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A preliminary study of the impact of high school astronomy research-based learning in Thailand

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Abstract. In Thailand, annually there are more than 50 high school students presenting in the Thai Astronomical Conference (Student Session) and more than 20 high school students joining research activities mentored by their teachers and NARIT staff through the "Advanced Teacher Training" scheme. These opportunities offer a unique experience for students to learn various skills through proposing a research question, design research methodologies, acquire different knowledge conducting research, present and communicate their results and response to criticism. Data collection for this qualitative research study is conducted through interviews with the senior high school students who completed their research presentations, with a control group of students who did not have research-based learning experience but had other informal learning experiences such as planetarium visit, or after school astronomy activities. The study looks into students' learning behaviour, attitude towards science, skills acquired for other subjects, interest in science careers.

Keywords. research-based learning, impact study

1. Background

In Thailand, there are a couple of educational problems. Firstly, the classes are traditional lecture-based with a very large class size - usually more than 50, and also with a classroom culture that teachers discourage students to ask questions during classes, which makes student lack the ability to think and questions. More, the teaching is very heavily orientated to teach examinations techniques (which is mainly multiple choices, and the process thinking is very much lack in classroom settings.

The PISA (Programme for International Student Assessment) scheme is a standard assessment that runs in multiple countries to understand (and compare) student performance in reading, mathematics, and science. Take the 2018 assessment as an example, Thailand is way below the mean score, in all aspects of reading, mathematics, and science, which has reflected the shortcoming of the Thai education system. People may argue that the universal test such as PISA is not suitable nor meaning to represent multicultural aspects of education, however, it still serves as a good starting point for referencing baseline.

On the other hand, Thailand has successfully included astronomy in its national science curriculum since 2001. This important move has resulted in a series of teacher training offered by the National Astronomical Research Institute of Thailand (NARIT) annually, they come in three different levels - beginning, intermediate and advanced level. In the advanced level teacher training, teachers will guide 20 high school students (grade 10-12) to conduct research projects with support from NARIT staff. And learning from Japan,

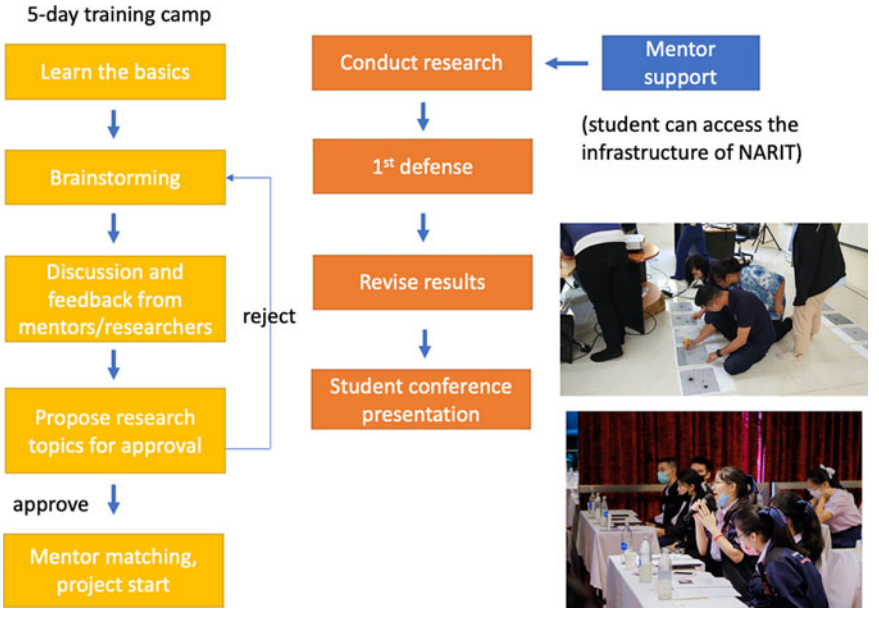

Figure 1. Flow chart and some photos of the research learning activities.

Thailand organized "The Thai Astronomical Conference Junior session (TACS)" every year, around 50 high school students joined the conference every year. TACS is described more in detail in Sappankum *et al.* (2018).

