"Evaluating the Alignment of Physics Lessons with Flood-Related Topics"

*Dr. Gajendra Gupta

ABSTRACT

Natural catastrophes, including floods, are a common occurrence in Padang City. For this metropolis, the combination of physical and flood materials works well. Actually, there has been zero incorporation of disaster-related content, particularly flood-related content, into the field's official physics subject package textbook. Prior to incorporating flood-related content into physics lessons, it is necessary to assess whether or not the Curriculum Objectives for physics align with flood-related content. Researchers in Padang, Indonesia, utilised the 2013 Curriculum to compile a sample of physics textbooks used by students in grades ten, eleven, and twelve. The study was qualitative descriptive in nature and relied on the nonprobability sampling approach known as Purposive Sampling. The results are based on an analysis of 15 different high schools in Padang, Indonesia, using data from the 2016 edition of High School Physics, reviewed and published by Erlangga.

The research found that eleventh grade was the most appropriately sized class to include this subject into because of its high degree of appropriateness. Contrarily, this content is not appropriate for twelfth grade. In conclusion, developing teaching materials that include flood materials is important to increase the relevance and efficacy of physics learning in Padang city high schools. This is particularly true for eleventh grade, where the degree of applicability is greatest, and should be prioritised. What makes this study unique or novel is: High school physics curricula in Padang City, a city prone to floods, should benefit greatly from this study's proposed addition of natural disaster education, with an emphasis on flood-related topics. With the goal of better preparing students to comprehend and cope with real-world natural events, it uniquely combines basic physics concepts with practical knowledge of catastrophe avoidance.

KEYWORDS: flood; level of conformity analysis; physics lesson.

1. Introduction

So long, classes in geography, sociology, or social studies have been the ones to cover topics pertaining to natural catastrophes. When seen through the scientific lens, knowledge gained by studying natural disasters is also considered to be part of the scientific community. Thus, it is important to teach it in a way that is consistent with scientific principles, both for the benefit of students and the community at large, and to facilitate the practical integration of disaster education into secondary school science curricula. Because of this, teaching physics via the lens of the flood is a good fit for Padang City. Natural catastrophes, including floods, are a common occurrence in Padang City.

Actually, there is a lack of integration between the study of Physics and disaster-related content. According to Shiwaku et al. (2007), disaster education is crucial in the field of education. A disaster education program may be put into place by creating an comprehensive curriculum of catastrophe materials. According to Rahma (2015), one way to educate people about catastrophes is to include disaster-related topics in the curriculum. The field of physics is one that might work well with disaster-related content. Physics is defined by Suparno in Zaman (2012) as the study of matter and its physical characteristics, including size, form, roughness, mass, and their interrelationships. A setting that permits direct interaction with the thing under study is necessary for the understanding of physical ideas. Coccia (2014) states that physics is the branch of science that seeks to understand the workings of the natural world. One goal of physics classes in senior high school, according to Ministerial Regulation No. 59 of 2014, is to help students learn to think analytically and reason both inductively and deductively by applying the principles and concepts of physics to the study of different kinds of natural phenomena and the solution of quantitative and qualitative problems.

According to the goals of physics education, students should be able to use what they study to make sense of the world around them. In order for kids to know what to do when faced with environmental challenges. On the other hand, there are some truths about physics education that have nothing to do with disaster-related content. In order for the curriculum to be effective, it must permeate every aspect of the educational process. Books and other instructional resources, as well as students themselves, are expected to reach their full potential in the learning process.

Publicly funded books are those that have been published by the Ministry of Education and Culture's Curriculum and Books Centre. Furthermore, there are publications that are produced by private corporations and used in educational institutions. Materials for disaster-related integrated physics lessons are easily accessible. The truth, however, is that neither the government nor any other publisher has supplied integrated teaching materials for catastrophe subjects, particularly floods, over the last semester. The fact that these textbooks are noticeably missing from Padang City's high schools is proof of this. In addition, after perusing a number of Padang bookshops, we were unable to locate any physics textbooks that covered flood disasters for a minimum of one semester. Before discussing floods in physics class, it's important to examine the course's physics materials for at least a semester to see if they align with the course's curriculum objectives. The integration of physics with disaster material is possible if the physics content aligns with the curriculum objectives. In order to include Flood content into Physics lessons, it is necessary to create new Physics curricula that incorporate Flood material.

