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Potential Benefits of Combination of English Language Teaching and STEM

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ABSTRACT

Application of a foreign language for subjects in STEM could benefit both the foreign language and the other discipline competence. Therefore, this study aimed to describe the potential benefits of the combination of English language teaching and STEM. The qualitative research approach was used in this research, and library research was applied as the type of this research. The researchers collected detailed information using a variety of references as the source of the data. The interactive analysis model was used as the technique of data analysis. The combined application of STEM and English is a new solution to obtain multi-skills. Students or users could learn and practice English and other subject materials simultaneously. Two main benefits that are offered by the application are social interaction and cognitive skills. In the social interaction skill term, students could train themselves to interact with other students and practice their skills in social life practice. Meanwhile, students could train their logical thinking skills to be critical thinkers in the pedagogic skill term. The application needs serious preparation, especially from teachers for their background and additional competence. The teachers must be ready with their competence because they have to imply multi-skills and knowledge to students. The third of last benefit is that the application could be applied for bilingual education programs. The main conclusion is that the application requires strenuous or high effort both from teachers and students.

Keywords*: Benefits, English, STEM*

1. INTRODUCTION

Nowadays, learners are faced with a new challenge of school life which is concerned with the linguistic and cultural aspects coming from various academic disciplines. Such a situation will bring them into academic communities where linguistic and cultural practices may be engaged together. All learners are expected to be able to use or engage language both as a cultural practice and achieve communities' goals and values [1]. Application of a foreign language for subjects by applying STEM could benefit both the foreign language and the other discipline competence.

English and STEM are very applicable for group or class learning processes rather than individual learning. A classroom activity is expected to give more progressive ideas rather than individual activities. What needs to be considered and thought about is that each academic community provides their specific ways to be socialized into the language use through conceptualizing, representing, evaluating, and engaging with the world [2]. From this point, training students for social interaction is a potential benefit of applying a combination of English and STEM. Students could encourage one another to develop their ideas, opinion and maximize their skill of interaction with other persons.

Combining English with STEM application also offers social interaction skills such as the previous paragraph and cognitive ability. The purpose is to balance their English and STEM discipline skills for individual passion and social skills. Both skills could support students' exclusive competence in any discipline of study. Cognitive skill is essential to train students to be critical thinkers. They could develop their ideas for materials in education and social interaction.

Meanwhile, the interaction skill could support them to apply their competence in social life practice. Obtaining success in learning English, each student must be able to acquire two different types of English consisting of the social language known as the basic interpersonal communicative skills (BICS) and

cognitive/academic language proficiency (CALP) [3]. Success application of English with STEM could propose a new paradigm that multi-discipline subject has good potential for future human resource development.

The combination of language study and other subjects requires good preparation and appropriate method. The multi-discipline study gives at least consequences of teaching-learning high-quality demand. Both the teacher and students must be as active as possible. The students will be faced by two factors – learners' educational experiences and teachers' teaching quality. Giving qualified experience of learning practice is essential to build good character of learners to students. In addition, the STEM could be applied together with English application to obtain qualified experience. In this term, the teacher must be prepared for the use of English and the main disciplined as detail as possible. The schema application of STEM should be prepared first, and then, they could arrange the application using the English schema. It means the application could be in a simultaneous application.

To cope with the situations above, EFL teachers are to lead the learners to use English as a cognitive ability and cultural resource to organize and make sense of their complex worlds. In particular, the EFL teachers need to direct how the learners learn English to enable them to participate in the community's cultural practices and its way of being [4]. As a result, the learners perform some interactions in which both the language and cultural values can be learned and engaged simultaneously. This model of teaching is known as STEM education. STEM integrates the four discipline areas, including science, technology, engineering, and mathematics, in every teaching and learning activity, held [5]. The application of STEM and English could give multi-skills to students. They could learn and practice more than one type of discipline. It minimizes the time-consuming learning portion, but it could enlarge the target areas.

