COLLABORATION BETWEEN DUY TAN UNIVERSITY AND HIGH SCHOOLS: A REPORT ON THE SUPPORT PROCESS FOR HIGH SCHOOL SCIENCE AND ENGINEERING FAIR

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ABSTRACT

Recent collaborations between Duy Tan University (DTU) and local high schools in Danang City and Quang Nam province in the Vietnam Science & Engineering Fair (ViSEF) have yielded successful outcomes through a series of awards won by students from these high schools at the fair. The collaborations, however, also revealed a number of gaps and issues in the approach of faculty members and students at both Duy Tan University and its high school partners, namely: (1) incompatible communication styles, (2) initial lack of trust in the skills and capabilities of both sides, and (3) different creativity techniques and project management schemes. Previous skills and knowledge acquired by DTU faculty members from the CDIO Initiative, however, turned out to be very helpful in bridging these gaps, especially regarding CDIO Standards No. 4, 5, 6 and 7. In particular, DTU faculty members have created a "crash" course to quickly teach high school students and teachers about the CDIO model and framework. An informal process of "design-and-trial" was also developed to help run many student projects at the same time, and to build trust between DTU and its partners through incremental progress in these projects. And yet, another major challenge was to get high school students and teachers to become involved and make effective use of the engineering labs at Duy Tan University despite their lack of previous formal training in such engineering fields. This paper, through a series of semi-structured interviews with both DTU faculty members and its partnering high schools' students and teachers, will provide a qualitative look into the opportunities and challenges of collaboration between a university and partnering high schools in engineering projects. The recognized roles and techniques of CDIO for smooth collaboration in these projects will be examined and emphasized.

KEYWORDS

CDIO, design-and-trial, partnership development, students' engineering projects, university-school collaboration.

INTRODUCTION

The Intel International Science and Engineering Fair (Intel ISEF), a program of Society for Science & the Public (the Society), is the world's largest international pre-college science competition. Each year, approximately 1,800 high school students from more than 75 countries, regions, and territories are awarded the opportunity to showcase their independent research and compete for on average $4 million in prizes. Today, millions of students worldwide compete each year in local and school-sponsored science fairs; the winners of

these events go on to participate in Society-affiliated regional and state fairs from which the best win the opportunity to attend Intel ISEF. Intel ISEF unites these top young scientific minds, showcasing their talents on an international stage, where doctoral level scientists review and judge their work.

Every year, Vietnam is one of the countries that always have high school students with their project attending the Intel ISEF and have won many awards. The projects were selected from the annual Vietnam Science & Engineering Fair (ViSEF) with more than 400 projects from many high schools across the country, including Danang City and Quang Nam province. With many experiences in teaching and supporting students to participate in international science and technology competitions, Duy Tan University has had positive support for high schools in these two provinces. Over the years, we've found that these things really have yielded successful outcomes through a series of awards won by students from these high schools at the fair. In the recent two years, with the support of Duy Tan University, both Da Nang and Quang Nam have achieved remarkable results. In 2016, Da Nang won 2 second and 2 third; Quang Nam province won 2 first prizes, 1 second prize, 3 encouragement prizes in nearly 300 projects of 33 schools nationwide; In 2017, Da Nang won 1 first prizes, 3 third prizes and 1 encouragement prizes.

The relationship between Duy Tan University and secondary schools is conducted in three stages:

- The DTU faculty members go to high schools to participate in the process of consulting, evaluation and approval of projects. At this stage, the high school will organize the idea contest. Here students are free to speak and present all their ideas to the judging panel. This council is composed of teachers of the university and high school teachers. The results of this internal competition will help the high school select the best and most viable project teams. Of course, the selected projects will then receive editorial suggestions from the council and especially from the teachers of the university. This gives students a more realistic view of their ideas.

- Project teams from high schools send their students to practice and implement the project in the labs of the university. Typically, each project in the field will be assigned to the corresponding lab. Each lab will have faculty members assisting students to develop their ideas into prototypes. In particular, the labs of the two faculties of the environment and electronics often receive groups of students to practice.

