STREAMIN Model for the Next Generation of Science Education in Indonesia

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Abstract: The rapid development of science and technology globally becomes a challenge that must be faced in the present and in the future. Reorientation of science education has seen science in a collaborative perspective through the STEM (Science, Technology, Engineering, and Mathematics) approach. Nevertheless, the "arts" aspect needs to be taken into consideration that it is important to cultivate an innovative spirit in producing the work. Furthermore, self identity as a nation that believes in God and a united country in cultural diversity need to be nurtured. The STREAMIN Model is needed to realize the next generation of science education which has innovative, religious, and nationalist character. This paper reviews the literature through identification of science education (S) regarding technology (T), religion (R), engineering (E), arts (A), mathematics (M), indigenous culture (I), and nationalism (N). In the planning, “Spider Web” analysis is needed to see the orientation of science learning. Classroom management emphasizing reading and writing activities, as well as project-based learning is needed to improve learners’ literacy. The flipped classroom is designed in accordance with the current millennial generation. The evaluation also emphasizes the availability of authentic assessment prioritizing aspects of innovation, religious attitude, and spirit of nationalism.

Keywords: Science Education; STEM; The Next Generation of Science Education; STREAMIN Model.

1. Introduction

Science, technology, engineering, and mathematics (STEM) are interrelated subjects in real human life. The four fields are hooked together and can not stand alone. During this time, STEM was studied separately and as if only understood theoretically. In fact, the four areas of study must be mastered by students so that they can solve problems in the world of work, society and in all aspects of their lives later. The rapid development of science and technology globally becomes a challenge that must be faced in the present and in the future. Reorientation of science education has seen science in a collaborative perspective through the STEM approach integrating science, technology, engineering, and mathematics into a cohesive learning paradigm based on real-world applications.

Influential education, policy, and business groups have declared various reports to develop, improve the quality, and impact of STEM education [1]–[6]. This is related to the many assumptions that STEM education can produce innovative products that are important for the progress of a nation. In addition, many entrepreneurs and public officials believe that all citizens, including children and
adolescents, should have literacy on STEM whether they work in a field directly related to STEM or not. This literacy is so important that the public can become a wise consumer in making decisions, and not easily instigated by issues that are not necessarily true to science and technology.

The STEM has been applied in a number of developed countries such as USA, Japan, Finland, Australia, and Singapore. The STEM is an initiative of the National Science Foundation, USA. The goal of STEM implementation in the United States is to make these four fields (science, technology, engineering, and mathematics) a major career choice for learners [7], [8]. Nevertheless, in recent years, the STEM is applied to various fields of study or majors at various levels of education.

The STEM is an acronym commonly used to refer to one or more of the four disciplines (science, technology, engineering, and/or mathematics) that are seen as related to each other. These are seen as vital elements in preparing the next generation of technological and scientifically literate citizens and those employed in integrated fields such as medicine, computer science, agriculture, and others [9]. Research on science learning with STEM approach in secondary schools in Indonesia has started in the last few years. Perspectives and beliefs about junior high school students' attitudes toward STEM education can be measured by developing the Attitudes Towards STEM (AT-STEM) questionnaire [10]. The Solar-Hydrogen science kit was introduced to students to create their own clean energy applications using renewable fuel and hydrogen cells made using solar and water energy. In line with previous research, STEM-based science teaching by applying balloon powered car as a learning medium to understand the concept of straight-line motion [11]. The results showed that learning can improve motivation and provide hands-on experience in the manufacturing process. Furthermore, integrated STEM education in science learning at elementary and middle schools that have conducted by Universiti Kebangsaan Malaysia in cooperation with Nangro Aceh Darussalam, Indonesia [12]. The STEM program integrated entrepreneurial thinking into science learning through science process skills in the form of Entrepreneurial Science Thinking (EsciT). The EsciT module has been tested in several primary and secondary schools in Malaysia and Aceh (Indonesia). The results showed that in addition to student achievement and interest in science learning is increasing, their attitudes and perceptions of entrepreneurship showed positive results.