It is based on pertinent research, developed physics e-modules for high school students using the SETS (Science, Environment, Technology, and Society) model and integrated them with flood disaster material to build students' competence in disaster mitigation. Here, for KD (Basic Competence) 3.9 and KD (Basic Competence) 3.10 class X, researchers provide physics lesson plans that use Flood content exclusively. While researchers have demonstrated the practicality and effectiveness of integrated teaching materials for Flood material, the problem is that researchers only integrate Flood material into certain KDs and do not conduct material suitability analyses throughout the semester to determine which semester is best for integrating with Flood material. Then, the level of suitability of the Curriculum Objectives in the eighth grade science textbook for class VIII during the first semester with the Flood material was assessed. However, this study only looked at the science content for that particular semester, not the entire semester, so researchers couldn't tell you which one would have been best for integrating the Flood material.

Prior study has not examined whether or if physics course goals may be adequately met by including Flood content for a minimum of one semester. In light of these issues and conclusions, the researchers urged more study into the compatibility evaluation of physics course materials with learning outcomes in order to include Flood materials. In order to ensure that textbooks are effective in meeting curricular goals, research will be conducted on the content inside the book. In order to determine whether physics textbooks provide important information that can be merged with flood material, this study will examine the applicability of the two sets of materials using the researchers' factual, conceptual, and procedural understanding of the physics content. This study will examine the physics content from the 2016 updated edition of the high school physics textbook produced by Erlangga, which is used by several schools in Padang, to determine its compatibility with the flood content. The following questions guide the research: How well-suited are physics course materials for senior high school (tenth, eleventh, and twelfth grades) to covering floods for at least one semester?

2. Methods

This study employed a qualitative methodology to communicate its findings, while the research itself was descriptive in nature. According to Margono (2010), the primary goal of descriptive research is to provide a detailed account of a subject or phenomenon. A qualitative technique is defined as research that generates descriptive data via the written or spoken words of individuals and their observed behaviour (Moleong in Margono, 2010).

Nonprobability sampling, a subset of purposive sampling that takes certain factors into account, was used to collect samples for this research. This study utilised the 2013 Curriculum as its basis and used the purposive sampling approach to collect physics textbook samples from Padang, Indonesia, for use in senior high schools (grades 10, 11, and 12). Based on data collected from 15 different schools in Padang, this study found that the 2016 updated version of Erlangga's high school physics textbook was the most popular choice among students.

The research tool for this study is the Physics with Floods Analysis sheet, which is used to determine whether or not the physics curriculum for senior high school (grades ten, eleven, and twelve) is suitable. There are four possible scores on this instrument: 1, 2, 3, and 4. Each indication has a possible range of scores, from 1 (very low) to 4 (very high). From a purely knowledge-based perspective, we can see that the factual, conceptual, and procedural aspects of physics content that are well-suited for incorporation with flood content are compatible with one another.

The methods used to gather data for this research were documentation studies, which included gathering information from a variety of textual sources. Collecting and thoroughly analysing relevant documents or data is the first step in conducting a documentation study. Data on the compatibility of Physics content with Curriculum Objectives and Flood content on Physics pedagogical resources for upper-level high school students (grades 10, 11, and 12) are gathered using the documentation technique. This information is derived using an analysis sheet tool that determines if physics material is compatible with flood material.

In order to classify physics materials according to their compatibility with flood materials, descriptive statistical analysis methods use ideal standard standards (Equation 1, Table 1, and Table 2). Using a Likert scale with four possible scores—Very Appropriate (SS), Appropriate (S), Less Appropriate (KS), and Not Appropriate (TS)—this study finds that a score of 4 is the best possible outcome when all three assessment elements align with the assessment indicator, a score of 3 when two elements do, a score of 2 when one element does, and a score of 1 when none of the elements do.