- Within 1 to 2 weeks before the official competition, teams will be required to report to the advisory board. The task of the advisory board is to review the entire project and make adjustments. The adjustments are mainly soft skills such as presentation skills, interview skills ...

The initial deployment process is quite convenient. High school students and teachers are excited to come to practice at the university. This is an opportunity for students to access modern equipment and devices that are not usually available in high school. However, over a period of time, this collaboration has had some problems. There are a number of gaps and issues in the approach of faculty members and students at both DTU and its high school partners. This will be discussed in more detail in the next section.

SOME ISSUES AND SOLUTIONS IN THE SUPPORT PROCESS

Normally, when we come to work at any high school, we bring 5 to 7 faculty members [figure 1). Each of them is an expert or has extensive experience in areas such as Information Technology, Mechatronics, Electronics and Embedded System, Behavioral and Social Sciences, Biochemistry. These are the main areas of the 22 scientific research areas that are defined by the ISEF for each subject [3].

Figure 1: DTU faculty members participate in the advisory board

At the first stage, our faculty members will be organized into an advisory counseling board to assist students. In this process we encountered many obstacles as follows:

- Incompatible communication styles. There is always a difference in the expertise and communication skills between the university teacher and the high school teacher because each of the learners is different in age and knowledge. The university environment is often student-centered. Students take the initiative in the research process; lecturers only convey the content and research orientation for students. Meanwhile, teaching methods in high school in Vietnam usually provide students with a foundation in natural science and social sciences subjects that are very good, but they make students passive and do not promote the creativity of students. This makes our teachers have a great challenge to be able to impart the skills of scientific research to students.

- The different creativity techniques and project management schemes. The students that we approach seem to have no idea about scientific research and propose ideas of scientific research. Often they get ideas from their own lives, either from their families, or from the place where they live. However, they are misleading in how to ask research questions. For each project, we always ask two questions: Q1: Who will be the most qualified to judge my project? What area of expertise is the most important for the judge to have? (For example, a medical background or an engineering background?); Q2: What is the emphasis of my project? What characteristic of my project is the most innovative, unique or important? (For example, is it the application in medicine or the engineering of the machine? Is it inserting the proper gene or the method of computer mapping to demonstrate the results?). These are the questions that Intel ISEF recommends to project teams when they choose which type of category they will participate in. The result we received was that no student answered or answered the question correctly. For project management, it usually takes two to three months for the team to complete the project from concept

selection to completion of the sample and reports. Obviously this is a very short amount of time to conduct a scientific study while students are also required to attend formal academic courses.

- Initial lack of trust in the skills and capabilities of both sides. Usually at the high school, each team participating in the competition has a teacher. Initially, when DTU faculty members recognized mistakes in the way students define research questions and suggested changing the approach for each project, we received the reverse reaction. Either do not care, or do not approve. It seems that high school teachers do not believe their projects are failing in approaching the problem and they do not believe the changes will make their projects better.

Although there are many obstacles, but with sincerity and objective feedback, we have helped high schools select the best projects. According to the regulations of ViSEF, in the national competition, each city will compete with six projects. So in each city, we choose the best 6 projects to put into the next stage. Each of these projects may be of one or more high schools or may be from junior high school. In the second stage of the support process, with previous skills and knowledge acquired by DTU faculty members from the CDIO Initiative, however, turned out to be very helpful in bridging these gaps, especially regarding CDIO Standards No. 4, 5, 6 and 7. At this stage, six teams of students are sent to the university with their project. To provide students with immediate access to state-of-the-art laboratory equipment, previously DTU faculty members had prepared some equipment for students to use as soon as they arrived at the laboratory (Figure 2). The equipment and components we prepare are mostly synthesized from the teaching of CDIO projects for DTU students. Depending on the category of project, each team will be assigned to the appropriate laboratory (Figure 3).

