A TEACHER'S PERSONAL JOURNEY IN USING SCIENCE PROJECTS

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This paper will reflect on the experiences of an educator who had supervised students in a number of science projects entered for competitions organised regionally and internationally. Personal experiences and difficulties faced are shared and possible solutions are discussed. Various factors that affected the progress of the science projects and hence influenced their success are also discussed. The perceived benefits of science projects with students and those involved directly and indirectly are shared. Lastly, an attempt is made to discuss ways to make the science project teaching and learning strategy more viable, meaningful and useful in school-based lessons.

INTRODUCTION

Science education holds an important position in education particularly in the preparation of a scientific and technological workforce for a developing country such as Brunei Darussalam. Much of attention and funds have been given to promote and develop science education in the country to ensure that the workforce for the science and technological industry are met. Much

of the focus in education is to get students to pass examinations and to graduate so as to fill positions in the workforce where graduates are needed. However, feedback from local industries indicate that skills and abilities that are needed for working effectively may not have been developed by gearing students to pass examinations only. Such abilities needed by industries are the abilities to think and solve real problems. Hence local industries have given much to develop these skills in particular events such as annual science project competitions for students. However, measures such as these only can promote thinking and solving problem skills in a few students rather than for the majority. The aim of this paper is to map out a practising science teachers' personal experiences with supervising students for science project competitions so that they can be utilised to promote the kind of abilities that are required. These personal accounts may be useful as starting points for other science teachers new to supervising science projects. The accounts may also give useful insights to those wishing to take further measures to promote the thinking and problem solving abilities that are needed.

A 'science project' for this paper is defined in this paper as an activity conducted to solve real problems using scientific and investigative activities so that students' inquiry abilities are developed. The scientific skills involved include asking questions, thinking, making predictions and drawing conclusions while investigative skills involve discovery and experimenting to test hypothesis. Inquiry strategies include questioning, hypothesizing, experimenting or testing, analyzing and drawing conclusion (Trowbridge & Bybee, 1996). Another way of describing a science project work could be adapted from the problem-based work definition where questions that are relevant to real life problems are used to drive investigations conducted by students with the collaboration of a community or between students and teachers resulting in the development of an idea or product usually presented

and shared by the use of technology (Krajcik, Blumenfeld, Marx & Soloway, 1994). In this paper, the benefits that students are perceived to have obtained from being involved in science projects are matched with the above aspects of science learning usually expected from science projects.

Collaborative action research in education establishes groups of people committed to changing themselves and, by doing so change their educational work. In this way education can be improved by changing people, their ideas, activities and their social relationships (Kemmis & McTaggart, 1988). Further, in order to help students achieve the high levels of science learning that are required, professional development for science teachers need to be continuous and foster true teacher growth and be directly linked to the teachers' work as well as build on their current beliefs, knowledge and understanding (Loucks-Horsley, Hewson, Love & Stiles, 1998). For this paper, the authors report on a collaborative action research exercise where a practising science teacher (first author) reflects on her experiences with science projects based on her beliefs and understanding of science learning, and her report is refined after interacting with a science educator (second author) to determine if the focus of the reflections are within the framework of science learning. In doing this exercise, the practicing teacher is undergoing a professional development process by taking stock of her experiences, and establishing whether she has progressed in her teaching or has to refocus in areas that would help her to improve her teaching abilities.

BACKGROUND

The practising science teacher of this paper graduated four years ago with a Bachelor of Science Education degree. As soon as she graduated, she joined and took up active roles in professional associations. The nature of her job is teaching science in a high school in Brunei Darussalam. Her journey in using science projects

started half a year after she graduated. Since then, she had supervised four science projects for competition held internationally and locally. All completed science projects were awarded first runner up (two) and as second runner up (two) respectively.

METHOD

The method used in this study is based on a collaborative action research framework where the practising science teacher's personal journals in the supervision of science projects with secondary students are recorded and reflected upon. The recording of journals and reflections on paper formed the qualitative data of this study. These journals and reflections were then read by the second author of the paper. Interactive discussions were held to clarify, comment and analyse the recorded journal data to make some sense of them. The journal and reflections were then constructed into common categories or themes and subsequently rewritten in reduced and more readable form for this paper. The reflections that follow here are about what the practicing science teacher did with science projects and the circumstances of the science projects that she supervised.