Education focusing solely on the STEM was considered by some parties including companies, educators, and parents that missed some key components of child growth. What is needed is not only knowledge and skills, but children must also have creativity. By experts, such creativity is trained by integrating STEM with the "Art" aspect. STEAM is an approach that has been developed in several countries. The STEM to STEAM movement has begun over the last few years and is intensifying as an effort to meet the challenges of the 21st century [13]. Nevertheless, Indonesian education certainly has a distinguishing character from other countries. Given the distinctive Indonesian society with its diverse cultures and religions, the integration of science with cultural and religious knowledge is required. The learning outcomes of responsive teaching to indigenous cultures are to ensure students achieve academic success as well as cultural competence in which students can build their cultural identity, as well as think critically about current cultural identity [14]. Education integrating science and religion has been widely studied and discussed in Indonesia and produces good results in improving the science literacy of learners [15].

The importance of providing students with cultural and religious knowledge also intends to inculcate the spirit of nationalism. Thus, the love of Indonesian students to the nation does not fade and will be stronger. Therefore, this paper will discuss alternative models in exploring STEM through the STREMIN model as an effort to bring science education to future generations. This paper reviews the literature through identification of science education (S) regarding technology (T), religion (R), engineering (E), arts (A), mathematics (M), indigenous culture (I), and nationalism (N).

The rest of this paper is organized as follow: Section 2 presents the proposed research method. Section 3 presents the obtained results and following by discussion. Finally Section 4 concludes this work.
2. Methodology

This paper presents the idea of a form of science learning model with an integrated approach with technological, religious, engineering, arts, mathematical, indigenous, and nationalism aspects. These aspects are studied through the library research method which is a series of activities related to library data collection methods [16]. The findings were arranged to explain the concept of STREAMIN Model in planning aspects, the implementation aspects, and the assessment of instructional process.

3. Results and Discussion

Science Education is the scholarly and practical discipline concerned with the teaching, learning, and assessment of science content, science processes and the nature of science [17]. The STREAMIN Model is a form of perspective that leads to the belief that learners and educators need to understand how science and science education have always been part of a wider society and culture beyond the classroom [18]. Thus, the perspective of science subject is not just a text that is learned and practiced in formal academic education, but science also has a large share of community and state, as well as a great opportunity in his contribution through interaction with the culture and religious life.

The STREAMIN model describes the framework of science instruction through the perspective of relevance to aspects of technology, religion, engineering, art, mathematics, indigenous culture, and nationalism aspects. Instructional model is the home or frame of implementation approach, method, and learning technique. Instructional model is a framework for organizing learning experiences to achieve learning goals [19]. The instructional process refers to a process design system to achieve the planned goal. The approach to designing the science instruction process can be seen in Figure 1 [20].

![Figure 1. Development of The System of Science Instruction Design](image)

3.1. “Spider Web” for Planning STREAMIN Model

The educator needs to determine the direction of instruction through the determination of orientation for identifying the purpose of science instruction. To define the orientation within the structure of the development of science instructional system, it is initiated through the use of "Spider Web" to review
the direction and potential of activities covering STREAMIN aspects. In the end, the aspects of technology, religion, engineering, art, mathematics, indigenous culture, and nationalism (TREAMIN) are linked to the preparation of science instruction objectives. By preparing the web spider first, it can be seen portion of each aspect in the presentation of learning that will be modeled.

An example of "Spider Web" to present the science subject of SMP (Junior High School) Class VII [21] on basic competence 3.3 (Explaining the concept of mixture and single substance, physical and chemical properties, physical and chemical changes in daily life) and basic competencies 4.3 (Presenting the results of investigations or works on the nature of solutions, physical and chemical changes, or the separation of mixtures) can be seen in Figure 2. The developed "Spider Web" can help to reflect the potential topics and methods to support STREAMIN. The "Spider Web" includes seven aspects and focuses on the science aspect of the understanding theory, law, principles in science. Based on the area formed, the educator can determine the proportion of activities that would require more attention based on the score given (0, 1, 2, or 3).