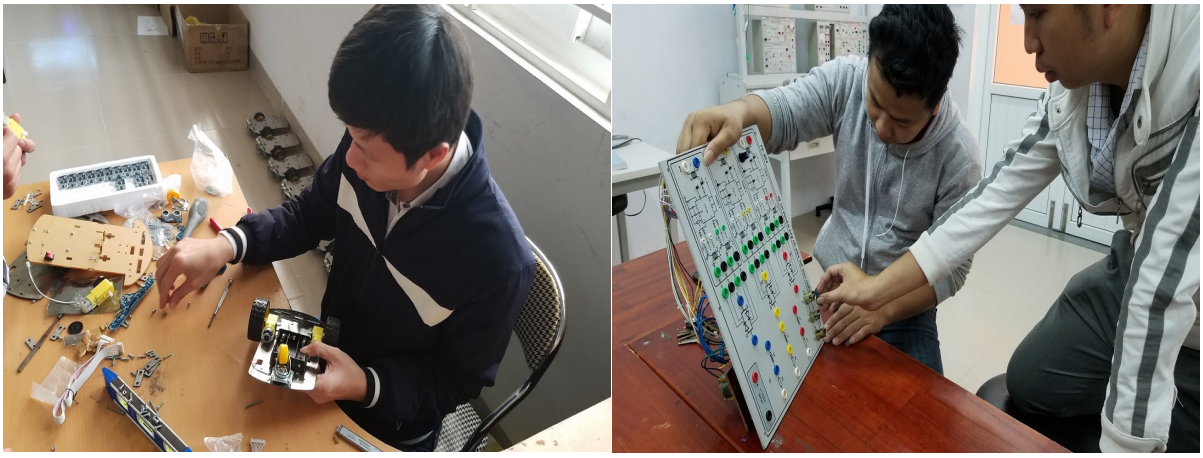

Figure 2: DTU faculty members are preparing laboratory instruments

As mentioned above, high school students often have to attend the mainstream curriculum, so they have very little time to practice in the university lab. Meanwhile, our greatest desire to bring students to the university is to help them experience a whole new way of learning. So, we created “crash” course to quickly teach high school students and teachers about the CDIO model and framework. This is essential for students to have a sound scientific research process and to help them develop more effective projects. Standard 4 and 6 is used by DTU faculty to introduce students to technical equipment in labs aim to stimulate students' interest in, and strengthen their motivation for, the field of engineering by focusing on the application of relevant core engineering disciplines. In Figure 3, a group of junior high school

students are introduced by the DTU faculty on conveyor simulation systems that are often used in factories. In integrating the introduction of these devices we explain to students why it is necessary to have such systems in the factories and why these systems are so designed. It is very important to help fill the gap in the way students make research questions.

Figure 3: Junior high school student beside a conveyor systems and high school student with a robot arm

An informal process of “design-and-trial” was also developed to help run many student projects at the same time. In Figure 4, groups of students are practiced in the lab with equipment and tools that have been prepared in advance by the DTU trainers. Standard 6 is applied flexibly to help students to develop the knowledge, skills, and attitudes that support product and system building competencies. These competencies are best developed in workspaces that are student-centered, user-friendly, accessible, and interactive.

Figure 4: High School Student practice in the CDIO workspaces

Through the above activities, we have helped students become familiar with a method of project implementation in a scientific way with a correct and effective process. Significant progress has been made through a number of improved projects and even completely changed designs. For example, the product supports text-to-speech pronunciation for the blind (Figure 5). Initially students designed an integrated product that included functional keys to control text reading (figure 5 – left side). However, this design still has some difficulties for users, the process of reading text is very slow because it's only read one syllable one time when user press the button. Through a series of activities carried out in the lab, students have new ideas to change the design in a more scientific way, more suitable for

the visually impaired. The new design (Figure 5 - right) allows for faster reading of texts and can change the speed of pronunciation, while incorporating a specially designed rotary axis to display similar braille characters self but braille books for the visually impaired. So with the new design, people can listen to and read by hand, very convenient and easy to use.