Application of English and STEM bring students to real-world training or social practice. EFL teachers are to bring the learners both in using language and encountering new cultural practices through talk, text, and other systems in which sharing meaning and making sense of the world can be made. The use of English for some different subjects encourages students to attempt multi-knowledge and skills [6]. It is a high effort, but it is in line with the result.

2. METHOD

The researchers used the qualitative research approach, with the library research desaign. The researchers collected detailed information using a variety of references as the source of the data. The interactive analysis models by Miles et al. [35] is used as a data analysis technique, in which there are three primary processes for the data analysis.

3. RESULT AND DISCUSSION

3.1. Outlines of STEM Implementation

One of the most popular teaching models nowadays is the implementation of STEM education. As an emerging model, the descriptions of what STEM is about and how it should work in the field may vary in the experts' opinions [7], [8]. In some instances, STEM needs to be implemented by representing each discipline area, including science, technology, engineering, and mathematics [8]. Then, those four areas collaborate with other subjects such as language, art, and social science [9]. In particular, the implementation of STEM as one of the teaching models needs to be done by integrating the four areas involved and removing the subject barriers to make some links to the real world and unique experiences for the learners [10].

Regarding the descriptions above, the teachers' most important thing in implementing the STEM teaching model is concerned with doing or performing the integrated learning system for the students. In this case, the teachers are expected to involve STEM discipline areas in association with another in the teaching and learning activities [9]. Hence, the integration of the discipline areas occurs not only among the four STEM areas but also with other subjects.

However, the concepts of integration or integrated learning system promoted by STEM are not fixed. There are various or different opinions about how to conduct the integration of the STEM discipline areas mentioned. Some ways of doing the integrated learning system within the STEM teaching model have been promoted by some experts. The integrated learning system in the STEM teaching model can be done by involving, linking, or combining two or more discipline areas of STEM such as science and technology, technology and engineering, science and mathematics, and etcetera [8]. The other way of integrating the four STEM discipline areas is to deal with the level and degree of complexity of the learning materials and learners' capacity. The STEM implementation needs to refer to the integrated learning system that deals with the level and degree of complexity [5]. In this case, it can depend on how good the learners' capacity to understand the materials that will be taught. Besides, how high the level of the learning materials to be taught or given to the learners. It is very crucial to make sure that the structure of STEM education matches with the school.

The actual practice of the integrated learning system promoted by the STEM teaching model may also refer to the levels of the educational system created by the government curriculum in each country. For example, in

primary schools, the integration can be done throughout the school day. It may differ from what happens in the high schools that are more eligible to be conducted across different subject classes or several lessons [11].

Regarding various ways of implementing the integrated learning system of the STEM teaching model above, one crucial thing that can be considered is its flexibility. In this case, the implementation of the STEM teaching model is suitable for school conditions. Some factors need to be considered to implement and choose one of the varieties of the concepts of the integrated learning system of the STEM teaching model, such as time frames, challenges, and opportunities [12].

3.2. Key Elements of STEM

Many teaching models have been promoted by various experts so far. Like other teaching models, as the current teaching model, the STEM teaching model also has some key elements that have to be paid attention to by the teachers. First, the STEM teaching model promotes the learners' outcomes as the main focus in the teaching and learning activities [10], [13]. In this case, what happens in the teaching and learning activities done, the teachers must lead the learners to have or gain the learning experiences as much as possible. Even though the teachers will try to include or involve some concepts of the four STEM discipline areas within the teaching and learning activities done, it does not mean that the teachers must focus on the contents of the four STEM discipline areas. However, the learners' learning experiences in applying the concepts of those four STEM discipline areas should be targeted to be the outcomes that must be reached. Hence, the STEM contents are not the fundamental focuses or targets for the learners, but they are only an approach to get actual learning practices and experiences [9].

