

Advancing Vocational Student's Self-Efficacy Through Integration STEM (Science Technology Engineering and Mathematics) Education

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Abstract— The existence of the 4th industrial revolution will force schools to be more creative in presenting the skills that will be faced by job seekers along with the rapid competition in the world of work. This study aims to gain several ways of advancing students' self-efficacy through STEM education based on the learning process. This study uses a literature review method with big data from several online database resources. There are several techniques that a lecturer can use to deliver STEM in the good direction. The lecturer can enrich the students' prestigious skills by creating out of class learning, display curiosity and shows them something that very interesting, encourage students to ask to develop problem-solving skills, and it very uses full using real-life experiences. On the other hand, self-efficacy was not developed automatically. It needs some treatment for advance students self-efficacy. Finally, some suggestions were proposed for future research on reforming and improving vocational students' self-efficacy.

Keywords—STEM; vocational education; student; teaching and learning; self-efficacy

I. INTRODUCTION

STEM-based learning (Science, Technology, Engineering, and Mathematics) is one of the most appropriate models to be applied in teaching and learning activities as an effort to cultivate 4Cs skills in learners. In the face of increasingly complex global challenges, some countries have tried to integrate STEM in learning and have achieved great results in improving the skills of 4Cs [1]. They added that, STEM learning is also able to cultivate the latest science and technology invention with problem-based learning process. In addition, STEM bridges someone in preparing for a career because with STEM-based learning can improve a variety of literacy skills.

The integrated STEM education approach aims to remove the dividing wall between each STEM field on the separate approach and embedded approach, and to teach students as one of the subjects. The integrated approach differs from the embedded approach in terms of evaluation standards and the assessing or purpose of each curriculum area that has been included in the lesson [2]. Ideally, interdisciplinary integration

allows students to gain the mastery of the competencies required to complete the task. Student training in this way is considered beneficial because it is a multidisciplinary world that relies heavily on the concept of STEM, where students should be used to solve real-world problems. In addition, implementing instruction through interdisciplinary integration will result in increased expectations of interest in the field of STEM content, especially if it begins when students are still at a young age. Two important STEM education approaches to integrated instruction are multidisciplinary and interdisciplinary integration.

Mitchell [3] says that there is a significant difference in perceptions about whether transversal skills impact a person's success in the workplace, although educators strongly recommend developing transversal skills for students as well as students needing work experience to change attitudes through the integration of transversal skills. Furthermore, if transversal skills are not given to the learning process in earnest, younger generations will tend to have unfavorable habits [4]. Conversely, if transversal skills can be effectively implemented through school initiatives it will increase the number of students who have sufficient skills to be able to compete in the future.

Meanwhile, [5] stated that the concept of categorizing transversal skills had been an issue of education in Indonesia for the past few years. Some concepts of transversal skills have been tested in the formal education system in Indonesia. However the results have not shown any progress in the level of skills expected by industries. The university should encourage students to learn more competencies that give an advantage, promote their life value, and increase the achievement. Previous studies indicated that student academic achievement was related significantly to their personal factors, such as creative thinking [6] and self-efficacy [7].

II. LITERATURE REVIEW

A. STEM Education

STEM stands for science, technology, engineering, and mathematics. The word STEM was introduced by the National Science Foundation (NSF) in 1990 as the theme of the educational reform movement in all four disciplines to foster the

labor force of the STEM fields, as well as enhance global competitiveness in science and technology innovation [8]. Furthermore, [8] stated that the STEM education reform movement is driven by a study report that indicates a shortage of candidates to fill the field of transversal/ transferable skills or better known as life skills/ soft skills. According to [9], STEM education has been defined as "a standards-based, meta-discipline residing at the school level where all teachers, especially science, technology, engineering, and mathematics (STEM) teachers, teach an integrated approach to teaching and learning, where discipline-specific content is not divided, but addressed and treated as one lively, fluid study."

B. STEM Education Approach

Three methods of teaching approach in STEM education at this time are often done. The difference between each method lies in the applicable level of STEM content. The three most frequently used methods of STEM education approach are (1) separate method, (2) embedded, and (3) integrated approach [10].

A separate approach known refers to isolated instruction, where each subject of STEM is taught separately or individually. Emphasis is placed on the acquisition of "knowledge" as opposed to technical / engineering abilities. Each individual concentrated study enables students to gain a deeper understanding of the content of each subject. Focused instruction on one subject can awaken the appreciation of the beauty of the content itself. The silo approach emphasizes how science, technology and engineering, and mathematical education have been approached in curriculum design and teaching [10]. [10] added an embedded STEM may be widely challenged as an approach to education in which knowledge domains can be gained through an emphasis on real-world situations and problem-solving techniques in a social, cultural, and functional context. In practice, teaching with an embedded approach, instruction becomes effective as it seeks to strengthen and complement student learning materials as in other classes. A technology and engineering education teacher using an embedded approach aims to reinforce a lesson that is beneficial to students through understanding and application.

Multidisciplinary integration requires students to connect content from different subjects taught in different classes at different times. Furthermore, [10] explains interdisciplinary integration can begin with real-world problems. Combine cross-curricular content with critical thinking, problem-solving skills, and knowledge to reach conclusions. Multidisciplinary integration asks students to link content from a particular lesson, but interdisciplinary integration focuses students' attention on the problem and combines content and skills from various fields.

