STEM-Oriented activities for improving student performance in Chu Van An secondary school, Thai Nguyen province, Vietnam

Thanh-Tung Nguyen¹, Dieu-Linh Hoang¹, Hoang-Thuy Linh Nguyen², and Thanh-Binh Nguyen³*
¹ Thai Nguyen University of Technology, Thai Nguyen, Vietnam
² Chu Van An secondary school, Thai Nguyen, Vietnam
³ Thai Nguyen University of Education, Thai Nguyen, Vietnam
the corresponding author’s e-mail : * nguyenthanhbinh@dhsptn.edu.vn

Abstract. In this study, we investigated the STEM-oriented activities have been applied in Chu Van An secondary school, Thai Nguyen province, Vietnam which aimed to improve the student’s performance. By conducting the appropriate approaches, student can improve their self-awareness, scientific thinking and actively participate in learning activities. Several students have awarded high prizes at city and provincial science and technology competitions. This study aims to show a STEM-oriented implementation model at secondary school which might apply in different contexts.

1. Introduction

STEM is an abbreviation that stands for Science, Technology, Engineering, and Mathematics¹. Rather than teaching the four disciplines as separate and discrete subjects, STEM refers to an interdisciplinary education approach for learner where academic knowledge is incorporated with real-world lessons². Students apply their knowledge and skills in science, technology, engineering, and mathematics to solve problems in real contexts, so that yielding the connections between classroom and the world around them. STEM education curriculum is designed based on Next Generation Science Standards (NGSS), in which student improvement was quantified and examined, especially in applying science performance. STEM education typically focuses on project-based learning in the classroom, where educators incorporate student activities with technology, science applications to prepare further lessons in a gradual level program [1], [7], [8].

STEM education has played an important role in new general education program due to its close link with society’s technological and scientific advancements. STEM education aims to encourage every student to use their creativity in solving real-world problems and develop their critical thinking skills for each idea or comment. The benefits of STEM education are also far-reaching for students of all ages, levels, and educational backgrounds. Actually, STEM approach is separated from the traditional education program by the interdisciplinary learning environment, where students are trained how the real-world problems work through a scientific view and scientific thinking³. Therefore, STEM education should begin in early childhood while their brains are filled of numerous questions and their thinking is being finalized [2], [3], [9], [10], [11].

Nowadays, students should be equipped a strong STEM platform to be successful in the information age, where all the jobs require the interdisciplinary knowledge and skills. According to government of Western Australia report⁴, currently, 75 percent of jobs in the fastest growing industries require workers with STEM skills; 90 percent of jobs will need digital skills in the next 2 to 5 years. In
the next 15 years, some routine manual jobs will be lost to automation; current jobs will be transformed and new jobs will be created. In the job market, 50 percent of current jobs will skill shortages are in STEM field and in the next 5 years, the demand for professional, scientific and technical services will increase 14 percent while the demand in heath care field increases 20 percent. According to a report by the website STEMconnector.org, by 2018, projections estimate the need for 8.65 million workers in STEM-related jobs. The United Kingdom will have to graduate 300,000 STEM majors until 2020 just to meet demand while Germany proposes a shortage of 210,000 workers in the mathematics, computer science, natural science and technology disciplines. Of course, the average starting salary for entry-level STEM jobs is higher than the jobs in the non-STEM fields (about 26 percent) [4], [5], [6].

In Vietnam, STEM-oriented activities have been applied since 2012, targeting high-end markets in large cities and focus on robotics and coding. The implementation process illustrated the significant improvements of student performance. In Thai Nguyen city, Chu Van An secondary is one the earliest secondary school applied the STEM-oriented activities in order to improve student the knowledge and a critical thinking for further studying process. Students have been participated in various activities in order to improve student knowledge and practical skills. After participating in STEM-oriented activities, students at Chu Van An secondary school showed the great improvement in education results, while several students have been awarded high prizes at city and provincial science and technology competitions.

2. STEM-oriented activities implementation in Chu Van An secondary school

In order to improve the scientific thinking and science interest for students, Chu Van An secondary school had cooperated with Thai Nguyen University of Science for science-camping. All students from 6th to 9th grade had participated in the event with lots of excitement and passion. Staffs in science group are lecturers in Physics, Chemistry, Biology departments with really good knowledge and pedagogical skills always ready to support the students. Students are encouraged to participate in science camping under the guidance of staffs and followed steps described below:

- **1st step:** Observation of phenomenon
- **2nd step:** Studying the phenomenon under guidance of staffs
- **3rd step:** Using knowledge to solve the problem
- **4th step:** Students directly install and arrange the products
- **5th step:** Performing the products and listening to staff’s comments

![Figure 1. Students are observing the product and its phenomenon](image)