3. Results and Discussion

The goal of this study is to identify which Physics course materials are well-suited for incorporating Flood content into them. Factual, conceptual, and procedural understanding of both the Physics and Flood topics included in high school physics textbooks (for grades 10–12) will be used to determine the degree to which the two bodies of knowledge are compatible.

Evaluation of the appropriateness of incorporating flood-related content into physics classes for tenth graders

Figure 1 displays data on the appropriateness level of physics courses that use flooding materials from KD 3.1 to 3.6. Depending on the context, facts may be best expressed using KD 3.2, KD 3.5, or KD 3.6 aspects, the values of which can vary among KDs.

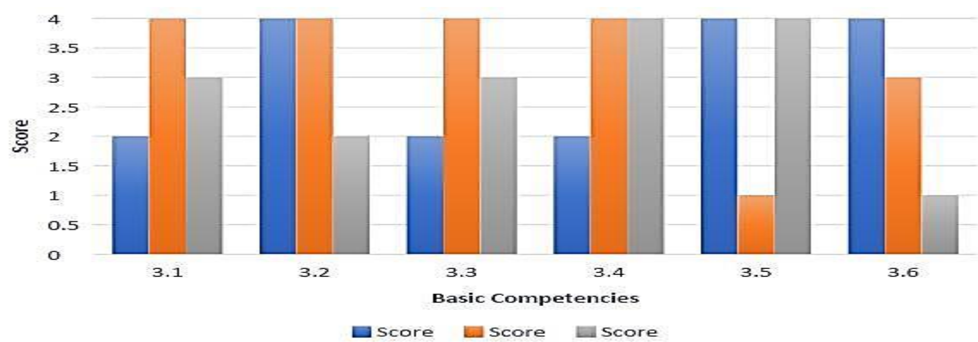

Fig. 1. Analysis of the level of suitability of physics lessons with the flood material of tenth grade first semester

All things considered, the conceptual knowledge is suitable, with the exception of KD3.5, which is much below the very adequate level. Parabolic motion, vectors, and their physical significance and practical applications are all things that KD 3.5 is supposed to be able to handle. However, when it comes to procedural understanding, KD 3.6 seems to have achieved the lowest level of conformance. This KD assumes that students can understand and apply physical numbers in circular motion at a constant velocity (fixed).

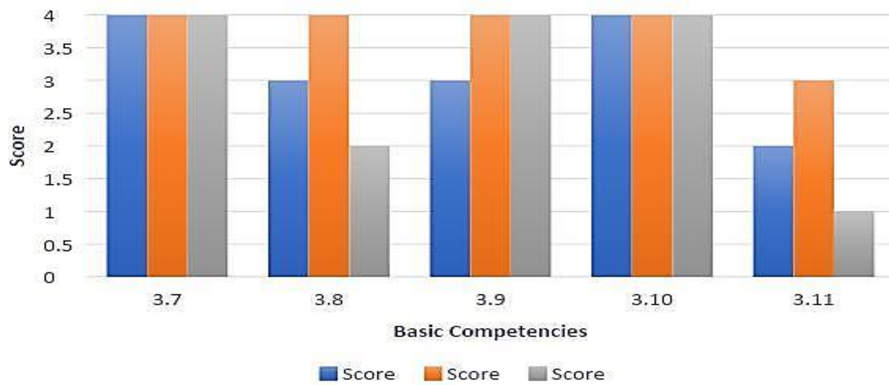

Fig. 2. Analysis of the level of suitability of physics lessons with the flood material of tenth grade second semester

With a value of 4 for each facet of knowledge, physics classes seem to be well-suited according to Figure 2, which is based on the flood of fundamental competencies (KD) 3.7 and 3.10. Whereas in KD 3.7, students are expected to understand and apply the law of conservation of momentum in real-world situations, and in KD 3.10, they are expected to understand and apply the concepts of momentum, impulse, and the relationship between force, mass, and the straight-line motion of objects. During the first semester of tenth grade, KD 3.11 had the lowest score out of all three knowledge domains. This demonstrates that the existing literature on floods is at odds with the current understanding of force and vibration.