C. Self-efficacy

Bandura [11] proposed self-efficacy as a significant element in social cognitive theory and has generated more research in various subject areas in the past decade. [11] described self-efficacy as, "The belief in one's capabilities to organize and execute the courses of action required to produce given attainments" (p. 3). The definition of self-efficacy has been

expanded [12], referring to, "People's beliefs about their capabilities to exercise control over events that affect their lives" [13] and their "beliefs in their capabilities to mobilize the motivation, cognitive resources, and courses of action needed to exercise control over task demands" [11].

Bandura [12] investigated self-efficacy from the grades, generality, and strength across activities and contexts. The grades of self-efficacy refer to its dependence on the difficulty of an exceptional project, such as spelling words of increasing difficulty; generality pertains to the transferability of self-efficacy beliefs across activities, such as from algebra to statistics; strength of perceived efficacy is evaluated by the quantity of one's certainty about performing a given task successfully [14]. Furthermore, research has indicated that the connection between self-efficacy and outcomes was strongest when the detail of the efficacy assessment matches the criterion [15]. For this reason, self-efficacy has been operationalized and studied in a diversity of areas. Barry and Finney [15] have conducted two surveys to test the validity of evidence for the College Self-Efficacy Inventory, by investigating dimensionality and theoretically based relationships with external criteria. They concluded that there are three constructs within 15 items of inventory to predict college self-efficacy, including course self-efficacy, roommate self-efficacy, and social self-efficacy.

In the educational psychology area, self-efficacy has received exceptional attention and has generated significant research advances that have led to the improvement of teaching experiences and instruction. Empirical research has fully shown that self-efficacy is more predictive of academic performance than other cognitive variables, it can predict a future success and it is as important a cognitive mediator of competence and performance as favoring cognitive processes [7].

In a study of previous research [16] reported that self-efficacy highly correlates with college achievement and is identified as an essential ingredient for successful students. The researchers indicate that self-efficacy is influenced by academic motivation and achievement. Hence, students with higher self-efficacy tend to participate more readily, work harder, pursue challenging goals, invest a greater effort in fulfilling identified goals, and persevere longer in the face of challenges. Thus, scholars not only need to acquire the skills necessary to successfully complete academic tasks, they also need to develop a firm feeling that they are capable of completing jobs successfully.

Iovu, Runcan, and Runcan [17] added that academic self-efficacy is specific to the academic context and focuses on a person's opinion about themselves regarding their academic tasks. An academic self-efficacy has proved to be a major component of academic performance, as students with a high academic self-efficacy also had higher grade point averages (GPA). In addition, students with a higher high school GPA demonstrated higher academic self-efficacy, academic expectations, and academic performances in college compared to pupils with a lower high school GPA.

III. METHOD

This study uses large literature on STEM education and self-efficacy from several online database resources, including ProQuest, Web of Science and EBSCOhost. There are several techniques that a lecturer can use to deliver STEM in a good direction. More than 60,000 articles are discussing STEM education and self-efficacy. The search was conducted in October 2018. The purposes of this review was to identify peer-reviewed research that discusses STEM education and students self-efficacy.

Brown [18] noted that for literature study there were several inclusion criteria used to determine the relevance publication: (1) The study focused on instructional decision-making or practice intended for undergraduate students in a residential/on-campus course or academic program, (2). The article was written in English. (3). The article was published as part of a peer-reviewed academic journal or peer-reviewed conference proceedings. (4). The article provides a full accounting of the research process, as well as information about the reliability and validity of the data presented. No summary research reports or research in brief articles were included.

IV. FINDING AND DISCUSSION

Integrated STEM education programs apply equal attention to the objectives of the STEM fields. Previous studies showed that the integrated STEM learning has the potential to prepare competitive future workforce with the 21st-century skills and positive impacts towards students' interest and achievement [19]. However, STEM faced huge challenges to strengthen the effectiveness of its implementation in education. They added that STEM educations develop problem-solving skills, promote student-centered learning, and cultivate higher order thinking skills. Integrated STEM education can be complimented by prevailing teaching and learning approaches such as project-based, problem-based, inquiry-based and theme-based learning.

There are some barriers of the implementation of STEM education according [20]: (1) Poor preparation and shortage in supply of qualified STEM teachers; (2) Lack of investment in teachers' professional development; (3) Poor preparation and inspiration of students; (4) Lack of connection with individual learners in a wide variety of ways; (5) Lack of support from the school system; (6) Lack of research collaboration across STEM fields; (7) Poor Content preparation; (8) Poor Content delivery and method of assessment; (9) Poor Condition of laboratory facilities and instructional media; and (10) Lack of hands-on training for students.

Given that academic success and extracurricular involvement may represent a start along one of many paths to positive growth, it is important to realize the components that lead adolescents to achieve good degrees and participate in extracurricular activities [21]. In a meta-analysis of psychological correlations among university students' academic performance in general, the performance of self-efficacy was found to have the strongest correlation with motivation and has been repeatedly associated with academic achievement [22]. The substantial result of self-efficacy on an individual's academic

achievement is not surprising, because self-efficacy deals with the point of confidence in which people perceive their own ability to carry through certain courses of action or accomplish specific outcomes, especially in relation to academic achievement [23].

V. CONCLUSIONS AND RECOMMENDATIONS

The conclusion from previous research findings, as mentioned above, is that youths who participate in extracurricular activities can get benefit from a means to enrich their social skills and heighten their sense of self, ultimately increasing self-efficacy [24]. It can be taken for granted that participating in extracurricular activities has an impression on students' thinking, which becomes more creative, thus increasing their academic motivation, and allowing them to receive support from people in their social life. In other words, these programs develop students' self-efficacy and contribute to their ability to gain the highest academic grade that they are capable of achieving.

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