

## **Science, Technology, Engineering, and Mathematics (STEM) as a Vehicle for Supporting Service Learning**

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### **ABSTRACT**

Nowadays, more attention has been taken in the teaching of STEM in Hong Kong. On the other hand, service-learning is one of the key learning pedagogy in local universities. However, service learning projects in local schools are not common, particularly in the teaching of the STEM concept. This research aims to investigate students' learning experience in local university by making use of STEM as a vehicle for supporting service learning. We intend to measure students' learning experience in their intellectual and civic development. Results have shown that there is a significant gain in students' learning experience.

Key Words: STEM, Service Learning, intellectual development, civic development

### **1. BACKGROUND**

In 2009, the president of United States of America, Obama, announced a series of campaigns to motivate and inspire students to excel in science, technology, engineering and mathematics (STEM) subjects. STEM not only enhance students' critical thinking, increases science literacy, it also enables students' innovative. These skills are essential elements leading to new products and processes that sustain our economy. The innovation and science literacy depends on a solid knowledge base in the STEM areas. Therefore in 2014, the Obama administration invested \$3.1 billion in federal programs on STEM education, an increase of 6.7 percent over 2012 (White House, 2013). According to (U.S. Department), it is estimated that the need for workers in STEM-related jobs will increase to more than eight million by 2018. Due to these reasons, more attention has been taken in the teaching of STEM in Hong Kong nowadays. STEM is based on the idea of educating students in four specific disciplines, science, technology, engineering and mathematics, in an interdisciplinary approach. Rather than teaching the four disciplines as separate and discrete subjects, STEM integrates them into a cohesive learning paradigm based on real applications (Caine, 2015).

Service-learning is an experiential learning pedagogy that integrates community service with academic study and reflection to enrich students' learning experience. It enhances students' sense of civic responsibility and engagement on the one hand, and benefits the community at large on the other. Service learning projects can benefit many different areas such as the public sector, non-profit and government agencies, etc. (see figure 1).

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Although service learning is not a new pedagogy, there are only a few examples of delivering service learning in the school curriculum for middle school students (Mueller, 2011). Carrying out service learning projects in local schools is not common in Hong Kong, particularly in the teaching of the STEM concept. In this research, we aim to investigate the gain in students' learning experience by making use of STEM as a vehicle for supporting service learning. We intend to measure students' learning experience in their intellectual and civil development. In this service learning project, university students are required to help the local school students in comprehending and overcoming learning hurdles in STEM.



Figure 1: Beneficial parties in the service learning project. Source: (FGCU)

## 2. LITERATURE REVIEW

Service-learning is a popular subject in the education sector. A number of service learning projects have been conducted to serve primary and secondary schools. Chung and McBride (Chung, 2015) utilized service learning to build the social and emotional skills of middle school students. A case study was conducted to integrate service learning, built on a positive youth development framework, into middle school curricula. Robertson et al. (Robertson, 2015) presented a case study in a middle school, a community-based organization and a university, to implement a social and emotional program. STEM has become an important issue in secondary education, and a number of service learning projects have delivered services related to STEM. Kim et al. (Kim, 2015) reported a research project to help pre-service teachers' STEM engagement, learning, and teaching

via robotics. Recently, a study (Eddy, 2014) was conducted to evaluate the achievement of service learning transforming educational models in Science, Technology, Engineering, and Mathematics. They attempted to integrate service learning as part of the undergraduate educational experience for students in the STEM fields. The results showed that self-assessment ratings in the integration of service learning in STEM increased.

### **3. METHODOLOGY**

In this project, the aim was to investigate the gain of students' intellectual and civic development through service learning projects. The investigation was conducted in a service learning subject at the Hong Kong Polytechnic University, which was a credit-bearing general university requirement course. Students are required to complete this subject in order to satisfy graduation requirements. In this subject, university students are required to deliver at least 40 hours service to local secondary school students. Teaching STEM concepts acts as the entry point for supporting service learning. Students worked in groups and were attached to a secondary school with students who have certain learning hurdles (e.g. financial, cultural or socioeconomic difficulties that negatively impact their learning performance) in STEM. In order to help the secondary school students overcoming the learning hurdles, university students were required to attend a seminar to understand the existing problems and difficulties faced by the secondary school students first. The seminar was delivered by the mathematics and science teachers from the partner school. Then, students were required to design their own teaching materials such as games, videos, teaching materials, etc. The teaching materials should be funny and contain STEM elements that enable to arouse the interest, and deliver STEM concepts and theories to the partner school students. Through the development of the teaching materials, university students were able to develop expertise among them, giving them a greater understanding of the characteristics of effective materials.

At the beginning of the subject, students were required to complete a pre-service questionnaire. To measure the students' intellectual and civic development, the questionnaire was used to assess students' own reflection in four learning development aspects: application of knowledge and skills, understanding of the linkage between service learning and academic learning, self-reflection on civic development and demonstration of empathy. A 7-point grading scale was used in each question. Upon completion of the Service-Learning, students were required to complete a post-service questionnaire in order to compare the learning gain for each learning development aspect.

### **4. RESULTS**

In this research, 160 students majoring at the Faculty of Engineering, Faculty of Construction and the Environment, and the Faculty of Applied Science and Textiles participated in this project. Students were required to fill in a questionnaire to determine students' own reflection in the four learning development aspects. In this quantitative statistical analysis, 149 valid responses were received. A mean score was used to calculate the students' own reflection on different aspects. Figure 2 shows the students learning mean scores for each learning development aspect, in which there is a positive learning gain for each aspect from the service learning. The paired t-test was adopted to determine the mean difference between pre- and post- service scores in different aspects. A P-value of 0.01 was considered as statistically significant. Table 1 summarizes the mean differences and P-values for each students' learning development aspect. The results show that there is a significant gain in students' learning experience for all different aspects through the designed service learning project. In this study,

application of knowledge and skills and understanding of the linkage between service learning and academic learning was used to measure students' intellectual development. For the students' civic development, self-reflection and demonstration of empathy was used. It was found that the mean scores for intellectual development was generally higher than civic development before and after delivering the service. However, students' have higher gains in their learning experience for civic development compared with intellectual development after delivering the service.