Evaluating the Accuracy of Eleventh Grade Physics Lessons Covering Floods

Figure 3 shows the results of the study evaluating the compatibility of eleventh grade KD with flood content found in school physics textbooks. The factual knowledge component is, generally speaking, suitable for any KD. It is clear from KD 3.6 that there is little value increase in terms of conceptual understanding. Students are expected to demonstrate knowledge of gas kinetic theory and their properties in enclosed areas by the end of the KD. At KD 3.2, the procedural knowledge element also achieved the lowest score. Elasticity and its practical applications are covered in the KD.

Figure 4 shows that, once again, all KD are approaching a level of factual knowledge that is extremely adequate. Both KD 3.11 and KD 3.12 fell short of fully realising this element. With respect to both conceptual and procedural knowledge, KD 3.11 receives the worst possible score. Shiva textbooks do not include flood-related topics in their optical instrument content. The physics lessons in KD 3.7, particularly those involving procedures, and in KD 3.8 and 3.10 might need some work to make them more appropriate for use with flood materials. In contrast, KD 3.13 should enhance the factual knowledge parts of physics classes by making them more appropriate for flood matter.

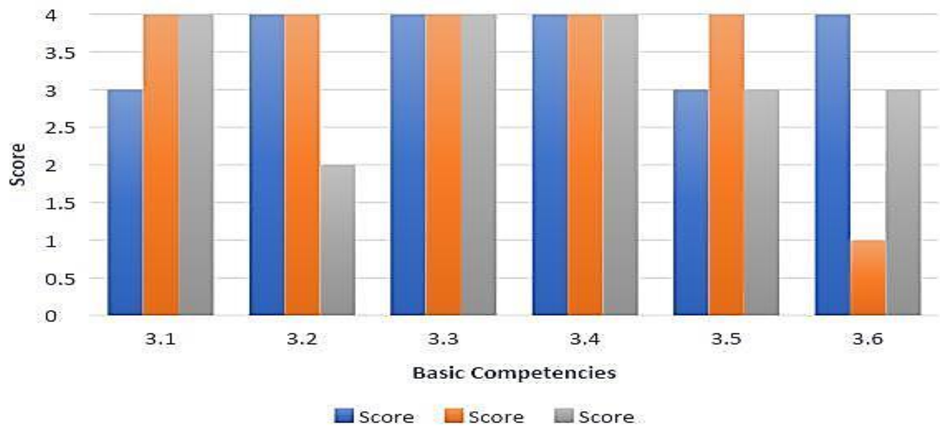

Fig. 3. Analysis of the level of suitability of physics lessons with the flood material of eleventh grade of the first semester

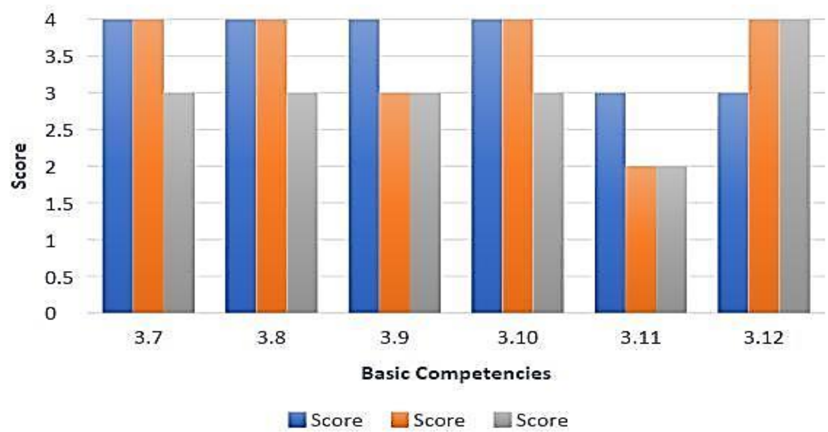

Fig. 4. Analysis of the level of suitability of physics lessons with the flood material of eleventh grade second semester

Analysis of the level of suitability of twelfth grade physics lessons with flood material

The findings of the investigation about the compatibility of physics lectures with flood material are shown in Figure 5. In most cases, none of the KDs have achieved their full potential in all three areas.