In addition, questionnaires were sent to thirty students and four supervisors who had participated in science project competitions to solicit their perceptions of the difficulties faced and the benefits from being involved in science project competitions. Interviews were conducted with four students to probe further their perceptions of their involvement with science projects. Relevant responses from the interviews are quoted in this paper and are used as evidences and elaborations of the perceptions.

EXPERIENCES IN SCIENCE PROJECTS

The accounts that follow here are descriptions of the practising science teachers' experiences in the supervision of science projects in competitions, one of which was entered an international competition while three were entered in Brunei. Her experiences in conducting school-based projects were also reported.

SCIENCE PROJECT COMPETITIONS

Science Project One. In 2000, the first author was selected by the Brunei Association for Science Education (BASE) to supervise two (2) pre-university students for the project entitled "*Length-Weight Relationship Of Indian Mackerels Caught In Brunei Waters"* and participated in an international science project competition in Taiwan. The project conducted won the second runner-up prize for the biology section.

Science Project Two. The author's second supervision in science projects was for a regional competition in 2000. She volunteered to supervise a group of four Year 8 students in a science project entitled "*How Important And Beneficial Is The Sewage Treatment System To The People In Brunei Darussalam?"* The group investigates the sewage system in Brunei Darussalam; and produced a teaching and learning resource for Year 8 students in a written and oral report as well as in a compact disc. The project was placed second runner-up winner.

Science Project Three. In 2001, the author sent a science project proposal that was accepted for competition in the "Princess Rashidah Young Nature Scientists Award" (PRYNSA). Only five projects were selected and named as the PRYNSA teams each year. The proposed project entitled "*The Vertical Distribution Of Fruit Flies In Ulu Temburong National Park"* was a follow-up project, initially conducted by 3rd year university undergraduates. Using similar experimental procedures, the students were able to prove the previous findings by the undergraduates to be faulty. Our science project was placed first runner-up.

Science Project Four. In 2002, a science project the author proposed for PRYNSA, "*The Validity Of The Nitrogen Content Present In Pitcher Traps*" was again selected. The project earned first runner up prize.

SCIENCE PROJECTS IN SCHOOL-BASED LESSONS

The previous experiences in science projects had encouraged the author to supervise science projects that were not competition-driven. Due to limited timetable time, only the briefing sessions were conducted during the school time, while the fieldwork during out of school time. In one project, the "*Study of a Pond"*, students were to identify the living things present in the pond and to measure the biotic and abiotic factors in and around it. Another project I conducted investigated the "*Power exerted in running a flight of stairs at Bukit Shahbandar."*

TEACHER'S REFLECTIONS IN SCIENCE PROJECTS

The author's personal journey in using science projects is reported here to share the good and bad points of using science projects for those that are interested in using science projects or those that are proponents of science project competitions. The author's reflections have been categorised into three themes: (1) difficulties and problems faced with possible solutions; (2) perceived benefits of a science project for teacher and to students and (3) using science projects in normal lessons.

DIFFICULTIES AND PROBLEMS FACED AND POSSIBLE SOLUTIONS

A science project would only be complete if it is written up and the findings of the project are shared either in a presentation with peers or with other audience. From the experiences that the author had, the difficulties and problems faced are categorised into the following: (1) supervisor, (2) students, (3) resources, (4) science

project contexts and (5) support. The solutions offered here are also from the author's experiences and may only be suitable for similar contexts.

Supervisor

As a project supervisor, the author felt one had to be mentally and physically prepared and alert to any difficulties that might arise during the supervision. To run a science project smoothly, responsibilities must be shared between the supervisors if there is more than one supervisor involved. The author found that it was useful to prepare the following items before meeting the students for the first time, such as (i) an idea of the problem to be solved and a tentative action plan, (ii) the proposal for the science project, (iii) permission forms for parents, (iv) a contract for students to sign, and (v) students' contact numbers. Before conducting the investigation such as in the fieldwork, the author found it useful to prepare a checklist for students so that they remember what to take to the field site, view the site first with students to give them an idea of the fieldwork and conditions to expect. More importantly, the author felt that as a supervisor, the author must understand what the project is aiming at, so that the investigation is focused and the students are provoked to contribute their ideas by raising key questions for the project.