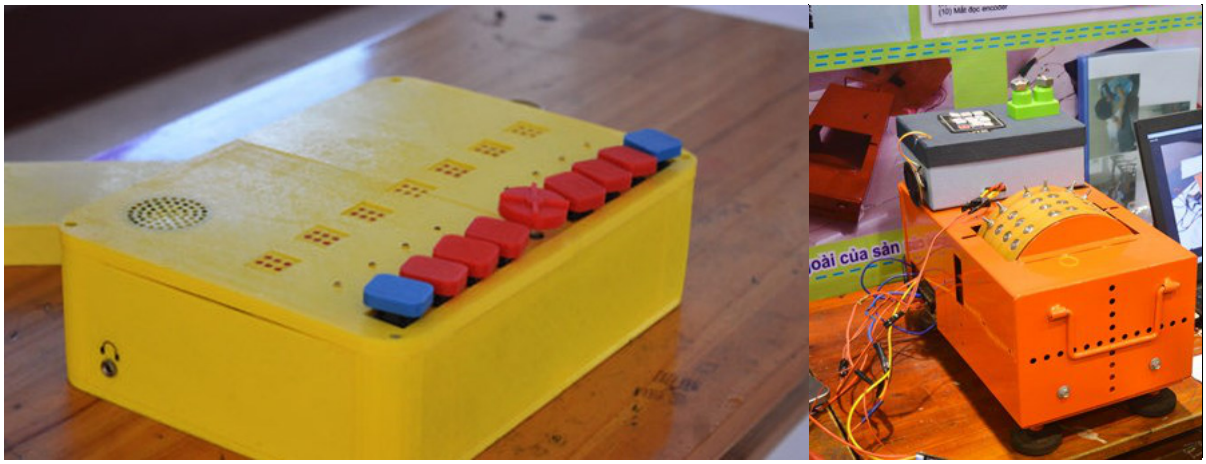

Figure 5: Text reading device for the blind

Figure 6: Equipment used to chase birds in rice fields

Another interesting project is the chasing device in rice fields. Based on the reality in the fields in the village of Vietnam, the phenomenon of birds destroying rice is very common. Due to the fact that students have tried to create a device that allows automatic chasing birds without human operators. The primary ideas of students are to use the wind to make puppets shake and birds fly. However, creativity will stop there without the support of our faculty. Thanks to this, students have found ways to improve the equipment feature and help the puppet can operate continuously thanks to the combination of wind, hydropower and combination bell to increase the ability to chase birds.

In addition to helping students improve their technical skills, at the third stage of the support process, we require students to carry out continuous reports in front of the advisory board to continue their feedback. As a result, students have improved their ability to present

themselves in front of the crowd, their ability to receive and analyze questions quickly from the advisory board, their teamwork skills is also improved. Students are not afraid to report to the council. This marked improvement has led high school faculty to become more confident in DTU faculty capabilities.

Figure 7: Students are reporting to the advisory board

With the efforts of the two sides, through the progress of students in each project, DTU faculty and high school faculty have become more cohesive, the collaboration seems to have become more effective. The encouraging results from the competition are very visible, but there are also co-existing obstacles to both sides that lead to results that have not yet been met as we would like.

OPPORTUNITIES AND CHALLENGES FOR THE PARTICIPANTS

Wishing to enhance the effectiveness of the DTU and high schools through the project and provide a qualitative look into the opportunities and challenges of collaboration between a university and partnering high schools in engineering projects. We made an open interview. Through the series of semi-structured interviews with both DTU faculty members and its partnering high schools' students and teachers, key questions are as follows:

Table 1: Semi-structured interview questions

Question	Content	Interview candidate
1	Please indicate the benefits you receive when attending and practicing at DTU labs?	High school teacher
2	How do you think about the learning method that applies the CDIO model? What does it have to do with improving your projects?	Student
3	What are the difficulties you have when participating in this program?	Student
4	The level of understanding of students after approaching learning method from the CDIO model?	DTU faculty
5	Which CDIO standards are most important to help students create the ability to question the problem correctly?	DTU faculty

In the form of semi-structured interviews, we used only five key questions to collect information. During the interview, the questions will be expanded dynamically depending on the candidate's answers to clarify the issues. By collecting and compiling the information from the candidates' answers (see table of no results at 7), we draw some conclusions as follows:

Opportunities

- High school teachers and students have access to more modern laboratory equipment in labs and more resources from DTU libraries that are not available to high schools because they are not available sufficient resources.

- One high school teacher declared that “the university-school collaboration has made it possible for me to watch other teachers teach and pick what is best from them and use these ideas to improve my class and with time I have learnt to carefully observe my own learning environment.