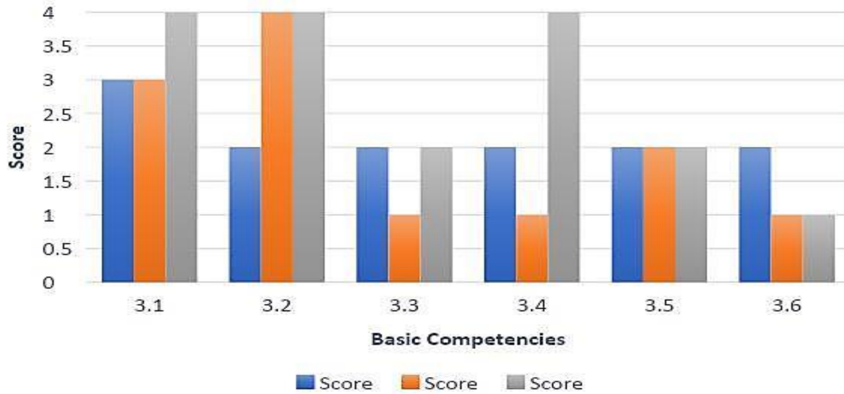

Fig. 5. Analysis of the level of suitability of twelfth grade physics lessons in the first semester with flood material

No version of KD beyond 3.1 makes use of the average component of factual knowledge. At the same time, different areas of conceptual knowledge have found varying degrees of success with each KD. Nevertheless, KD 3.3, 3.4, and 3.6 have the lowest values. Material involving magnetic fields, electromagnetic induction, and magnetic force are all part of the three KDs. So are the phenomena of electromagnetic radiation, its technological applications, and the effects it has on living things. Also, in terms of procedural knowledge, KD 3.6 has to be revised to be more in line with flood materials.

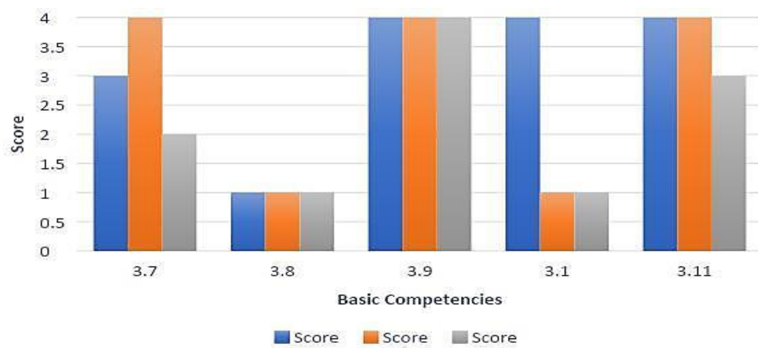

Fig. 6. Analysis of the level of suitability of twelfth grade physics lessons in the second semester with flood material

Figure 6 demonstrates that KD 3.9 achieved the highest possible value in all three domains of knowledge. On the other hand, KD 3.8 is not very useful. This explains why ordinary X-rays, photoelectric effects, the Compton effect, and blackbody radiation—all phenomena using the qualitative idea of quantum mechanics—do not work with flood matter. Furthermore, with the exception of factual knowledge, KD 3.10 also received poor marks. The atomic nucleus, its properties, its applications, safeguarding radioactivity, and its effects on daily life are all covered in this KD.

Table 3. The percentage of the degree of suitability of physics lessons to flood material

No	Class/ Semester	Conformity percentage (%)	Criterion
1	Tenth/1	79	Appropriate
2	Tenth/2	83	Appropriate
3	Eleventh/1	88	Fits perfectly
4	Eleventh/2	85	Fits perfectly
5	Twelfth/1	60	Not compliant
6	Twelfth/2	68	Not compliant

Table 3 shows the percentage breakdown of how well high school physics classes cover flood topics overall. Different percentages are used for each of the three grade levels. The tenth grade was classified appropriately since it achieved a compliance rate of 79% and 83% each semester. With 88% and 85% with extremely acceptable categories, respectively, physics courses in tenth and twelveth grade textbooks about flood material are more suitable. The twelfth grade textbooks were deemed unacceptable due to their low conformance percentages of 60% and 68%, in contrast to the prior one. The eleventh grade physics curriculum has not done a good job of covering floods.