Resources

Science projects will need funds for them to progress. In the author's experiences, if a project is not sponsored, she would try to claim back expenses from the school or we (supervisors and students) agree to donate a few dollars for the project. Another problem was the difficulty in getting references and resources. I found the best way to overcome this was to visit the good libraries with the students to find the relevant materials needed. However, permission letters were usually asked for if we were borrowing books from libraries

from government offices. An easier literature resource was to search the Internet and university lecturers and scientists. Even with references as resources available, if the project subject or data are not readily available, the research will be stalled. Therefore, it is important not to choose a seasonal subject of research, as the author found with the lack of mackerel caught for the first science project I supervised.

Students

A major problem was the students' difficulties in understanding the aims of the project. It is crucial to brief students about the science project in a very simple manner and an interesting way to create a scenario of the investigation. Common complaints that can be heard from students are about tiredness and difficulty in explaining the project in English. Here, the author highlight the need for the supervisor to listen and act to motivate the students. By praising their work completed the student's feelings of wanting to give up, can at least be alleviated. The author found that she needed to help the students to formulate their sentences for their reports and train them in presentation skills. The author also involved other teachers in the school to help edit the reports produced by students and also to comment on practice presentations.

Shy students were another issue, in that they were not putting forward opinions in discussions. The author found she had to give the students time. This could be done by involving the shy students during the discussions and not leaving them out.

The author also faced student discipline problems, such as, students not attending meetings and not doing the tasks that they were given. The author feel it is important to pace the project according to the students' abilities and maturity.

Science project context

A major drawback is that students inevitably miss their normal school lessons when they are involved in science project competitions. The author felt that this must be avoided and usually try to fit the project meetings to a time where it does not affect the schooling hours. With a science project conducted in the science course rather than as a science project competition, the author still did not use school hours for the students to conduct the projects. Although the author have not done this, she was aware that it may be possible to rearrange the students' timetable for one or two weeks so that one or more whole mornings could be used for the science projects to be conducted during school hours.

Support

Parents' and schools' permission were usually obtained before the conduct of science projects. The author faced unsupportive parents, administrators, and other educators towards the project. Some students were not allowed to come for the afternoon meeting by parents, and teachers sarcastically scolded the students for missing their extra class in the afternoons. The author found one way to alleviate this was by sending letters to the parents and other teachers concerned to obtain their permission with the school principal's signature. The letter should include the proposed students' schedule of activities and an action plan so that parents are aware of what their children are getting involved in.

On the presentation day where the projects are to be shared with peers or an audience, the authors have always faced technical problems, especially with the computer. Therefore the author found it safer to be prepared with a contingency plan if these problems occur. Here the support of my colleagues as back up with extra hands and minds was sought after.

The unavailability of computers is another factor that could affect the progress of a science project. The author's first option was to obtain permission to use the computer laboratory in the school, otherwise the author look for computers available that we can use for free. In the author's experience, there is always a computer room available in a nearby mosque or in the students' home. The author's last option would be to use my personal computer. The author considers the use of computers to be important, so the author usually starts by finding out the status of students' computer skills, and usually they tend to learn from their peers to manage the computer.

PERCEIVED BENEFITS OF SCIENCE PROJECTS

Much of the claims of benefits of science projects in literature are reported for benefits to students but little reports are found for benefits that teachers' obtain from supervising science projects. In this paper, the benefits for the teacher supervisor are reflected upon as well as what the students perceived they benefit from doing science projects.

For teacher

Not all teachers would be willing to sacrifice their time to conduct science projects with students. This is evident from my own colleague missing meetings sometimes without reasonable excuses. However, the author felt that it was worth spending extra time with the students because the author learnt a lot of new things about students and developed professionally, improved in my teaching skills and personal abilities.

In terms of professionalism, the author became more positive towards her career and more motivated and bolder in her science teaching. More importantly, the author looked forward to students' development in their science projects. In sharing experiences with other science project supervisors, the author found that they gave

similar feedbacks. One says, "I love to see students working together in achieving the goals of project." The author became more confident in handling bigger projects not only at school but also outside the school. For example, the author organized science quizzes and science projects held within the school. The author then was brave enough to accept BASE challenge in organizing and chairing a regional science activity with primary teachers for the country. These are courageous ventures that the author would not have done if the author had not obtained the experiences from the supervisions with science projects. The author became more confident to talk in front of teachers, answer their questions and was able to organise and instruct other teachers. The author feel that I have also gained the trust and respect from my administrators, my head of department and particularly the students. From dealing with science project students for many hours, the author feel that he had developed abilities in becoming a good motivator, counselor, listener and was more patient with students.