![Figure 2. "Spider Web" to Determine the Orientation of Science Instruction.](image)

One of the topics of the science subject of junior high school is a separation of substances through distillation. This topic can be attributed to the production of alcoholic beverages traditionally existing in Indonesia. Issues between cultural traditions and religious values embraced by learners further revive science learning through the determination of attitudes as part of the Indonesian nation. The student activities of the classroom orientation direction can be seen in Table 1.

| Components   | The Objectives of Science Instruction | The Student Activities |
|--------------|---------------------------------------|------------------------|
| Science      | Analyzing the change of the substance in the separation process of the mixture by the distillation method. | Discussing and exploring ideas related to the content of the science of the distillation process. <3> |
| Technology   | Understanding the technological principles and application of separation technology of substances by the distillation method. | Conducting experiments using standard laboratory distillation or distillation tools that have been created by themselves. <3> |
| Religion     | Understanding the law within the Islamic religion regarding alcoholic beverages is one of the products in the distillation process. | Discussing the law of alcoholic beverages which is one of the products in the distillation process. <2> |
| Engineering  | Creating a simple distillation device using used materials. | Working in groups to make simple distillation devices. <3> |
| Arts         | Drawing a design and decorating a distillation device designed to look aesthetically pleasing. | Working in groups to make simple distillation devices that look aesthetically pleasing <1> |
| Mathematics  | Calculating the amount of rendemen (percentage of yield) in the distillation | Discussing to determine the amount of rendemen (percentage of yield) in the |
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Scores on student activities indicate the level of urgency that leads to learning. This is necessary given that real conditions are sometimes limited by time and space. The exemplified orientation emphasizes the technological and engineering aspects of producing and applying distillation device products as a form of students’ understanding of the science content. The higher the score given, the priority of the aspect is increasingly to be considered. For example, if the religious aspect is given a score of 3 while the other aspects are scored 1, then the biggest focus is to understand students related to alcoholic drinks law by presenting various kinds of evidence from various sources such as Qur’an, Hadith, or Ulama.

3.2. Project-Based Learning Method for STREAMIN Model

In the example of "Spider Web", science instruction leads to project-based learning based on distillation device products. Project-based learning is a learning model that requires teachers and/or learners to develop a guiding question. Because each learner has a different learning style, project-based learning provides an opportunity for learners to explore content in ways that are meaningful to themselves, and to conduct collaborative experiments. This allows each learner to answer the guiding question [22]. Project-based learning is a systematic learning method, involving students in learning knowledge and skills through a long and structured inquiry and query process with authentic and complex questions and carefully designed tasks and products. In addition, project-based learning is a systematic teaching method that can involve students learning to acquire knowledge and skills through a complexly structured inquiry development process, with authentic questions and carefully designed to obtain products [23]. An example of a simple distillation device that can be generated in a project-based learning process can be seen in Figure 3. Project-based learning can be implemented in the instruction of STREAMIN model through the four phases as the storyline of science instruction presented in Table 2.
### Table 2. The Phases and Storyline of STREAMIN Model Instruction [25]

| Phase                        | The Storyline of Instruction                                                                 | The Components of STREAMIN Model                  |
|------------------------------|------------------------------------------------------------------------------------------------|--------------------------------------------------|
| The Phase of Contact         | a. Exploring the initial ideas and knowledge about traditional drinks in Indonesia            | Indigenous Culture and Science                   |
|                              | b. Bringing a picture of the Indonesian cultural diversity related to *Tuak, Arak, Cui, and Sopi* through articles, pictures, or videos. |                                                  |
|                              | c. Digging the students’ early knowledge about the science concepts they might find.         |                                                  |
| The phase of Curiosity and Planning | a. Growing curiosity about the scientific process that occurs in traditional distillation devices designed by the community. | Science, Indigenous Culture, Arts, Engineering, Technology, Mathematics |
|                              | b. Planning a project that is making a simple distillation device.                           |                                                  |
| The Phase of Elaboration     | a. Collecting data through the activity of reviewing references related to the distillation process. | Science, Arts, Engineering, Technology, and Mathematics |
|                              | b. Making tools and testing to produce non-alcoholic distillate products, such as essential oils from vetiver, pandanus, lemongrass, and other natural ingredients. |                                                  |
|                              | c. Writing down the test results report.                                                     |                                                  |
| The Phase of Deepening and Networking | Learn more about activity results in terms of associating topics with science content, as well as other aspects. | Science, Technology, Religion, Engineering, Arts, Mathematics, Indigenous Culture, and Nationalism |

