses Aiken's V validity test (Aiken, 1985).

The results of the validity of the tornado material compatibility instrument with Senior High School physics learning material obtained from 4 expert validators and 2 practitioner validators. These four validators are lecturers who are experts in their fields while the other two are physics teachers who have teaching experience. The value of the overall V validity coefficient is 0.89. This means that the instrument the researcher used is valid, because based on Aiken's V category, the instrument is said to be valid when it gets a large V value equal to 0.78 if validated by 6 raters / validators and the highest validation rating scale of 4 (Aiken, 1985).

The data gathering techniques employed in this study are documentation study techniques. employing content analysis techniques to analyze data, namely by looking at the written data's content. The data was processed using descriptive statistics by calculating the compatibility value for each Basic Competence (BC), finding the mean compatibility value for each semester, and calculating the average and standard deviation so that the compatibility value of tornado material with Senior High School physics material class X, XI and XII was obtained for semester 1 and semester 2 (Table 2). The resulting value is then seen in the category of compatibility of tornado material with Senior High School physics material classes X, XI and XII. The degree of compatibility of tornado material with physics materials of classes X, XI and XII is in Table 2.

Table 2. Description of the books analyzed

Book (Descriptions)	In English
Buku 1 Judul: Buku Siswa Aktif dan Kreatif Belajar Fisika untuk Sekolah Menengah Atas/Madrasah Aliyah Kelas XII Penulis: Ketut Kamajaya & Wawan Purnama	1st Book Title: Student Book Active and Creative Learning Physics for Class 12 Senior High School/Madrasah Aliyah

Penerbit: Grafindo Media Pratama. Jumlah halaman: 328 Tahun: 2016	Authors: Ketut Kamajaya & Wawan Purnama Publisher: Grafindo media Pratama Pages: 328 Pages Year: 2016
Buku 2 Judul :Fisika untuk SMA/MA Kelas XII Berdasarkan Kurikulum 2013 Revisi Penulis: Marthen Kanginan Penerbit: Erlangga Jumlah Halaman: 504 Tahun: 2018	2nd Book Title: Physics for Class 12 Senior High School/Madrasah Aliyah Based on Curriculum 2013 Revision Author: Marthen Kanginan Publisher: Erlangga Pages: 504 pages Years: 2018
Buku 3 Judul : Buku Siswa Fisika untuk SMA/MA kelas XII Penulis: Pujianto, Supradiningsih, Risdiyani Chasanah & Dhara Nurani Penerbit: Intan Pariwara Jumlah Halaman: 310 Tahun: 2016	3rd Book Title: Physics Student's Book for Grade 12 Senior High School/Madrasah Aliyah Authors: Pujianto, Supradiningsih, Risdiyani Chasanah & Dhara Nurani Publisher: Intan Pariwara Page: 310 pages Year: 2016

The following is the equation used to calculate the suitability value of class 12 material with a tornado. The steps to obtain the suitability score are

a. Calculating the average suitability value of each basic competency per semester with the equation 1:

$$Score\ (X) = \frac{Real\ Score}{Maximum\ Score}$$

b. Calculate the average suitability score for all semesters using equation 2.

$$Average\ (\bar{X}) = \frac{\sum X_i}{n}$$

c. Calculate the standard deviation of the average suitability score for all semesters using equation 3.

$$S^2 = \frac{n \sum \bar{X}^2 - (\sum \bar{X})^2}{n(n-1)}$$

Table 3. The compatibility category of Senior High School Physics material class X, XI and XII with Tornado material

Achievement Requirements	Category
$\bar{X} > \bar{x} + 1{,}5\ S$	Very Compatible
$\bar{x} + 0{,}5\ S < \bar{X} \leq \bar{x} + 1{,}5\ S$	Compatible
$\bar{x} - 0{,}5\ S < \bar{X} \leq \bar{x} + 0{,}5\ S$	Quite Compatible
$\bar{x} - 1{,}5\ S < \bar{X} \leq \bar{x} - 0{,}5\ S$	Less Compatible
$\bar{X} > \bar{x} - 1{,}5\ S$	Not Compatible

Source: (Azwar, 2015)

3. Results and Discussion

The research was conducted by taking data on the compatibility of certain knowledge of tornado material with physical material on that knowledge. The data for this study were numbers that were converted to descriptive data after being analyzed statistically. Analyses of physical materials integrated with tornado material are how the descriptive data is presented.