In terms of teaching skills, the author now tends to use more inquiry strategies during her teaching. The author had lots of practice using thought provoking questions during discussions with project students and these skills that the author developed benefited her own science teaching in normal lessons. Other peer supervisors voiced these benefits out. They agreed that supervising students in science projects benefited them "in terms of developing their teaching skills" too. In the classroom the author became more facilitative rather than directive, the author encouraged students to discover by doing practical activities, rather than giving them the knowledge that they need to cover in their science lessons. The examples the author provided to the students in class, the author felt, became more relevant and more interesting. In addition, the author have improved in giving instructions to students. During the author's first supervision, the author did not know what to do, but after several supervisions, her instructions become clearer and

more "straight to the point." Supervising science projects with all the difficulties faced was not easy, as it needed a lot of sacrifice in time, effort and even finance. The author felt that even though only a small number of students work with her in the science projects, it was difficult to get them achieve what she expected them to achieve. However, the author became aware that much higher level learning is achieved in students with science projects. Other than that the author gained experience and confidence in computing skills. The author improved her knowledge and skills in using information and computing technology (ICT) by using software that I had never used before. The author was then able to share this knowledge with her students for the preparation of their presentations of their projects.

To students

From the feedback the authors obtained from the students through the questionnaires and interviews, the benefits of their involvement in science projects can be categorised into attitudinal, cognitive, inquiry skills and overall performance.

The *attitudinal* benefits are evident with phrases such as, "It is interesting, fun, exciting, even though it is tiring"; and "I enjoy seeing new places". When the students were asked whether they want to join science projects again and their reasons, the feedback was mostly positive. "I would love to", "It was fun, I learnt to work as a team"; "I like science now", "Yes, if it involves graphical designing"; "Yes, since I get more benefit", "eagerly because working in science is part of my ambition", "I will gain experience", "it will help me to socialise with other people" and "to expand my mind". From these comments, it is evident that students not only gained satisfaction and enjoyed themselves, they were more motivated and interested towards their science. In addition, the students gained self esteem, other students look up on them because of their involvement in science projects. Even the administrators

and other science teachers become aware of these students who worked on science projects.

The *cognitive* benefits that were evident came in the form of students' responses such as, "We get to know the forest in detail". In addition, during the meetings and discussion, students showed they improved in their acquisition of cognitive skills as they progressed in their science project work. For example, the excerpts below show the students become more skillful in responding to questions raised by teachers with higher level of understanding;

Teacher:	What can you understand from that phrase "The Vertical Distribution of Fruit Flies?"
At the beginning.	*After several meetings.*
Student:	About flies? Student: The number of fruit flies found from zero level to the upper level.

The students worked on analyzing lots of data and came up with evaluation abilities such as:

Teacher:	The conclusion for the previous project shows there is a vertical distribution of the fruit flies. Now that you have your data and findings, how would you compare your results with the previous one?
Student:	Teacher, not all levels have flies, how can we say flies are distributed vertically?

The inquiry skills students gained were evident in phrases obtained from interviews, such as, "Writing reports improve my compositions"; and "We learnt to handle new apparatus". In addition, other inquiry skills gained included hypothesizing, experimenting, analyzing and drawing conclusions. Students found

it difficult to understand the meaning of hypothesis at first, but after providing examples, they were able to make reasonable hypothesis. For example,

Teacher:	What could be your hypothesis about the validity of nitrogen content in pitcher fluids?
Student:	Of course, there is nitrogen content in the pitcher fluid.
Teacher:	How are you going to say it scientifically, using null and alternative hypothesis?
Student:	Mmm, null is none, so, there is no nitrogen content in pitcher fluid, and the alternative, there is nitrogen content in pitcher fluids.

During the investigation stage, students became more aware of their tasks and were more able to make suggestions to changes in the design of the experiments. At first, they kept asking the same questions, "Should I do this?" "Should I do that?" After their first trial of experiments, students started to suggest changes to gain better and reliable data. For example,

Student:	Teacher, the rainwater may be causing the pitcher plants to show different pH.
Teacher:	How do you know?
Student:	I checked the pH before and after raining. Why don't we try cover the pitchers with plastic bags when we leave them?
Teacher:	Are you sure it will work?
Students:	Let's just try.