There have been many studies showed that active learning increases student performance in science, engineering, and mathematics, such as by Freeman *et al.* (2014). Teaching methods can also be classified into a spectrum of methods, range from the more teacher-directed methods to more student-directed methods, such as lectures, worked examples, interactive lecture, flipped classroom, questioning, discussion-based, scenario-based, case-based, collaborative learning, inquiry-based, problem-based, or project-based methods. Research-based learning is also project-based learning with added values from research exercises.

In our case, the flow of the research-based learning is outlined in Fig 1. Assuming the students have zero background in astronomy, they are asked to join a 5-day training camp to learn basic astronomy and research skills. Within the camp, a lot of time is devoted to brainstorming sessions in which the students, teachers, staff, and researchers will discuss and come up with a research project. The topic proposed will be subject to an approval process, rejected ones have to repeat the steps and come up with a new topic. This process played a very important role to allow the students to think logically and know what they are going to do, and also how to ask good questions. Then later the support staff or researchers will teach the students specific skills they needed for the project they proposed. After the topics were confirmed, mentor matching takes place, and students will learn many new things in a short time and then conduct their researches. Like proper research, the students are asked to present their results, both in the written and oral format in a defense with all research students, teachers, staff, and researchers present. They have to face criticism, they have to revise their results if necessary, and will be finally presented at the TACS.

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Table 1. Control set questions asked to both the planetarium visitors and research students.

learning behaviour	• I often read about astronomy • I can access astronomy information from other channels
Take away from the activity	• I learn something new about astronomy in the activity • I came away with a stronger interest in astronomy • I want to join the activity again in the next 12 months • I want to look up more information about certain topics of astronomy
Attitude towards science	• Learning about science and technology is useful for my life • Science and technology can shape a better society
Experience	• If I did not join the activity, I will miss an important experience in my life • It is more fun to learn in the activity than in school

2. The methodology of the impact study

The research learning activities have been organized for years, we see an increased interest in the schools wants to join the activities, but there was never a proper study to understand the impact of these activities, which is the main motivation for conducting this study to look into the details of its impact.

The study is conducted both in a quantitative and qualitative way, through comparing the data with the same set of questions given to planetarium visitors compare to research students, and also through interview with the research student. Table 1 listed the questions we presented to understand the learning behaviour, take away from the activity, attitude towards science and experience.

3. Preliminary results

In the prototype run, due to COVID-19 pandemic we were only able to collect very small sample (n=6 for planetarium visitors with age 11-20 and high school education level within a two-month interval; n=1 (out of the 20) research student who conducted the 1-hour in person interview) and therefore not conclusive. Therefore we only see this as a prototype run and will continue the study in the coming year activities with a new round of students and the students are well informed for the study, and also collect data from 3 more planetarium. Here are some observations are found for further testing when we have a larger sample size.

• Planetarium visitors has stronger motivation than research student to join the activities

• Research student become more resourceful than planetarium visitors

• Research student does not necessarily finish the project with stronger interest in astronomy than planetarium visitors

• Research student has a stronger "take home" impact than planetarium visitors (want to join the program again, look up additional information)

• Research student has shown a stronger believe in science and tech is good for the society, and usefulness of science in daily life

• Planetarium visitors and research students both enjoy the valuable experience of joining the activities

In addition, 10% of planetarium visitors (n=35) disagree ; 10% feel neutral towards science and technology can develop a better society. From the qualitative study through the interview with the student, we learn the following reflections:

• in Thailand, schools are usually conducted in lecture settings, students has little experience doing experiments;

• joining the research project helps to present experiments in school, write science report and also the skills and precaution in collecting data, interpretation, develop thinking and produce new ideas

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• the learning was also helpful for personal development on interpersonal skills, be responsible, build self confidence
• students considering if they will study astrophysics in university

4. Conclusion and next steps

The result presented here is still very preliminary, and further tests have to be continued, especially to increase sample size. More importantly, we are looking for other methods to understand the critical thinking aspect of the students, and also compare the results with students in different school environments, and use a different control group in classroom learning setting. Once we have enough data over years, we can look into the study path and career path of the participants.

Apart from the study, NARIT is planning to launch a scaled-down but international version of the program in 2021 via the NARIT operated UNESCO International Training Center in Astronomy. And we are also looking into the possibility to export this experience to IAU Commission C1 to promote research-based learning activities globally.

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