The purpose of this research is to find out how well Flood fits into high school physics curriculum (grades 10, 11, and 12). Alignment of Physics Content with Learning Outcomes The observable goals of the curriculum in terms of knowledge include students' acquisition of factual, conceptual, and procedural understanding of physics content in line with the goals of the curriculum in terms of scientific approach, authentic assessment, local content, and conformity with IC and KD.

Three areas of knowledge—factual, conceptual, and procedural—will be used to determine the appropriateness of flood and physics content. According to Gunawan and Palupi (2016), there are three types of knowledge: factual knowledge, conceptual knowledge, and procedural knowledge. Factual knowledge includes things like terminology and specific elements. Conceptual knowledge includes things like classifications and categories, principles and generalisations, theories, models, and structures. Procedural knowledge, on the other hand, includes things like skills and algorithms, techniques and methods, and knowledge of Each semester's junior and high school physics content (tenth, eleventh, and twelve grades) is structured according to the standards. This study will help researchers better understand how to include flood materials into physics lesson plans.

Local content items, such as flood material, have regional potential and may be used in integrated disciplines, particularly physics courses. The physics textbook delves into the whys and hows of the recent cool lava flows in West Sumatra province, for instance. Because it happened not long ago and is still very near to where the students live, they will be more invested in learning about it. This is due to the fact that local content does not exist in the curriculum in a vacuum but rather as an integrated component of preexisting topics (Idi, 2014). That is why there is no dedicated time slot for local payloads. The Curriculum is designed to include local material as well. Therefore, it is essential that this regional knowledge be included in course materials and used in the classroom.

The field of physics seeks to understand the workings of the universe by studying and explaining natural occurrences. One of the goals of physics classes in senior high school, according to Regulation of the Minister of Education and Culture of the Republic of Indonesia/Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia (Permendikbud RI) No. 59 of 2014, is to help students learn to think analytically and logically, both in terms of inference and deduction, by applying the principles and concepts of physics to the explanation of different kinds of natural phenomena and the solution of quantitative and qualitative problems. We may incorporate the components of natural occurrences into matter by studying physics. One way to do this is by combining topics in Physics with those dealing with natural disasters, such as floods. Due to the fact that flooding is a common occurrence in the West Sumatra region. In order to determine which Physics materials are appropriate for incorporation with Flood materials, it is necessary to conduct an analysis of their appropriateness.

Since the nature and application of physical concepts like parabolic motion, circular motion, the concept of force, and vibration are not directly related to the phenomenon of flooding, the results of research for tenth grade semester 1 and semester 2 indicate that these materials have a low level of conformity with the topic of flooding. Objects thrown at an angle against the ground, such balls or bullets, often exhibit parabolic motion. Typically, this occurrence is brought up while discussing projectiles or anything that undergo two types of motion (horizontal and vertical) at the same time. Rather of following parabolic motion patterns, water in a flood is more likely to follow the flow produced by gravity, height differences, and ground resistance.

When an item moves along a circular path, the centripetal force pulls it in the same direction as the circle's centre of gravity. Planets orbiting the sun and wheels turning are two common examples. The water's path does not often have a very circular pattern when flooding is present. More important factors affecting water flow include surrounding obstacles, flow rate, and land topography. Gravitational force, frictional force, normal force, and the attractive or repulsive forces between objects are all part of the force concept. This idea is more basic and applicable to a wider range of physical phenomena. Despite the fact that floodwaters are influenced by the force of gravity, most physics textbooks gloss over this fact and fail to provide a detailed explanation of how floodwaters behave. For example, when a spring or sound wave vibrates, they are both examples of objects that undergo alternating motion via their equilibrium point. The mechanics of flooding and the behaviour of floodwater are unrelated to the phenomena of vibration. More fundamental to the study of floods is the behaviour of fluids and the migration of vast bodies of water.