3.1. Analysis of the Compatibility of Senior High School Physics Material class XII semester 1 with Tornado Material

Class XII semester 1 physics material has a compatibility value of 0.316, so class XII semester 1 physics material is not compatible for integration with tornado material. The description of the compatibility value for each subject matter can be seen in Table 4 and the distribution data of the compatibility of knowledge of physical matter with tornado material is seen in Figure 1.

Table 4. Data from the Analysis of the Compatibility of Physics Material with Tornado Material for Each Basic Competence (BC) of Senior High School Class XII Semester 1. Physics material

No	Material Physics	Compatibility Score
1	Basic Competence (BC) 3.1 Direct Current Circuit	0,25
2	Basic Competence (BC) 3.2 Static Electricity	0,58
3	Basic Competence (BC) 3.3 Magnetic	0,25
4	Basic Competence (BC) 3.4 Electromagnetic Induction	0,25
5	Basic Competence (BC) 3.5 Alternating Current	0,25

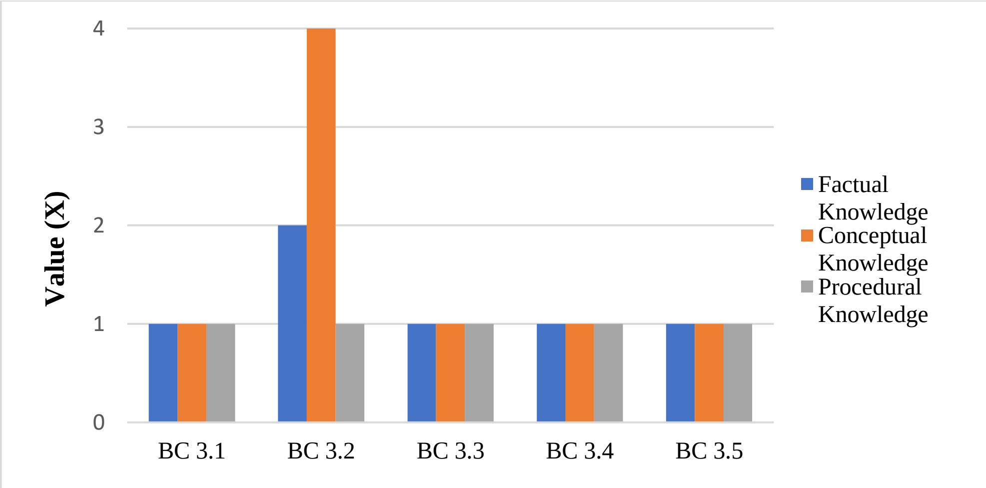

Figure 1. Compatibility of Senior High School physics material class XII semester 1 with tornado material

Class XII physics material semester 1 consists of 5 main materials, namely direct current circuits, static electricity, magnetic fields, electromagnetic induction, and alternating current. Based on the data in Table 2, it is known that the subject matter of physics of Senior High School class XII semester 1 which has the highest compatibility value is found in Basic Competence (BC) 3.2 about static electricity with a value of 0.58 and the lowest compatibility value is found in other Basic Competence (BC) with a value of 0.25. The compatibility level score in class XII semester 1 is 0.316 obtained from the average score of all Basic Competence (BC) in class XII semester 1. So, we can conclude that tornado material is less compatible to be integrated into class XII physics material semester 1. The discussion of the results of the analysis of the compatibility of Senior High School physics material with tornado material is described as follows:

First, in Basic Competence (BC) 3.2 Static Electricity conceptual knowledge gets a value of 4. This is because there are 3 factual knowledge on tornado material that is compatible to be inserted in factual knowledge on Senior High School Basic Competence (BC) 3.2 physics material. In factual knowledge get a value of 2 because there is only 1 factual knowledge on tornado material that is compatible to be inserted in the factual knowledge of Senior High School Basic Competence (BC) 3.2 physics material. Meanwhile, procedural knowledge only gets a value of 1 because there is no procedural knowledge on tornado material that is compatible for insertion in the procedural knowledge of Senior High School Basic Competence (BC) 3.2 physics material