Second, STEM teaching models enable learners to undergo authentic, active, and meaningful learning activities [10], [14], [15]. Learners need to be given authentic learning activities following what they need to overcome some challenges of the current life in terms of the development and changes of information through STEM. It can be done or given through the STEM teaching model by involving the four discipline areas integrated.

Besides, learners are also crucial to be given some learning activities in which there are some great opportunities for them to perform what they are learning actively. In this case, they can feel some real experiences by joining the class. By integrating the four discipline areas, the STEM teaching model can lead the learners to perform and experience practicing those areas in the learning activities done. In short, how the teachers give authentic materials or manners and active learning activities may lead the learners to gain or reach meaningful learning activities. It can also be done by applying inquiry-based learning activities [14] and problem-solving learning activities as variants to create authentic, active, and meaningful learning activities [16].

Third, the STEM teaching model promotes planned learning experiences based on theories, pedagogical approaches, and even proven research [17]. The involvement of science, technology, engineering, and mathematics as the integrated learning materials learned will give broader or larger learning inputs or potentials to base what the learners can do on the theories, pedagogical approaches, and proven research. The STEM teaching model will be done for the learners to practice the actual concepts of the four discipline areas integrated or mentioned authentically according to what has been listed on the theories, pedagogical approaches, and proven research supported.

Furthermore fourth, the STEM teaching model provides learners with other experiences by collaborating with external resources from the partnership programs with several organizations, associations, industries, and even universities [18]. The involvements of the four discipline areas, including science, technology, engineering, and mathematics, will open some great opportunities for the schools to build positive cooperations or partnerships with some external related stakeholders which deal with STEM matters. The collaborations with some external stakeholders may be beneficial to create access for the learners to gain highly qualified real-life learning experiences.

3.3. STEM for EFL Classrooms

Language can be seen as a combination of cognitive ability and a cultural resource for the learners to master [4]. It implies that each language contains linguistic and cultural aspects. These two aspects are related to each other and cannot be separated. In particular, language contributes to building the culture, making the language functional, or working for the community.

Regarding the information above, learning a language should not only be concerned with understanding the structure of the language itself through the learners' cognitive ability, but also with understanding the culture of the language, which constitutes with the community to meet the functional goal of the language itself. To accommodate this concept, the schools or EFL teachers must be able to find or provide one or two teaching models which can lead the learners to master both the structure of the language resulting in the understanding of the social language and the cultural values inserted in the language learned. In academic contexts or educational settings, the cultural values are related to the ways of being which constitute the community as individuals and knowledgeable members to make sense

of the world by enabling the learners to accomplish their functional goals [2].

One of the teaching models accommodating the learning system by offering the learners' language competence to conceptualize, represent, evaluate, and engage with the world is called by STEM teaching model. In this case, what the learners can do in learning the language is not only trying to acquire the social language concepts as the daily expressions to be used in communications but also leading them to be more potential in broadening the language proficiency by mastering the requisite new patterns of language and expressions through STEM disciplinary practices [19], [20].

Nowadays, language learners are often faced with some across school subjects [4]. This situation makes the learners meet new specific discourse patterns and ways of using language to interact with their meaning-making resources and share their perspectives as they engage with the concepts. It is supposed to be the new challenge for the learners to get a broader and deeper foundation upon which to layer new concepts and language.

The STEM teaching model can do for the learners to get the learning experiences to find and use new discourse patterns conceived inside the four STEM disciplines areas inserted or integrated with other subjects. There will be some development for learners learning a language through the STEM teaching model [4]. It may happen since the STEM teaching model, through its four subjects or discipline areas, support the learners with the findings of various new discourse patterns through the knowledge in each subject area presented or engaged with.

Regarding the information above, it can be inferred that implementing the STEM teaching model in learning language may lead the learners to learn the language as meaning-making. What is listed on the meaning-making in the language learning through STEM teaching model is concerned with how to make the primary function of language learned by the learners to make sense of the world through sharing meanings with others [6].