Typically, physics textbooks are crafted to impart widely acknowledged fundamental concepts of the subject, which include a vast array of natural occurrences. Not particular events like floods, but rather generalisable ideas and their applications are the main points. Geographical, meteorological, hydrological, and fluid dynamics viewpoints provide light on the phenomena of floods. The field is more focused and applicable than general physics as it examines ground-level phenomena like as rainfall patterns, drainage systems, terrain, and the behaviour of water flows. A holistic explanation of floods requires an interdisciplinary approach that draws on expertise in several scientific domains, not limited to physics alone. Hence, it's possible that physics textbooks don't add much to our overall knowledge of floods. Having said that, most of the current physics textbooks are suitable enough to include flood content. Considering that eleven KD were considered unsuitable in tenth grade, this explains why there are only three in ninth grade.

Since there is a great deal of factual, conceptual, and procedural knowledge on Flood material with Physics material that is compatible, it is possible to insert Flood material into Physics material as local content. In the first semester of eleventh grade, the suitability of Physics material with Flood material receives a percentage of 88%, and in the second semester, it gets 85% with very appropriate categories. In both static and dynamic fluids, for instance. Dynamic fluid matter is a physical substance that is ideal for introducing Flood material. Since a lot of water is produced when it rains quite heavily, dynamic fluids are strongly associated with floods. According to the physical principle, the larger the water outflow, the bigger the volume of water generated per unit of time, therefore a wide cross-sectional area is necessary for water with a high concentration.

A direct correlation exists between the water output and the velocity of the flow of water. When we consider the relationship between force and pressure, we can see that a high water flow rate exerts a lot of force, and that a lot of force causes a lot of pressure. An additional factor in water flow rate is the height of a given site. The rate of water flow is directly proportional to one's elevation. It follows that higher-discharge rainfall and water spilling from higher-level rivers, dams, or reservoirs both result in faster water flows because of the increased kinetic energy of the former. The flow of water is accelerated by a high water speed. Depending on how they interact with the water's surface, nearby items will either be swept away or left where they are. One of the causes of floods is global climate change, hence there is a connection between floods and climate change literature. Heavy rains that provide an abundance of river water flow are the typical cause of floods in Indonesia. The result was that people's houses were overwhelmed by the excessive river water. Reforesting or replanting deforested area and terrain that is traversed by several water currents might help the soil prevent erosion and landslides.

However, discussing floods in a physics class for twelfth graders, which covers concepts like electricity and magnetism, is not a good fit for the curriculum. Electric fields, capacitance, Ohm's law, electric current, electric circuits, electromagnetic induction, electric fields, Coulomb's law, electric potential, and the technological applications of electromagnetism are typical subjects covered in twelfth grade electrical and magnetic materials. Given the specialised nature of the subject matter, a solid grounding in the characteristics and governing principles of electricity and magnetism is essential. According to Merz et al. (2014), the occurrence of floods is primarily influenced by fluid dynamics, hydrology, geography, and meteorological variables including rainfall and drainage systems. Although the electrical and magnetic physics curriculum does touch on some topics related to floods, such as the potential for electrical dangers (such as short-circuits) and the need for disaster management strategies, they mostly pertain to safety concerns. The introduction of flood content has the potential to divert attention away from the primary learning purpose and lead pupils astray as to what that objective really is.

4. Conclusions

This study highlights the critical need of including flood-related topics into physics curricula in Padang City high schools, given the city's susceptibility to flooding. A review of the issues' compatibility with physics reveals that not all high school physics courses are well-suited to covering floods. Research conducted using the nonprobability sampling technique with the type of purposive sampling on the 2016 revised edition of Erlangga's high school physics textbooks (tenth, eleventh, and twelfth grades) indicated that the integration of flood material is most appropriate for eleventh grade and least appropriate for twelfth grade. Factual, conceptual, and procedural knowledge are all taken into account when determining this appropriateness. With percentages of 88% and 85% respectively, eleventh grade in the first and second semesters demonstrated an exceptionally high degree of appropriateness. The difference is shown in the first and second semester twelfth grades, when the appropriateness level is low at 60% and 68%, respectively. Tenth grade had a considerable degree of appropriateness, with first-semester percentages of 79% and second-semester percentages of 83%.

