Analysis the components of Science, Technology, Engineering, Art and Mathematics (STEAM) in Senior High School Physics Textbook

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Abstract. The purpose of this research was to analyze the STEAM components in physics textbooks for class XI senior high school including balance and rotation dynamics, material elasticity, static fluids, dynamic fluids, heat, kinetic theory of gas, thermodynamics, mechanical wave characteristics, walking waves and stationary waves. Sound and Light Waves, Optical Devices, and Symptoms of Global Warming. This research is a descriptive qualitative research. The subjects of this research consisted of five book publishers. From the analysis with the STEAM indicator, it is found that 60% contains the science category, 30% contains technology, 30% contains the engineering category, 50% contains the art category, 50% mathematics. The results showed that physics textbooks in circulation generally did not emphasize the STEAM approach.

1. Introduction
Physics is a subject that seeks the interconnectedness of nature with mathematical concepts, so physics is an invention of existing concepts or facts. As part of natural science, so physics must also be based on scientific findings and going around. So in physics learning should be instilled about basic concepts up to the development of science and thinking skills. A proper understanding must be made of the integration of STEAM (Science Technology Engineering Art and Math) education with exam results that fit the purpose of learning. Learning with a STEM approach aims to make it easier for students to understand the concepts that will be conveyed and can apply them in their daily lives and to explore the potential that exists within them. The next development is the addition of "Art" to STEAM to further explore the creativity and art of students. According to Henriksen (2014) STEAM learning in addition to strengthening student learning in all disciplines, also through these disciplines students get the opportunity to explore and make relationships between art, music, science, and others. In addition with STEAM students feel more motivated and more effective in learning.

STEAM is designed to improve people's ability in science and innovate technology products in order to compete globally. High-quality STEAM should include (a) the integration of technology and engineering into science and mathematics; (b) prioritize scientific research and engineering design, including
mathematics and science instruction; (c) collaborative approach to learning, connecting students and educators with STEM and the arts; (d) Provide a global and multi-perspective perspective; (e) Combine strategies such as project-based learning, providing formal and informal learning experiences; And (f) Incorporating appropriate Technologies to improve learning (Kelley, 2016; Anas et al. 2020).

STEAM education means strengthening the practicality of education in steam fields separately, while developing an educational approach that integrates science, technology, engineering, art and mathematics, by focusing the educational process on real problem solving in daily life or professional life (National Education Center, 2014). STEAM education gives educators the opportunity to show students about the concepts, principles, and techniques of science, technology, engineering, art and mathematics that are applied in an integrated way in the development of products, processes, and systems used in daily life. Steam-based learning students use science, technology, engineering, art and mathematics in a real context that connects schools, the world of work, and the global world, to develop steam literacy that students expect to be able to compete in a new, knowledge-based economic era. Engineering is the knowledge and skill to acquire and apply scientific, economic, social, artistic knowledge and design and construction of machinery, equipment, systems, materials, and processes that benefit humans economically and environmentally friendly.

An important problem in the 21st century is integrating information and communication technology into learning. Teachers and students must be prepared to keep up with the increasingly sophisticated times. Teachers must be creative, active and innovative in the use of technology in learning so as to create more creative and fun learning (Rusman, 2017). The 2013 curriculum launched will not be able to address the globally competitive quality and quantity of Indonesian human resources, if not balanced systemically preparing Indonesian HUMAN Resources in developing the knowledge, skills, and attitudes required in the 21st century world of work, as realized in STEAM learning. In order to solve this problem, education with STEAM learning can be key to creating the next generation of nations that are able to compete on the global scene. The development of student creativity depends on the teacher in knowing how the creativity is developed (Bayindir & Inan, 2008). Most teachers still apply conventional learning, where the learning process in general only trains the convergent thought process, so that when faced with a problem, students will have difficulty solving the problem creatively. A teacher needs to use a learning approach that can train students' creative thinking skills (Kartika, 2019). The combination of art in learning can support the improvement of students' creativity in learning. One learning approach that can be used to train creative thinking skills is steam learning approach (Beers, 2011).

In STEAM learning there is a science component. The concept of the science component is a learning that is used to understand natural phenomena and changes that occur caused by human activities. In addition, the science component also trains students to have skills in participating in opinion taking in steam learning process has technology components. The technology component is closely related to the development of the digital age today. The digital age is known for the internet, especially computer information technology. Technology users have the ability to discover, access, use, and explore the various information contained in digital technology and internet networks.

