A Model building Approach to Optics (Flinders University)

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Introduction:

As a part of the ALTC Fellowship 2011 grant, we have implemented an interactive computer lab (3 hour lab session, week 10) in semester 2, 2012 where the students built simulation themselves and explored various aspects of geometric optics (building lens in different shapes, making ray diagrams for lens combinations- bi concave, convex lenses themselves & learning theory behind it) using the Mathematica software. One of the simplest and most useful lens combinations is the astronomical telescope. This computer based lab was configured in such a way to allow students to work alone and to promote their independent learning. After this interactive lab, students performed a laboratory experiment where they built an astronomical telescope (week 12). To equip first year students with the concepts and skills required in designing an experiment, we trialled an Inquiry-based practical in Semester 2, 2012 as a part of this Fellowship grant and the SaMnet Project. Aim of this lab was to promote higher order thinking, creativity and learning. Studies [1] reported that when students engaged in the design of experiments, they not only developed scientific abilities but use them without prompts and scaffolding on transfer tasks. One of the practical classes was changed from a 'recipe' format to an inquiry-based format (IB lab) that drives students to design and execute their own experiment.

The key question to evaluate the effectiveness of this new lab was: What are students' attitudes and perceptions towards inquiry-based practicals compared to traditional, recipe-based practicals. Inquiry-based practical evaluation involved students completing an anonymous questionnaire. This questionnaire instrument has been used previously in published studies [3]. The questionnaire was delivered on Flinders Learning online after the completion of all of the practicals. We have obtained ethics approval (#5757 SBREC) for the data collection.

Approaches/Method

It is a common perception that traditional recipe based laboratory experiments are generally boring, non-interacting and non-engaging. Inquiry-based experiments are usually designed to introduce concepts compared to recipe based labs which are for the confirmation of concepts [2]. We have implemented an Inquiry based lab on Radioactivity for non-physics majors in semester 2, 2012. The students were given 5 traditional and then 1 IB lab. We encouraged students to acquire prior knowledge through literature, synthesize the information and then design their own experiment incorporating innovation and techniques. In the light of students' feedback, we

offered a set of lab activities to students to choose from. These activities were designed in such a way to explore and critically examine their new lab experience where students to take charge of their own learning and time management.

We formed a student focus group (n=4) to test these activities before being delivered to the class. To gauge students' prior knowledge of radioactivity, we distributed a pre-lab questionnaire prior to the commencement of lab. Four activities on Radioactivity posted online for students to choose from. Reading materials were given to help them acquire prior knowledge to design their own experiment incorporating innovation and techniques.

Findings/Discussions

Evaluation of the inquiry based practical involved students completing a Semantic Differential Survey about their attitudes and perceptions towards IB labs [2]. 72% of students felt they had to do a lot of thinking and analyzing when doing the inquiry-based laboratory reports. Although only 36% of students preferred IB labs over recipe based labs, 55% of students believed that they learnt more with IB lab than recipe based lab.

Research statement 1 and 2 asked about students attitudes towards IB lab. Results indicate that 64% of students have a more positive attitude towards Inquiry based labs. For Statement 3 "It takes a smaller amount of effort to complete the inquiry-based laboratory reports", 95.4% of the students rated it between 1 and 0, where such a range of scores defines broad agreement. They all agree that it takes larger amount of efforts to complete IB lab reports. The analysis of the responses to statement 4 "I have to do a lot of thinking and analysing for doing the inquiry-based laboratory reports" is of particular interest to us, since it tested the effectiveness of inquiry based lab to promote higher order thinking skills. 72% students strongly agreed with the statement. These results are in agreement with [3]. The survey response shows that while 54% students found inquiry based labs were fun to do, there is almost 46% disagreement with this statement. Responses to the statement "I would choose to do an inquiry-based laboratory over a recipe-based laboratory" show that 67% students prefer to have procedures included in the lab reports.

Future work:

As a part of this project, we have implemented a computer based simulations lab (CBSL lab) on Geometric Optics in week 10, semester 2, 2012 and after that students performed a lab where they built as an astronomical telescope in week 12. All students were invited to complete a survey. We are still in the process of collating the data and analysing the survey results.