The Basic Competence (BC) 3.2 physics material discusses electric charge, electric force, electric field strength, flux, electric potential, electric potential energy and its application in various cases has compatibility with tornado material. Electric charge comes in two forms, namely positive charge and negative charge (Kanginan, 2018; Pujianto *et al.*, 2016). This conceptual knowledge can be integrated with tornado material. Maslov (2017) explains that in the development stage of tornadoes, lightning clouds have dipole or triple electrical structures. In the first case, the upper layer of the thundercloud is positively charged, while the lower layer is negatively charged. In the second case, in addition there is a relatively Senior High Schoolll region of positive charge located in the center under the lower layer. In addition, electrical power can cause the descent of the tornado funnel to the surface of the earth or rise back into the lightning cloud. Furthermore, the electric field is the area around charged objects where the object still has an electric force (Kanginan, 2018). Tornadoes show electrical phenomena. Krehbiel *et al* (2000) to try to quantify the possible electrical effects associated with tornadoes designed portable instruments to measure electric fields, pressure, and temperature. When the instrument is exposed to a strong tornadic wind, the average value of the electric field remains low and quickly relaxes back to zero after a flash of lightning to temporarily increase the field value. This behavior could be the result of an induced charge on debris lifted from the ground by strong winds.

In Basic Competence (BC) 3.1, Basic Competence (BC) 3.3, Basic Competence (BC) 3.4, and Basic Competence (BC) 3.5, the three domains of knowledge, namely conceptual knowledge, factual knowledge, and procedural knowledge, get a value of 1. This is because there is no discussion or connection to tornado material that can be inserted in factual knowledge, conceptual knowledge or procedural knowledge in Senior High School physics material.

The Basic Competence (BC) 3.1 physics material discusses the working principle of unidirectional electrical equipment and its safety in everyday life. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.1 physics material that can be integrated with factual, conceptual, and procedural knowledge of tornado material.

Material physics Basic Competence (BC) 3. 3 discusses magnetic fields, magnetic induction, and magnetic forces in various technological products. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.3 physics material that can be integrated with factual, conceptual, and procedural knowledge of tornado material.

Basic Competence (BC) 3.4 physics material discusses the phenomenon of electromagnetic induction in everyday life including electromagnetic induction used for various technologies that may be able to help human activities. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.4 physics material that can be integrated with factual, conceptual, and procedural knowledge of tornado material.

The physics material Basic Competence (BC) 3.5 discusses the alternating current (AC) circuit and its application. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.5 physics material that can be integrated with factual, conceptual, and procedural knowledge of tornado material.

3.2. Analysis of the Compatibility of Senior High School Physics Material class XII semester 2 with Tornado Material

Class XII semester 2 physics material has a compatibility value of 0.348, so class XII semester 2 physics material is less compatible for integration with tornado material. The description of the compatibility value for each subject matter in the material can be seen in Table 5 and the data on the distribution of compatibility of knowledge of physical matter with tornado material is seen in Figure 2.

Table 5. Data from the Analysis of the Compatibility of Physics Material with Tornado Material for Each Basic Competence (BC) of Senior High School Class XII Semester 2. Physics material

No	Material Physics	Compatibility Score
1	Basic Competence (BC) 3.6 Electromagnetic Radiation	0,67
2	Basic Competence (BC) 3.7 Special Theory of Relativity	0,25
3	Basic Competence (BC) 3.8 Quantum Phenomena	0,25
4	Basic Competence (BC) 3.9 Digital Technology	0,42
5	Basic Competence (BC) 3.10 Atomic Nuclei and Radioactivity	0,25