In the contact phase, students are given the opportunity to interact with the interconnections of Indonesian cultures with science contents. Various cultures and traditions are associated with technologies used by traditional societies in the manufacture of alcoholic beverages as shown in Figure 4. The phase of Curiosity & Planning and Elaboration emphasized on reading and writing activities. In the future, reading and writing skills are indispensable. Moreover, by looking at the results of surveys that have been conducted on the literacy condition of reading and writing Indonesian society, this problem is so important to be solved immediately. The latest PISA data reports that more than 86% of Indonesian 15 year olds read at PISA Level 2 or below – that is, they are unable to consistently perform Level 3 skills such as ‘locating… recognizing the relationship between several pieces of information’ in a text [26]. The Indonesian press lamented the results of the *World’s Most Literate Nations* report [27], which placed Indonesia 60th out of 61 countries using a combined measure of literacy and literate behaviour.
Figure 4. The simple technology used by Indonesian people in producing alcoholic beverages (Simple Distillation Devices).

Note:
(a) Production of beverage "Sopi", a typical drink from alor [28].
(b) Production of "Arak" in Bali [29].
(c) Production of "Sopi" beverages on Rote Island [30].
(d) Production of "Ciú" in Banyumas, Central Java [31].

In the final phase, the learner's knowledge should be deepened and expanded through an overview of the content of the science studied with the TREAMIN aspect. Conditions that often occur is that learners have not been able to expand their knowledge beyond what he has gained in classes and textbooks. This relates to the low literacy aspect of reading and writing that most of the students currently have. Therefore, the presentation of activities and examples as far as possible is not fixed on one reference book or other references. Exploration of learning resources is needed especially in the future. For an extended instance, the stimulus and brainstorming of other traditional distillation technology case issues, such as the crude oil distillation devices made by the Bojonegoro community, East Java (see Figure 5).

Figure 5. A crude oil miner in Wonocolo Village, Kedjung District, Bojonegoro, East Java, has traditionally stored refined diesel from crude oil production in the local village [32].
3.3. Flipped Classroom Design for STREAMIN Model
The flipped classroom has existed quite a long time in various forms, but is actually popularized and formulated as a model. This model aims at reforming traditional inefficient teaching methods and often fails to engage students in the classroom with a concept in which schoolwork is completed at home and homework completed in school. This model is also known as "inverted classroom" [33]. The flipped classroom is a learning model by minimizing the number of direct instructions but maximizing one-on-one interactions. Students read the material, view the learning videos before they come to class and they start discussing, exchanging knowledge, solving problems with the help of other students and teachers, training students to develop procedural fluency if required, inspiring and assisting them with challenging projects through giving larger control learning [34]. The reasons for using the flipped classroom learning model are that the model increased one-on-one interaction between student and teacher [35], gave more active learning opportunities for students, addressed multiple learning styles [36], presented efficient use of class time [37], showed student responsibility for learning [38]. Technological developments that exist today should be easily utilized by educators and learners in presenting the learning model of the flipped classroom. A variety of free platforms as a Learning Management System (LMS) can be used such as Schoology (https://www.schoology.com/), Edmodo (https://www.edmodo.com/), Moodle (https://moodle.org/), or google classroom (https://classroom.google.com). The flipped classroom is designed in accordance with the current millennial generation.