- Both sides participant identified a major limitation of the nature all of the high school students candidates hardly being able to communicate well both in spoken and written English. However, the practice at DTU has created opportunities for students to improve their presentation skills in English. This is extremely important when students join the Intel ISEF in the international round.

- The students also responded that they were very interested in this new method of project implementation. Especially in the process of forming the idea of the CDIO model that helped them overcome the knowledge barriers, they realized that the former things were difficult for them, now it becomes easier. They also recognize that with a problem there will always be many methods to solve, it is important to know the evaluation to choose the appropriate method. This perception opens up an opportunity for students to effectively expand their project ideas without being constrained by the amount of knowledge they are equipped with in high school.

Challenges

- One expected finding was that the high school teachers identified lack of adequate resources to run the necessary collaborative activities as a major challenge of the collaboration. In the words and voice of one of the school teachers “funding of workshops and other activities are not well facilitated,” which indicates minimum administrative support.

- Some other high school teachers said that the experimental equipment at DTU is modern, but the access time of teachers and students is not much (for many reasons) leading to the use of This device for their projects is not really effective. Some DTU faculty members said that high school students were not well aware of the regulations in the lab, so the practice was still flawed. Therefore, the safety requirements for students at laboratories are also a concern.

- Another identified common challenge is the time to fit collaboration activities into the busy workload of the school teachers. This engagement suggests that the monitoring of the project to check on the teachers may be problematic if not well planned, and

the time to run workshops if not valid may lead to problems. Lack of time on the part of the teachers could be because of understaffing and inadequate number of teachers in schools leading to heavy teaching loads in the schools. This finding agrees with the findings of [4] who indicate that among the conditions necessary for successful school-university collaboration is time commitment on the

- These answers also reveal obstacles of and barriers to university-school collaboration that hinder growth of the institutions and their physical and human resource. However, the collaboration must be built on a firm foundation embedded in trust, mutuality and reciprocity [5]. The glaring benefits of the collaboration for the school teachers to grow professionally in their practices are unmistakable

CONCLUSION

Bringing students to the university's laboratories and using the CDIO model to assist them in completing their projects has helped bring about a high level of achievement in the ViSEF. This has made the leaders and teachers of high schools realize the benefits of cooperation and superiority of the CDIO model that Duy Tan University is applying. Therefore, the distance between Duy Tan University and secondary schools has been narrowed, we increasingly trust each other. This is the good way that the CDIO framework specifically help bridge the gap between the two educational institutes. For the challenges encountered as mentioned above, we have also come up with some solutions to solve them.

- Duy Tan University will sign a Memorandum of Understanding on comprehensive cooperation in the field of science and technology for provincial departments of education and training. Based on that, members between high schools and Duy Tan University will be able to easily exchange information and exchange resources (including knowledge, skills and facilities) to jointly perform tasks on science and technology, including support for science and technology competitions for students.

- The two sides regularly organize study tours for students from the high school to the university for 1-2 days in a semester. This gives students access more often to modern tools in laboratories. This allows them to become more proficient in using these tools.

- To enhance the effectiveness of supporting high school students. We have used the last year university students as good students and have extensive experience in implementing CDIO projects. They will be a significant resource to help resolve the overload of teaching and time limits for teachers.

Clearly, with the results achieved from the above cooperation, the role of the CDIO model and techniques applied in the implementation of CDIO models has been successfully applied by us. It helps the technical projects of secondary schools to be more complete and of higher quality.

With the problems mentioned above, we realize that the collaboration between the university and the high school in the project has really worked. Through the support of DTU, high school students have formed a scientific mindset in implementing projects. They are more responsive and identify the problem better. In addition, high school teachers have gradually changed their outlook on university faculty in general and DTU faculty members in particular.

This is a favorable condition for the cooperation between the two sides to develop more widely than not only support for technical and scientific projects but also cooperation in other fields such as education set up the affiliate program. This will enable the two sides to optimize the resources of the university, reducing the cost of high schools. Beside, successful collaboration is built on coordinators and leader who communicate vision, build trust, manage conflicts, balance interests, and facilitate group interactions [6].

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