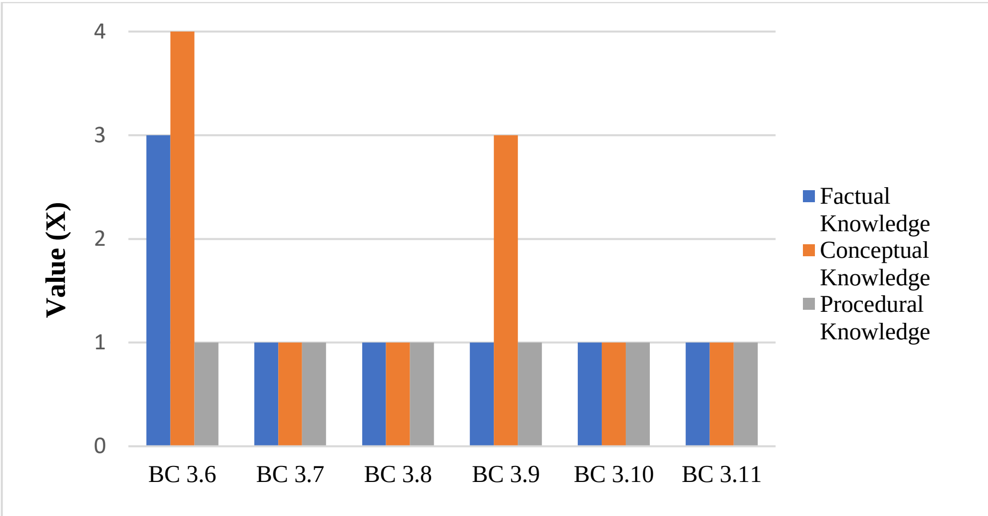

Figure 2. Compatibility of Senior High School physics material class XII semester 2 with tornado material

Class XII physics material semester 2 consists of 6 main materials, namely electromagnetic radiation, special theory of relativity, quantum phenomena, digital technology, atomic nuclei and radioactivity, and energy sources. Based on the data in Table 5, it is known that the subject matter of Senior High School physics class XII semester 2 which has the highest compatibility value is found in Basic Competence (BC) 3.6 about electromagnetic radiation with a value of 0.67 and Basic Competence (BC) 3.9 about digital technology with a value of 0.42 and the lowest compatibility value is found in other Basic Competence (BC) with a value of 0.25. The compatibility level score in class XII semester 2 is 0.348 which is obtained from the average score of all Basic Competence (BC) in class XII semester 2. So, we can conclude that tornado material is less compatible for integration in class XII semester 2 physics material because only 2 main materials, namely electromagnetic radiation and digital technology, are compatible for integration with tornado material. The discussion of the results of the analysis of the compatibility of Senior High School physics material with tornado material is described as follows:

First, in Basic Competence (BC) 3.6 conceptual knowledge gets a value of 4. This is because there are 3 factual knowledge on tornado material that is compatible to be inserted in factual knowledge on Senior High School Basic Competence (BC) 3.6 physics material. In factual knowledge, it gets a value of 3 because there are only 2 factual knowledge on tornado material that is compatible to be inserted in the factual knowledge of Senior High School Basic Competence (BC) 3.6 physics material. Meanwhile, procedural knowledge only gets a value of 1 because there is no procedural knowledge on tornado material that is compatible for insertion in procedural knowledge of Senior High School Basic Competence (BC) 3.6 physics material.

The physical material Basic Competence (BC) 3.6 about the phenomenon of electromagnetic radiation, its use in technology, and its impact on life has compatibility with tornado material. Electromagnetic radiation in the form of primary radiofrequency electrical activity appears to radiate from the process of lightning discharge within the parent cloud that produces tornadoes. According to Taylor's research (1973), the predominant radiofrequency electrical activity was linked to the strong tornado-producing storms that impacted Oklahoma City. This was demonstrated by radiation measurements from the lightning discharge process. In order to preserve the explosive character of the received impulse signal, the rate of atmospheric occurrence at frequencies between 10 kHz and above 3 MHz is measured using a short time constant circuit. Doppler radar can be used to detect tornado speed, while long-range infrared sensors can be used to monitor temperature. Doing these measures together will yield the best measurement results. Long-range infrared measurements currently available present challenges. Tanamachi *et al.* (2006) noted that the tornado condensation funnel was obscured by rain or dust. Other factors that affect readings include ozone or haze that emits infrared radiation, objects that are not at the same distance from the camera, and clouds that cool other clouds that are far away and may be seen in holes in the measured cloud.