Creative thinking skills are needed to become reliable Human Resources in people's lives in global development. Good character is required to balance the virtual world indefinitely. The concept of the publisher's printed book as a source of teaching materials is considered to be difficult to keep up with global developments. It is not uncommon for books to still contain simple components, so it is perceived to be lacking in supporting STEAM learning. The implementation of learning with steam approach is certainly supported by STEAM-based teaching materials. Teaching materials can use webbed, connected, shared, or integrated combined depending on the characteristics of the subject matter. The presentation of teaching materials is done with the approach of science, technology, engineering (engineering), and mathematics. Books as a print media used in learning are expected to support the development of student
creativity. Books containing STEAM components can stimulate students to understand the components of science, technology and engineering in a simpler and more interesting way and supported by art and math content so that variations of physics learning are much more interesting to students. So it is necessary to have physics books containing STEAM components to make it easier for students to understand physics properly.

Improving the quality of creative human resources needs to be supported by good learning facilities and infrastructure. The selection of teaching books that students use is considered very important to support the learning process. Teaching materials are considered monotonous presenting concepts, theorems, and facts can decrease students' interest in innovating developing science in this case physics lessons that are very closely related to technology and mathematics. STEAM-based learning aims to prepare students to meet the capabilities of the digital age industry 4.0. To support STEAM-based learning, teaching materials are needed that are able to facilitate the implementation of such learning. After reviewing previous research, no research was found that analyzed grade XI high school physics teaching books related to STEAM learning. Currently, there are many high school physics books in grade XI that are circulating with various publishers. Therefore, it is necessary to find out if the teaching book that is circulating has been able to facilitate the implementation of steam approach in learning. The solution to this problem is to analyze the extent to which the teaching book has fulfilled the STEAM component.

Based on the results of the report Onner et al (2016) shows the results of research that aims to look at the level of confidence of students who do learning with STEM combined with art. As a result, there is an increase in student confidence after learning with STEM and art termed STEAM. Claudia Cornett's With About In and Through (WAIT) method when designing STEAM learning is able to improve students' learning achievement (Kuhn, 2015). Thompson et al., (2018) in literature studies focusing on the application of STEAM (Science, Technology, Engineering, Arts, and Mathematics) in K-12 education programs in the U.S. emphasizes the need for researchers to address the disruptive potential of pedagogical satisfaction teachers assigned to teach in STEAM disciplines who have no background in the field represented by STEAM and or who have no prior teaching experience in uap. Research aimed at testing the influence of Intensive professional development on the level of pedagogical dissatisfaction of K-12 teachers relative to steam application in all classrooms in rural school districts in the southeastern United States. Agnezi L.A et al (2019) in his research that analyzed five books of high school physics teaching in class X obtained the results of teaching books that meet stem components. A teaching book that meets stem components well is in book 1. Books that have not fulfilled stem components are found in book 3. These findings show that there are still many teaching books that have not fulfilled the components of STEM learning let alone the combination of art in STEAM learning, for which this should be of particular concern to all of us.

The above exposure shows the importance of STEAM learning in improving student creativity. Good learning should be supported by teaching materials that are as important as steam learning indicators, this is what makes researchers conduct research with the problem of how the quality of grade XI high school physics teaching books related to the components of Science, Technology, Engineering, Art and Mathematics (STEAM).

2. Method
This research includes descriptive qualitative research. The population in this study is all grade XI high school physics books. The sampling technique used is nonprobability of the sample, with purposive sampling type. In this study there were five books taken as research samples. These five books were selected based on the most commonly used published books in schools in Medan. The instruments used include five steam components namely Science, Technology, Engineering, Art and Mathematic in grade
XI high school materials. The instrument used contains 20 items of statements related to each steam indicator component. The data collection technique used in this study is by way of observation conducted by students based on the instruments that have been compiled. Observations are made to see if each of these materials contains steam components or not. The data obtained in this study uses steam-based high school physics book analysis observation sheet. Each instrument item is given a choice of 5 statements based on the Likert scale to assess whether or not there are indicators contained in the physics teaching book.