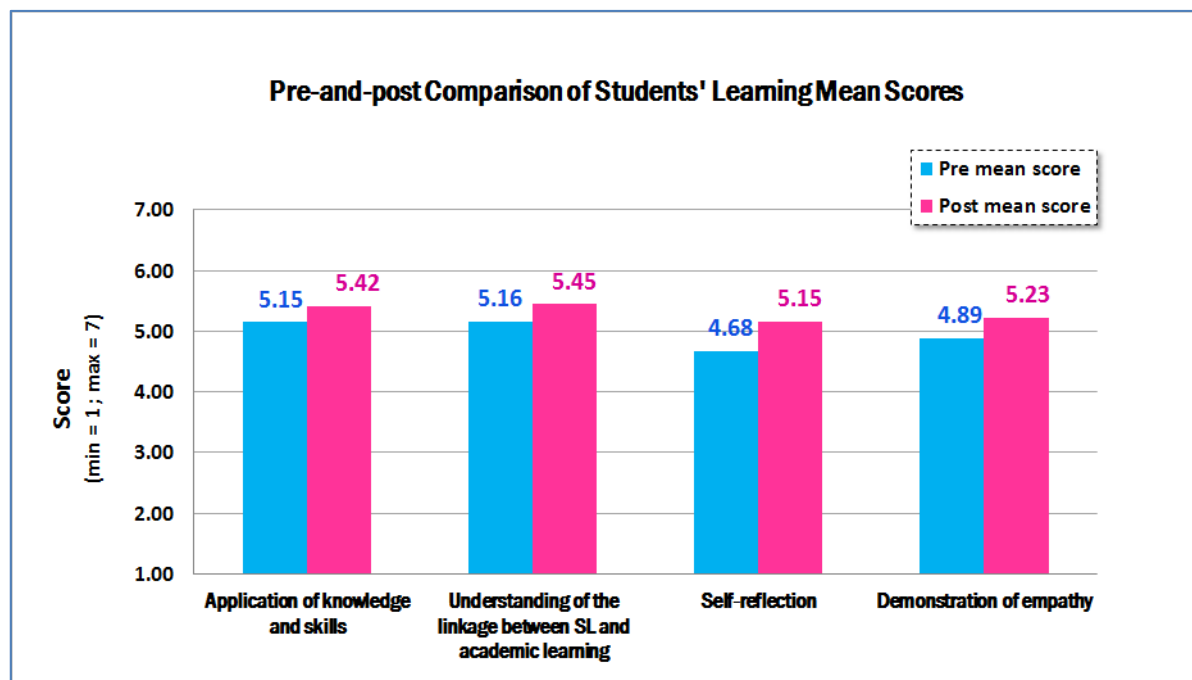


Figure 2: Comparison of pre- and post- service mean scores for each students' learning development aspect.

Learning gain from service learning	Intellectual development		Civic development	
	Application of knowledge and skills	Understanding of the linkage between SL and academic learning	Self-reflection	Demonstration of empathy
Mean difference	0.270	0.290	0.470	0.340
p-value	0.004	0.002	0.000	0.000

Table 1: Summary of the mean difference and P-value for different students' learning development aspect.

## 5. CONCLUSIONS

Nowadays, service-learning has become an important part of academic study in university education. Despite numerous work was conducted to assess the achievement in service learning projects in the education sector, carrying out service learning projects by delivering the STEM concept and theory to local students is still not common in Hong Kong. This project aims to investigate the gain of students' intellectual and civic development from service learning. Teaching STEM concepts and theory to secondary school students acts as the entry point for supporting service learning. Students are required to help secondary schools in overcoming learning hurdles in STEM through various self-designed teaching material. Quantitative statistical analysis was performed to determine the students' own reflection in four learning development aspects before and

after delivering the service.

With the use of STEM for supporting service learning teaching, the results have shown that there is a significant gain in students' learning experience for all the four different aspects. In particular, there were two major findings in this study. First of all, there is a significant gain in students' learning experience and 2) students have higher gains in civic development in comparison to intellectual development. Based on the results, we believe that the use of STEM as a vehicle is a suitable approach to support service learning. It is because the students not only able to learn the STEM concepts, they can also apply the knowledge and skills through preparing different teaching materials to deliver their service. By delivering the service to the secondary school students, the students can understanding the linkage between service learning and academic learning directly. On the other hand, they can also demonstrate their empathy through the ice-breaking games and understanding the learning hurdles of secondary school students. Despite the students were able to apply the STEM knowledge and skills to deliver the service and support academic learning of secondary school students, their teaching skills are still in its infancy. In the contrast, there is only a small age gap between the university and secondary school students. This helps our students to understand the learning hurdles and demonstrate their empathy towards the secondary school students. Therefore, the students have higher gains in civic development in comparison to intellectual development based on the results.

Although the results shows the positive impacts on the outcome areas assessed, there was no comparison group included in the study. One explanation of the positive results could be due to students' overall maturation and development over the course of their academic program. In other words, the secondary school students might have naturally shown gains even if the service-learning experiences had not been conducted. Therefore, control group may be included in the future study.

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