Based on these findings, it is clear that the present physics textbooks' coverage of topics like vibration, the idea of force, parabolic motion, and circular motion does not adequately address the issue of floods. Considering the significance of disaster education in equipping students with practical knowledge and understanding, it is essential to provide physics teaching materials tailored to flood materials for successful integration. To sum up, if Padang City's senior high schools want to make physics lessons more engaging and successful for their students, they need to create new curricula that include flood materials, particularly for the eleventh grade, when the content is most applicable. Students will have a better understanding of floods in a physics context and be more prepared for the frequent natural catastrophes in the area if they follow this step.

Here are a few suggestions that might be offered, namely First, the Development of Integrated Textbooks. Physics concepts like fluid dynamics, pressure, and flow should be included in this textbook in relation to floods. Improving Upon What Is Already There: Current Physics textbooks should have new sections or chapters added that connect what students learn in class to real-world flood events. It is possible to include instances of water flow during floods into discussions on fluid dynamics, for instance. 2) Educator Professional Development Opportunities. Instruction on the use of various learning aids, as well as strategies for creating and delivering lessons, may be a part of this program. Thirdly, make advantage of active learning strategies. As an example, students might be asked to analyse flood data, comprehend water dynamics during floods, and build mitigation strategies using project-based learning (PBL) models or case studies.

***Department of Physics**
B.B.D Govt. College
Chimanpura, Shahpura (Jaipur)

References

1. Gunawan, I., & Palupi, A. R. (2016). Taksonomi Bloom–revisi ranah kognitif: kerangka landasan untuk pembelajaran, pengajaran, dan penilaian. *Premiere educandum: jurnal pendidikan dasar dan pembelajaran, 2*(02). http://doi.org/10.25273/pe.v2i02.50
2. Idi, A. (2014). *Pengembangan kurikulum teori & praktik*. Jakarta: PT Raja Grafindo Persada. Lestari, L. (2019). *Pengembangan E-modul Fisika SMA/MA Berbasis SETS (Science, Environment, Technology, and Society) Terintegrasi Materi Bencana Banjir untuk Meningkatkan Kompetensi Mitigasi Bencana* (Doctoral dissertation, Universitas Negeri Padang).

   http://repository.unp.ac.id/27902/
3. Margono. (2010). *Metodologi Penelitian Pendidikan*. PT. Asdi Mahasatya.
4. Merz, B., Aerts, J. C. J. H., Arnbjerg -Nielsen, K., Baldi, M., Becker, A., Bichet, A., ... & Nied, M. (2014). Floods and climate: emerging perspectives for flood risk assessment and management. *Natural Hazards and Earth System Sciences, 14*(7), 1921-1942. https://doi.org/10.5194/nhess-14-1921-2014
5. Rahma, A. (2018). Implementasi program pengurangan risiko bencana (PRB) melalui pendidikan formal. *Jurnal Varidika, 30*(1), 1-11.

   https://journals.ums.ac.id/index.php/varidika/article/download/6537/3986
6. Shiwaku, K., Shaw, R., Chandra Kandel, R., Narayan Shrestha, S., & Mani Dixit, A. (2007). Future perspective of school disaster education in Nepal. *Disaster Prevention and Management: An International Journal, 16*(4), 576-587.

   https://www.emerald.com/insight/content/doi/10.1108/09653560710817057/full /html
7. Widoyoko, E. P. (2009). *Evaluasi program pembelajaran*. Pustaka Pelajar.
8. Zaman, M. Q. (2012). Pengembangan Multimedia Pembelajaran Interaktif Menggunakan Macromedia Flash Professional pada Mata Pelajaran Fisika. *Indonesian Journal of Curriculum and Educational Technology Studies, 1*(1), 6-7.