3. Results and Discussions

Book 1 consists of 13 chapters in which each chapter explains the purpose of learning accompanied by images and concept maps. Book 2 consists of 11 chapters in which each chapter explains the basic competencies and characters developed accompanied by images and concept maps. Book 3 consists of 12 chapters in which each chapter explains the basic competencies accompanied by images and concept maps. Book 4 consists of 12 chapters in which each chapter explains the purpose of learning accompanied by images. Book 5 consists of 12 chapters in which each chapter explains the purpose of learning accompanied by images. The results of the analysis of the entire book are presented in Table 1.

| Books  | Science | Technology | Engineering | Art  | Mathematics |
|--------|---------|------------|-------------|------|--------------|
| Book 1 | 60.28   | 29.23      | 28.21       | 51.11| 50           |
| Book 2 | 62.23   | 31.52      | 31.52       | 53.64| 50.91        |
| Book 3 | 57.5    | 30         | 30.3        | 46.11| 48.21        |
| Book 4 | 60.42   | 31.11      | 28.72       | 48.89| 52.56        |
| Book 5 | 59.17   | 27.69      | 31.28       | 50   | 48.2         |
| Average Percentage | 59.92 | 29.91 | 30.01 | 49.95 | 49.98 |
| Rounding Percentage Value | 60 | 30 | 30 | 50 | 50 |

From the percentage result, it can be seen in Table 1 all components of Science, Technology, Engineering, Art and Mathematics (STEAM) in the physics teaching book analyzed are in the low category. Thus the physics teaching book analyzed has not emphasized steam learning approach. In the application of the STEAM approach, a science does not stand alone but the result of the integration of some sciences, such as the merging of knowledge. The lack of results obtained from the analysis of the science component of the teaching book is due to the whole teaching book not integrating various science knowledge. On the entire content of the book, students only gain knowledge of Physics. Science should include other lessons, namely biology and chemistry. In the entire book analyzed there is no scientific process skill consisting of various aspects. Books are less directing students to understand nature in depth. So the learning that is done is facilitating students to gain experience directly because science not only consists of facts, concepts, and theories that can be memorized, but also consists of active activities or processes using scientific thoughts and attitudes in studying the symptoms of nature that have not been explained.

Mastery of Information and Communications Technology (ICT) and information literacy is a must. Without ICT and all-source resources, it can be difficult for students to develop their competencies. The
whole book is teaching, lacking in exposing what technology is used to obtain a form of information. In addition, in experiments there is no direction for students to use technology. This can have an impact on the ability of technology literacy that should be owned by students can hinder the development of the nation's next generation to career and do business in the digital age. Students must learn not only to understand the scientific basis of the new technology, but they must also learn about its social impact. Students must learn to be innovative and creative in terms of new technologies, but they must also be able to question the underlying values and what is right and wrong in the use of such technologies.

The low results of the analysis of engineering components in the book are due to the lack of exposure to the techniques used by students during the completion of the project. The teaching books analyzed tend to describe the working procedures of an experiment but do not describe the technical design process, in which previous students had to be able to identify and define problems, conduct research, develop multiple ideas for solutions, and come to one idea they designed prototypes. Students can then test prototypes, ponder and evaluate designs, and redesign to make improvements. As a result of this series of engineering process components, students can learn many social, collaborative, teamwork, and leadership skills. Students can also learn to conduct open exploration and direct investigation, making this a natural part of their learning, and most importantly, they can engage in deeper learning, to develop a mindset to always evolve where "failure" is considered a positive step toward better improvement and solutions.

The tendency of teaching books to display only images but does not lead students to a clue for example: viewing a video at a particular URL or triggering student creativity in designing projects and mathematics that are the formulas, calculations, or build spaces that students use during learning activities. In addition, the art component for student activities does not exist at all making students to be able to take responsibility for the resulting products that can show the components of art in the form of painting and color. Whereas art on STEAM is important for strengthening basic skills to make students more creative related to project activities in the learning that is being carried out. The teaching books analyzed underemphasously emphasize education as a gift of an environment in which students feel really compelled to engage in their future creation by understanding how important their presence is. Surely this should be instructed so that students can contribute something important and unique to a project.