In the first step, students observed phenomenon performed by staffs. This step aims to create the initial science thinking inside the student brain. Several important questions should be appeared such as: “What makes the motion? How it can move like that? Can we control it?”… In this step, the attention of students is very important, therefore teachers are required to perform the experiment slowly and clearly for ease observation.
In the second step, students were required to work in groups and listened to staff’s explanation about the mechanism. This step aims to elicit the disciplines' science knowledge inside their brains. Students will start to ask with numerous questions, such as: “What kind of knowledge relates to this stuff? (Energy? Work?) What is the source of energy?”... In this step, the most important thing is how to create the linking between science knowledge and real-world problems, therefore teachers are required to ask the elicited questions and be ready to answer the questions backwards. By preparing the good platform of knowledge in this step, students will be easier to theoretically study the mechanism in the next step.

In the third step, students directly studied the mechanism by themselves. This step aimed to create the science thinking inside the student brain. Students had to use their knowledge, science, and math skills to explain the phenomenon mechanism theoretically. Several important questions should be appeared such as: “What kind of theory I have to use? Is there the energy transition in here? How does it change if I use a higher current battery?”... It should be noted here that the teacher is willing to accompany with students in solving the problem but never do it for them.

After thoroughly understanding the mechanism, students started to make their own product by combining all separated parts. This step requires student’s practical skills and interdisciplinary knowledge. Numerous questions and problems will appear in this step, such as: “Is the battery arranged correctly? Why do I have to assemble this part firstly? Why I cannot assemble these parts together?” Teachers should be ready to help students, especially in practical skills as they were not familiar with them before.
After completely assembled the product, all groups presented their results with teachers and others. A good result refers to a well-arrangement and well-working product. In addition, each group has to describe their own work in arrangement and explain in detail about the mechanism. Other groups were required to give the comments and responses. Furthermore, teacher should give the question which can elicit the student thinking about the real-world situations such as car, motorcycle... and energy definition. In conclusion, teacher might conclude all the work results and contributions of each group, the prospect and drawbacks that should be improved.

3. Results and discussion

After participating in science-oriented activities, student illustrated their interest in experiential and learning activities. A survey has been used to investigate the thinking of students about the STEM-oriented activity immediately after the event. Five questions have been used with 4 levels of interest: Absolutely dislike, normal, like and really like. Figure 6 reveals the statically result after survey with three questions: Q1: Do you like the science-oriented activity which is hosted by Thai Nguyen University of Science and Chu Van An secondary school in school year 2018-2019? Q2: Do you want to change the traditional education to experience activities? Q3: Do you like to integrate these experience activities with class subjects? Q4: Do you think the experience activities is useful for career orientation in the future? and Q5: Do you want to participate in further science camp?
In the first question, there are 75% of interviewed students reveal that they are interested in STEM-oriented activities with about 50% show the highest level, illustrating the successful of experience event. In the second question, it is interesting that about 67% of students express that they want to change the traditional education curriculum by the experience activities program. The same tendency also can be found on the third question when 66.67% of asked students really want to integrate the experience activities with class lessons and 22.22% like to implement new curriculum on class subjects.

Figure 6. The statically results of our survey with five questions
In the fourth question, we want to investigate the feeling of student about their expected career in the future. According to the results, there are about 89% of interviewed students feel that the scientific activities are useful for their future careers, while there is no student see that the experience activities is useless. Subsequently, the consistency can be found in results of fifth question while 89% of students are willing to join the science camp and related activities again in the future.

Nguyen Phuong Anh, a student in 8th grade participated in provincial Science and Technology competition and got the second prize with the *Automatic tea-maker project*. By using the broadcasting equipment incorporated with a main board, the machine can automatic generate a cup of tea with human voice. The others students participated at other fields such as social investigation or health care also have got the high prizes (Nguyen Thi Thuy Trang and Pham Phuong Thao Linh - third prize; Pham Ngo Minh Chau and Ly Ngoc Anh Thu – fourth place). All students who participated in competitions revealed that they benefited the scientific and coherent thinking from STEM-oriented activities. By using the critical thinking and interdisciplinary knowledge, students from Chu Van An secondary school have not only fulfilled their ideas but also proposed the potential for further useful inventions.

**Figure 7. Students’ poster of automatic tea-maker project participated in provincial Science and Technology competition**

4. Conclusion

The results showed the significant contribution of science-oriented activities in improving student performance. The difference can be seen through the behavior of students before and after operating science class. After participating in class, student exhibited their interest in science lessons such as: gave more comments, critical thinking, comments, gave more questions to teachers. The effects also can be observed through the student performance in research activities. Students who positively participated in science-class have award high prizes in city and provincial science and technology competitions. Totally, the STEM-oriented implementation in Chu Van An secondary school has proposed the very good and potential results for widespread STEM implementing in different contexts and educational environments.
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