Second, in Basic Competence (BC) 3.9 conceptual knowledge gets a value of 4. This is because there are 3 conceptual knowledge of tornado material that are compatible to be inserted in conceptual knowledge in Basic Competence (BC) 3.9 physics material. Meanwhile, factual knowledge and procedural knowledge get a value of 1 because there is no factual knowledge on the tornado material that is compatible to be inserted in the factual knowledge on the physics material of Senior High School Basic Competence (BC) 3.9.

The Basic Competence (BC) 3.9 physics material discusses the concept of storing and transmitting data in analog and digital forms and its application in real information and communication technology in everyday life has compatibility with tornado material. Tornadoes are a local-scale meteorological phenomenon and occur in a short time. Although this phenomenon lasts briefly, the impact can cause considerable damage and losses to casualties. Therefore, it is necessary to use digital technology in making an early warning system from a hazard-prone area. Murdyaningrum *et al.* (2016) designed a tornado early detection system. SMS gateway software distributes messages created by information systems through SMS media handled by cellular networks with the use of computers and integrated cellular technology. The program SATAID (Satellite Animation and Interactive Diagnosis), which was created by the Japan Meteorology Agency (JMA), was also mentioned by Harsa *et al.* (2011) in their investigation. The application's purpose is to extract information about meteorological parameters from satellite pictures. For the purpose of processing satellite photos, SATAID is a collection of software that works with the Windows OS. A program that converts satellite binary data into pictures is at the heart of the SATAID system. As JMA's contribution to the World Meteorology Organization (WMO), this application was created. At the moment, JMA uses SATAID as a functional instrument for daily meteorological analysis, including tropical cyclone monitoring. There are several variations of the SATAID program such as GMSLPD which is devoted to the analysis of tropical cyclones and also tornadoes.

Third, in Basic Competence (BC) 3.7, Basic Competence (BC) 3.8, Basic Competence (BC) 3.10, and Basic Competence (BC) 3.11, the three domains of knowledge, namely conceptual knowledge, factual knowledge, and procedural knowledge get a value of 1. This is because there is no discussion or connection to the tornado material that can be inserted in factual knowledge, conceptual knowledge or procedural knowledge in Senior High School physics material in the Basic Competence (BC).

The physics material Basic Competence (BC) 3.7 discusses the phenomenon of changes in length, time, and mass associated with the frame of reference and the equivalence of mass with energy in the special theory of relativity. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.7 physics material that can be integrated with conceptual knowledge, factual knowledge, and procedural knowledge of tornado material.

Physics Material Basic Competence (BC) 3.8 discusses quantum symptoms that include the nature of blackbody radiation, photoelectric effects, compton effects, and X-rays in everyday life. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.8 physics material that can be integrated with conceptual knowledge, factual knowledge, and procedural knowledge of tornado material.

The physics material Basic Competence (BC) 3.10 discusses the characteristics of atomic nuclei, radioactivity, utilization, impact, and protection in everyday life. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.10 physics material that can be integrated with conceptual knowledge, factual knowledge, and procedural knowledge of tornado material.

The physics material Basic Competence (BC) 3.11 discusses the limitations of energy sources and their impact on life. However, there is no conceptual knowledge, factual knowledge, and procedural knowledge of Basic Competence (BC) 3.11 physics material that can be integrated with conceptual knowledge, factual knowledge, and procedural knowledge of tornado material.

4. Conclusions

The level of compatibility of tornado material with Senior High School physics learning materials classes X, XI, and XII where class XII physics materials in semesters 1 and 2 are in the category of less compatibility. In class XII semester 1, there is only 1 out of 5 physics subject matter that has a high enough compatibility to be integrated with tornado material, namely static electricity material with a compatibility value of 0.65. In class XII semester 2, there are 2 out of 6 subject materials that have a high enough compatibility to be integrated with tornado material, namely electromagnetic radiation material with a compatibility value of 0.67 and digital technology with a compatibility value of 0.42. So, we can conclude that tornado material is less compatible to be integrated with class XII physics material semester 1 and 2. It is hoped that the outcome of this study in the future can be a reference for developing learning resources in physics learning that are integrated with tornado material.

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Conflicts of Interest

The authors declare no conflict of interest.

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