Here the author's students had developed the ability and initiative to prove what they think could be the cause of the problem with varying data they experienced. Students are practising their thinking skills and learnt to make decision other than understand their study. They were also showing they were becoming more independent in their thinking.

During the write-up stage of the project work, the author's students developed and improved in their ICT skills. For most of my students, their computer use during the project was their only chance to use computer. They also experienced using a microscope connected to a computer, a hardware not often used by teachers and students in normal science lessons.

During data analyzing, they took some time to be clear about their results but once they got the idea, they were able to work fast. On top of that, my students developed the ability to relate one idea to another. For example,

Students:	Teacher, I am getting pH 2.4 (acidic) in the pitcher plants, so what does this show?
Teacher:	Could it have something to do with the organisms inside?
Student:	You mean, the organisms died because of the acidic fluid, so, is there a connection with the nitrogen content? I'd better check with the other species of pitcher plants, see which one is more acidic.

Other than benefiting in inquiry skills, my students improved performance in their school. The author's project students felt that they had improved their subjects not only in Science but English and Geography since their involvement in science project

competitions. Most of the students became the top ten students in the school even though they did not start off that way before being involved in science projects. This proves that science project does not discourage students but in fact help them to improve their academic performance.

SCIENCE PROJECTS IN NORMAL SCHOOL LESSONS

There are many projects that do not need long stretches of time for investigations and can be conducted within the normal school timetabling allowed for science lessons. However, many teachers would agree that it is quite difficult to conduct science projects during school hours in normal science lessons. Many of the investigations take up long stretches of hours, particularly those that need to be conducted in specific locations like the forest, such as was the case in my last two projects. For this type of investigations, science projects could be conducted by rearrangement of lessons so that the investigation work is conducted in one morning or day. The authors have observed the rearrangement of science periods before but for different reasons, not science projects. Although the authors have not tried this route, the possibility lies with the administrators in the schools. Are they willing to work on rearranging the school timetable to allow for science projects? The authors feel that if the teachers understand the need for science project as a strategy to develop inquiry skills and other benefits, they would support the rearrangement of lessons to allow for investigations to occur.

Other alternatives are to have all subject teachers to plan to cover a specific theme. For example, if the theme chosen is water, other subject teachers such as for example, English, cover the report work with the project on water, while the science teacher cover the inquiry aspects on investigations with problems in water. This alternative needs cooperation from all in the school.

CONCLUSIONS

The process of recording of the authors' reflections and working with others to discuss the relevance of my reflections, and to get feedback about the significance of the study are important steps that the author have made towards my own professional development. The author have learnt even more by writing this paper as it makes me take stock of what the author have achieved and what the author have yet to achieve. The author's analyses of her teaching ability in this exercise of writing this paper assured her that she have improved in her confidence, her teaching behaviour have moved to a more constructivist mode where, she asked more questions, spent more time with small groups of students on an interactive mode rather than a transmissive mode. Nevertheless, the author feel she still have a lot to improve in my skills for science project supervision particularly in getting students to be able to identify real life problems to focus in their project work as in all the science projects that she have supervised; the real life problems for the projects were more or less identified by me. In addition, the designs of experiments were duplicated from previous experiments in two of the projects. The author would like to be able to develop students' abilities in designing their own experiments in the near future.

In many contexts, particularly in developing countries, Brunei included, teachers and students do project work only for the sake of joining competitions or only for higher ability students. Strategies of teaching in science courses such as project work are not new but seldom used due to lack of support from many aspects such as in curriculum materials and suggested strategies or traditional evaluation practices that look into examination using paper and pen or practical tests rather than the achievement of problems solving and investigative skills. Now, there should be enough expertise in science teachers to conduct science projects for all

students rather than for the high abilities students only. Indeed in many countries all students not just the higher ability students need to achieve scientific literacy and in order to achieve this, students not only need to be learning science and learn about science but also do science, specifically by engaging in and developing expertise in scientific inquiry and problem solving (Hodson, 1998). If problems solving and investigative abilities are one of the important objectives of science education and project work are agreed to encourage these abilities, then efforts must be made to find ways to make project work a viable teaching and learning tool in science and technology education for all rather than for the more able only. These efforts are needed from the policy makers, curriculum developers, examiners, researchers, university lecturers and teacher trainers in science education, not just teachers.

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