In particular, what is supposed to be the learning language done by the learners in the class is not separate from the contents and vice versa. In this case, the language is learned through which the content is presented [21]. The learners need to understand that the language cannot be separated from the content. In other words, the use of language needs to present the content. In this way, what is supposed to be the meaning-making of the language may occur.

To sum up, the STEM teaching model for EFL classrooms can be promoted by understanding the differences between social language and academic language. The social language is supposed to be the primary language proficiency that the students must have. The social language may consist of nonverbal cues and context clues to meaning [22], [23]. In other words, social language may be built from the students' social situations or daily lives. It means that the social language may grow as the students live in their environment surrounding. In the context of foreign language learning, the social language may refer to some social expressions found or employed by the students to communicate in their daily lives. In this case, no specific concept is related to a particular content area of technical terms or terminologies.

Furthermore, looking at the linguistics concepts, people may use the language differently following what is being done. The phenomenon about the use of the language in different contexts or situations is known as the term ‘register’ [24]. This term was then developed into systemic functional linguistics (SFL) [25]. It is stated that the terms 'register' and systemic functional linguistics' are used to facilitate the phenomena of various ways of using language depending on the different contexts or situations. In particular, the term 'register' is concerned with various ways of using one expression of the language spoken by people referring to its different contexts or situations. It may include the linguistic and non-linguistic aspects that are engaged under specific contexts or situations faced by different kinds of speakers of the language and through different modes of communication. Contents influence the differences in contexts or situations talked about, relationships being enacted, and modalities available to draw, shape the actual language and meanings being presented. Application STEM could increase students' competence in social practice, such as explained in the previous sub-chapter. The use of English could increase their English competence too. It is concluded that the combination of English and STEM offers multi-benefits for English and multi-discipline skills and competence.

One example of a STEM teaching model is that language needs to refer to the different subjects talked about. One word or expression found in mathematics as one particular register may have different meanings from what is listed on engineering. It may happen since the contents in each field or subject are not similar. It may also occur when mathematicians and engineers use the word or expression to depict its different relationships. Moreover, this may also have different meanings or perceptions when the two engineers or mathematicians used the word or expression within different expressions to depict modalities. The development of English material for STEM is to imply unique vocabularies for students according to their necessary.

Regarding the understanding of the role of language and culture in relation to any differences recognized, the STEM teaching model may help the language learners be able to see and understand the links among the discipline areas mentioned [7], [26], build higher-order thinking

and greater understanding of a real-world problem and its solutions [12], [27], [28], and understand how knowledge across each discipline combines in different contexts and situations [7], [29], [30].

3.3. Overview of English Status and STEM Implementation of the EFL Classrooms in Indonesia

Nowadays, English has been one of the compulsory subject matters at university levels in Indonesia. The development of English status has also influenced how English should be taught at Indonesian schools and universities. This has also made various English programs offered by the learners, such as General English (GE.) and English for Specific Purposes (ESP). General English program is given chiefly or taught to school learners both at junior and senior high levels. Meanwhile, English teaching and learning activities at universities are done within General English and English for Specific Purposes programs.

Facing various programs of running the English teaching and learning activities at schools and universities, the EFL teachers must think of the contribution of English for the learners. In this case, there must be a severe concern about the learners' needs of learning English, whether it is learned to meet the working situations or support the academic competence improvements.

It is the fact that whatever English needs to be taught to the learners for, teaching and learning English activities cannot be separated from the contents. Teaching and learning English must also touch the targets of getting or understanding both social and academic languages. In addition, the STEM teaching model is assumed to be the effective instructional strategy and the bridge or access for helping the learners develop their broader and deeper language proficiency and language learning experiences.

Moreover, the integration between the four discipline areas, including science, technology, engineering, mathematics, and other subjects such as language, is crucially done in teaching and learning activities. In this case, what STEM teaching method concept within its integrated learning system can be the solutions to improve the quality of EFL classrooms in Indonesia.