3.4. Assessment of STREAMIN Model Instruction
The evaluation of STREAMIN model provides criteria for assessment standards to assess progress toward an integrated vision of science education with aspects of technology, religion, engineering, art, mathematics, indigenous culture, and the spirit of nationalism. The evaluation also emphasizes the availability of authentic assessment prioritizing aspects of innovation, religious attitude, and spirit of nationalism.

The standard evaluation describes the quality of assessment practice used by teachers to measure student achievement that is not limited to knowledge of science content, as well as project opportunities given to students to study science. By identifying the essential characteristics of exemplary assessment practice, the standard serves as a guide for developing assessment tasks, practices, and policies. These standards can be applied equally to the assessment of students, teachers, and programs; for the practice of summative and formative assessment; and classroom assessments and large-scale external assessments [39]. For that reason, the future of STREAMIN model requires standards to be further developed so that it can be evaluated appropriately. Changes in the standard emphasis of future science learning can be seen in Table 3.

| Less Emphasis on | More Emphasis on | Description |
|------------------|------------------|-------------|
| Assessing what is easy to measure | Assessing what is most valuable | The judgment no longer measures the cognitive aspect of the content of science but also how students can relate the content of science to other aspects. Assessment may take the form of project portfolios and project products, as well as student performance. |
| Assessing discrete knowledge | Assessing knowledge rich and well structured | Students' diverse knowledge in understanding science with other aspects of STREAMIN interconnection. In addition, assessment of skills in the 21st century such as cooperative skills, communication skills, and adaptation skills should also be emphasized. |
| Assessing scientific | Assessing | Assessment of processes in reading and writing activities |
| Less Emphasis on | More Emphasis on | Description |
|-----------------|-----------------|-------------|
| knowledge       | understanding and scientific reasoning | through presentation performance and creation of learning products. |
| Assessing to learn what students do not know | Assessing to learn what students understand | The assessment undertaken to evaluate the understanding of STREAMIN aspects is not only limited to knowledge. Aspects of the development of religious attitudes, nationalism, and creativity can also be assessed. |
| Assessing achievement only | Assessing achievements and opportunities for learning | Assessment should provide a projection on the opportunity to improve the model that has been implemented. |
| The final assessment is done only by the teacher | Students engage in continuous assessment of their work and the work of others | Assessment is not only done by the teacher but the students are asked to be actively involved through self-assessment, peer assessment, and process assessment of STREAMIN learning. |
| The development of external assessments is conducted by measurement experts alone | Teachers are involved in the development of external assessment through a lesson study or coteaching and cogenerate dialoguing. | Teachers are involved in the development of external assessment through a lesson study or coteaching and cogenerate dialoguing. |

STREAMIN models represent a paradigm shift from traditional science education philosophy, based on standardized test scores, to modern ideas that focus on assessing the learning process of science as much as the outcome. In essence, we challenge our students to go wrong, try some science ideas, listen to alternative opinions about science, and create a knowledge base that applies to real life related to TREAMIN aspect, not just a test.

4. Conclusion

The STREAMIN education does not conflict with STEM education. This model enriches and extends the scope of STEM education. The STREAMIN model is a curriculum philosophy that empowers science teachers to engage in the development of school-based curricula that integrate aspects of technology, engineering, religion, art, indigenous culture, and nationalism. The STREAMIN engages teachers in developing a 21st century humanistic vision of education and their role as professionals. The STREAMIN provides creative design space for teachers in various learning areas to collaborate in developing an integrated curriculum. On a simple scale, instructional plans can use "Spider Web" generating an orientation area of STREAMIN aspects for directing the learning objectives. The STREAMIN can take inspiration from a project-based learning program, with emphasis on reading and writing activities. The STREAMIN can also be designed and implemented by teachers with a freely available platform of Learning Management System (LMS). The flipped classroom model can be implemented in accordance with the millennial generation characteristics. Ultimately, the STREAMIN model evaluation involves teachers and students through the optimization of authentic assessments that are not just limited to the content of science but are also extended the relationship of science to religious attitudes, creativity, and the spirit of nationalism.

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