Exposure to teaching books related to mathematics components is very much presented, but students are forced to memorize various formulas, pressed to reach a specific target number, and teaching methods that are only one-way lectures. Teaching book exposure that is textual and less contextual. Similarly, the enrichment of knowledge from teaching books does not lead students to high-level thinking abilities (HOTS) that should provide a clear illustration. Similarly, the problems in the mathematics component do not present a problem that solves not only using formulas directly, raises complex problems, has many solutions, requires interpretation and requires a hard effort in associating to make decisions. The mathematics component of STEAM relates to abstract concepts, therefore the presentation of mathematical materials in learning is often associated with daily life with the aim of so that students are able to discover concepts and develop their mathematical skills based on the experience or knowledge that has been possessed by students. Students are said to be able to solve a problem if the student is able to study a problem and is able to use his knowledge of a new situation.

4. Conclusion
The conclusions obtained in this study are:
1. The percentage of science components from the analysis of 5 physics teaching books is categorized as less than 60%.
2. The percentage of technology components from the analysis of 5 physics teaching books is categorized as low at 30%.
3. The percentage of engineering components from the analysis of 5 physics teaching books is categorized as low at 30%.
4. The percentage of art components from the analysis results of 5 physics teaching books is categorized as low as 50%.
5. The percentage of mathematics components from the analysis of 5 physics teaching books is categorized as low at 50%.
6. The physics teaching book analyzed has not emphasized the learning approach that steam implements

5. References
[1] Agnezi L. A dkk. (2019). Analisis Sajian Buku Ajar Fisika SMA Kelas X Semester 1 Terkait Komponen Science, Technology, Engineering, Mathematics (STEM). Jurnal Eksakta Pendidikan JEP | Volume 3 | Nomor 2| November 2019 e-ISSN 2579-860X p-ISSN 2614-1221.
[2] Anas LH, Rajagukguk J, Bunawan W. Video Technology Media based on Heat and Temperature to Improve of Learner Critical Thingking. Journal of Physics: Conference Series 2020 Mar 1 (Vol. 1485, No. 1, p. 012037). IOP Publishing.
[3] Becker, K., & Park, K. (2011). Effects Of Integrative Approaches Among Science, Technology, Engineering, And Mathematics (STEM) earning: A preliminary meta-analysis. Journal of STEM Education: Innovations & Research, 12.
[4] Henriksen, Danah. 2014. Full STEAM Ahead: Creativity in Excellent STEM Teaching Practices” dalam. The Journal STEAM, 15 (1): 1 – 6
[5] Kartika Y, Wahyu R, Sinaga B, Rajagukguk J. Improving Math Creative Thinking Ability by using Math Adventure Educational Game as an Interactive Media. InJournal of Physics: Conference Series 2019 Jul (Vol. 1179, No. 1, p. 012078). IOP Publishing.
[6] Kelley T.R. 2016. A Conceptual Framework for Integrated STEM Education. International Journal of STEM Education. Springer.
[7] Kuhn, Mason (2015) "Encouraging Teachers to W.A.I.T Before Engaging Students In Next Generation Science Standards STEAM Activities," The STEAM Journal: Vol. 2: Iss. 1, Article 15. DOI: 10.5642/steam.20150201.15
[8] National Science Teachers Association in collaboration with the Association for the Education of Teachers in Science. 2000. Standards for Science Teacher Preparation
[9] National Research Council. 1996. National Science Education Standard. Washington, DC.: National Academy Press.
[10] National Research Council. 2001. Inquiry and the National Science Education Standards: A Guide for Teaching and Learning Standards. Washington, DC.: National Academy Press.
[11] Simanullang NH, Rajagukguk J. Learning Management System (LMS) Based On Moodle To Improve Students Learning Activity. JPhCS. 2020 Feb;1462(1):012067.
[12] Onner, Ayse Tugba; Nite, Sandra Bonorden; Capraro, Robert M.; and Capraro, Mary Margaret (2016) "From STEM to STEAM: Students’ Beliefs About the Use of Their Creativity," The STEAM Journal: Vol. 2; Iss. 2, Article 6.
[13] O. F. Nugroho, A. Pernamasari, H. Firman. 2019. The Movement Of Stem Education In Indonesia: Science Teachers’ Perspectives. Jurnal Pendidikan IPA Indonesia. 8(3): 417 – 425
[14] Thompson et al., 2018. STEAM (Science, Technology, Engineering, Art, And Mathematics) Education And Teachers’ Pedagogical Discontentment Levels. International Journal of Social Sciences ISSN 2454-5899.