Weekend Lab Challenges bring physics learning from the laboratory into everyday life

Shinjiro OGAWA

WASEDA University High School, 3-31-1 Kamishakujii, Nerima, Tokyo 1770044, Japan

Abstract. An inquiry-based teaching programme was developed to have students work on Weekend Lab Challenges with the aim of enabling students to develop a view of what they learn in secondary school physics lessons that they can use in their daily lives and in their future lives. Working on challenges at home not only brings physics learning out of the laboratory and into everyday life, but also allows students who are interested in what they are learning to take the time to try it out, thus both improving student agency and realising inquiry-based learning.

Background

In Japan, it is known that few students have high self-efficacy despite their high science scores in PISA. The percentages of students who consider the science they learn at school to be useful in their lives and important for their future career are also low [1] .

One of the main reasons for this situation is that many teachers teach in a knowledge transfer style, even though teachers are required by the Ministry of Education, Culture, Sports, Science and Technology to teach in an inquiry-based manner. Furthermore, even if the lessons are exploratory, if the activities are confined to the laboratory, it is assumed that students' attitudes towards learning physics will not change.

In order to increase the effectiveness of learning physics, teachers need the opportunity to understand students' thinking and to develop strategies on how to transform students' perceptions. This includes the problem that students' everyday life experiences have become more diverse, making it more difficult to utilise these experiences as a prerequisite for teaching. It is also an equally important process for students to obtain convincing evidence through their own trial and error. Research on these methods has been widely conducted as physics education research and has been summarised in books [2].

In order to balance the above points in teaching, it is necessary to solve the major problems of time availability. For example, there is a form of flipped classroom teaching in which students attend classes having learnt theory by watching videos, etc., in advance, and in the classroom, they discuss issues and solve problems in a collaborative manner [3]. However, while this method allows time for collaborative learning, it is difficult to achieve deep conceptual understanding without direct interaction with teachers and other learners in secondary education.

In addition, a method called Just-in-Time Teaching (JiTT) [4], which encourages proactive participation in class by having students answer questions online before class, enables motivation of students and understanding of learners' ideas before class, but does not ensure time for inquiry-based teaching.

Taking advantage of the fact that the Learning Management System (LMS) became widespread after the Corona Disaster and made it possible to carry out educational activities without the limitations of class time or the school science room, we developed a learning programme, referring to the previously mentioned methods such as the flipped classroom and JiTT.

Methods

We developed a lesson programme based on the hypothesis that having students work on lab challenges at home on weekends in conjunction with classes at school would enable them to learn in an exploratory manner and increase their sense of self-efficacy, even during limited class time.

The programme is outlined below and is named the Weekend Lab Challenge (WLC), as it is centred on activities in which students work on a lab challenge at home during the weekend.

The WLC outlines (1) Motivate learning by having students work on lab challenges at home. (2) Give students a chance for trial and error by allowing them to work on lab challenges in their own time at weekends as much as they like. (3) Using an online LMS (Learning Management System) to share students' ideas with students and teachers before class to improve the accuracy of the lessons. (4) Plan lessons based on 'questioning' and 'lab challenges', which are based on the students' ideas about the tasks they worked on over the weekend.

By learning physics in an exploratory way in the WLC, which combines classroom and home activities in this way, the following effects are expected. (a) Increase students' understanding of physics concepts by teaching with a high degree of accuracy. (b) Increase the usefulness of physics by allowing students to freely use measurement equipment outside school. (c) Increase self-efficacy by giving students as much trial-and-error time as they want. (d) Realise Student Agency by taking physics learning out of the laboratory and into everyday life.

Conclusion

An inquiry-based teaching programme was developed with the aim of enabling students to develop a view of what they learn in physics lessons in secondary school that 'can be used in everyday life' and 'can be used in later life'. The results of a questionnaire after the two-year programme suggested that the hypothesis at the time of development was correct, as 93% of the students said that what they had learned in physics class was relevant to phenomena in their everyday lives, and 84% said that it would be useful in their future lives.

Working on lab challenges at home not only gives students a positive impression of physics learning, but also has the advantage that students have the opportunity to think for themselves about how to do the experiments, which can be a great benefit if safety is ensured.

It is also important that the tools for measurement and analysis remain in the hands of the students, as they conduct the experiments at home using items around them. This can be expected to contribute to the realisation of the Student Agency proposed by the OECD (the idea that students learn in school lessons to guide them in making decisions in various aspects of their future) [5], and can also be seen to have value as STEAM learning. In addition, as a private school, it could be assumed that by having students experiment at home on weekends, families would be involved in this, which would have the by-product of improving their understanding of the learning programme and their evaluation of the educational policy.

References

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