3.4. Findings of Related Previous Study

There are some previous studies whose significant findings. They represent how the ELT or English application potential for the STEM program is. Every finding gives different sight that could realize both ELT and STEM practitioners to collaborate their competencies. Meanwhile, the method and entire research schema of every previous study determine the finding. Their content and contribution are elaborated on one by one.

A critical issue exists for the gap between ELLs with mathematics and science (referred to as STEM) in US schools [31]. The researchers report the effects of a program that reconstructs the implementation of preparing pre-service and in-service mathematics, science, and ESL teachers into one comprehensive integration. A mixed-method approach was applied to collect and analyze their data. The findings it that teacher was aware of recognizing the necessity of ELLs in their classroom. Secondly, many teachers have a different cultural background from their students. Another finding reflects that ESL teacher teaching secondary-level ELLs mathematics was aware of the language rule played in the scope of content development. It is targeted to make content to be more focused and balance. The research benefit fulfills minimum English requirements and responsibility for ELLs in English and STEM subjects based on quantitative data. Based on qualitative data, the integration program is beneficial to increase teachers' responsibility for language and academic development.

The second previous study investigates potential benefits for STEM teachers' preparedness to work with ELLs [32]. The research data was taken from 2007-2008 and 2011-2012 School and Staffing Survey (SASS) and Teacher Questionnaire (TQ.). The research finding shows the percentage increase in Science teachers holding credentials in the categories of cultural state-level certification, cultural degrees, and linguistic certification. Mathematic educators are indicated that they gave ELLs service, but the middle percentage participated in ELL-specific professional development. The research contribution is to identify the level necessary to prepare ELs and STEM teachers to collaborate in effective teaching-learning. Balancing English and STEM competencies could maximize result expectations.

The third previous study revisits the concept of thinking and pedagogy of English for Specific Purpose (ESP) on the use of STEM [33]. The research identifies a specific gap between the pedagogy of ESP for STEM discipline students. The main findings show that ESP characteristics for STEM should cover; a) discovery-oriented and meaningful argumentation, and b) based on the strengths of learners' argumentation. Through a discovery-oriented approach to ESP in STEM and its effective management, the researchers prove that they could give meaningful scientific context rather than just giving language learning material. It also facilitates the integration of English skill development through an interactive framework. It is more appropriate to be implemented by using authentic materials. The second character will provide teachers and students with stimulating teaching-learning and cognitive performance

and achievement. Empiric achievement is possible to be obtained through the use of ESP for STEM disciplines.

The fourth previous study summarizes the effect of linguistic implications on STEM programs [34]. Their study result revealed the fact that Asian students performed better than Americans in sciences and mathematics. It interest because the language used is English. It turns to why native speakers cannot get as good as science and mathematics with non-native speakers. The finding reveals the fact that language-in-use contributes to how far learners could master learning materials. It is about how fluency learners could apply English and how they could integrate STEM material with English use. The researchers propose that making meaning and presenting knowledge involves competence in understanding and creating specific texts. STEM subjects are concluded best learned with the help of teachers who support ELs in engaging disciplinary practices. Supporting materials for the combination of English and STEM also faced another problem which is economic value. The combination is predicted going to cost more than a regular STEM program.

4. CONCLUSION

Combination application of English with STEM teaching method and material offers to give multi-skills and competencies to students. They could minimize their time-consuming learning portion, but they could maximize the learning benefits and targets. Students could learn and practice English and other subject materials simultaneously. Meanwhile, the application requires teachers to give high effort to gain the maximum result. It needs serious preparation of materials and sequence of teaching practice. The application could also be a solution for schools that would like to apply to bilingual programs. The schools could increase the English competence and the subject competence simultaneously. Serious preparation is also needed for teachers' human resource development to apply the combined material and method.

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