Using Reflections to Explore Student Learning During the Project Component of an Advanced Laboratory Course

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ABSTRACT

We redesigned an advanced physics laboratory course to include a project component to address learning outcomes such as modeling, design of experiments, teamwork, developing technical skills for using apparatus, and analyzing data. The final assignment given to students was a reflective essay, which asked students to discuss their learning and satisfaction in doing their six-week project.

Qualitative analysis of the student reflections showed that majority of the students reported satisfaction and achievement, functional team dynamics, learning outcomes unique to this experience, practicing modeling skills, and potential future improvements. We suggest that reflections are useful as support for student learning as well as in guiding curricular improvements. Our findings may be useful for other course redesign initiatives incorporating project-based learning and student reflections.

COURSE CONTEXT

The required third year laboratory course at Queen's University was taught to 61 students in the fall of 2017. We redesigned the course to better match the desired learning outcomes suggested by the American Association of Physics Teachers (AAPT)[1]. Students worked in pairs for 6 weeks of preparatory exercises and tutorial labs before taking on an experimental design project in teams of 4. The students had to research an existing project, assemble apparatus, design procedure and analysis, compare to a model, and report their findings.

The final deliverable for the course was a reflection exercise, where students were prompted to think about their successes, failures, the process, and what they learned during the project. It is these reflections that are analyzed in this work.

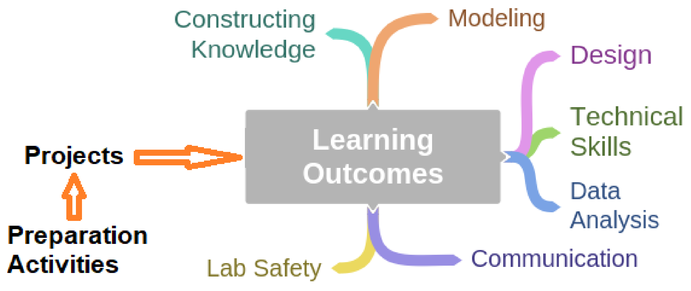

Fig. 1: We prepare students for the projects with carefully-scaffolded labs, while the projects themselves address the main learning outcomes of the laboratory course.

Guided reflection prompts given to the students are:

- At the end of your experimental project, are you happy with what your team achieved? Why or why not?
- How did your team work during the project? Could you have worked more effectively as a team?
- What did you learn over the course of the project? What technical techniques (apparatus, procedure, data analysis) did you learn – if any? What further learning could have helped the project?
- One goal of the project was to compare a prediction with a model. What did you find when doing this comparison? Did the model and/or the experiment show limitations that prevented meaningful comparison?
- If you were to do this same experiment again, what would you do differently? What worked well and should be done again? Have you changed how you would approach any new experiment?

METHODOLOGY & RESULTS

Our qualitative approach to exploring the learning experiences of students used the text-coding steps (open, axial, and selective coding) described by Corbin and Strauss[2]. These analysis steps allowed us to deduce how student reflection responses addressed our research questions. Five themes emerged from the deductive analysis and corresponded to the prompts we provided the students prior to completing the reflection assignment. These are: student project satisfaction, team dynamics, described learning, experiences with modeling, and future improvements to the project experience. Figure 2 depicts our research questions and corresponding findings. Specifically, it summarizes student reflections on each aspect of the project experience in this lab course.

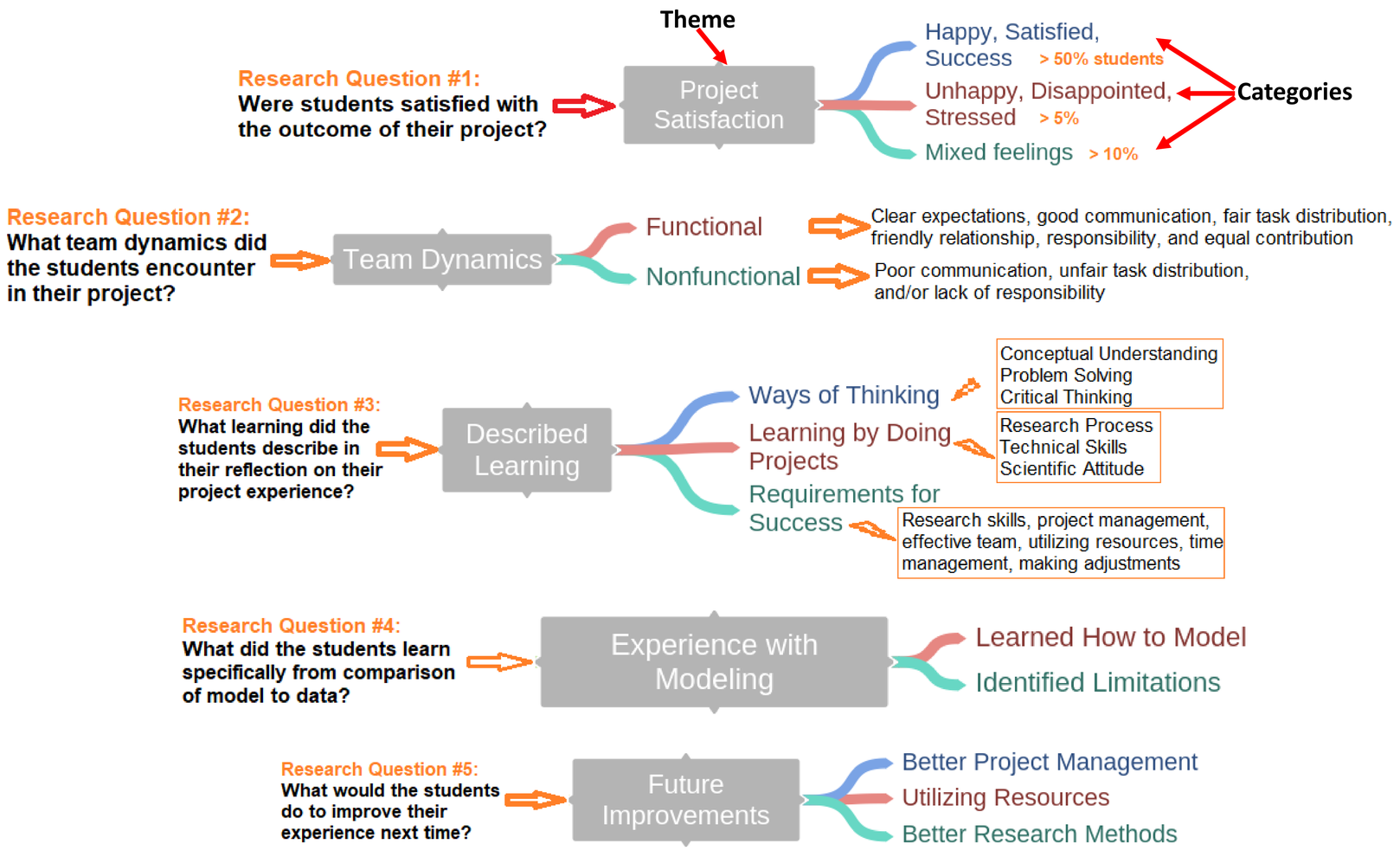

Fig. 2: This figure shows the five research questions (left) that directly informed the reflection prompts given to the students and also guided our qualitative analysis of the reflections. The five themes that emerged from the deductive analysis are shown in the grey boxes. We then summarize the ideas (categories) that came out of the final selective coding phase on the right.

CONCLUSION

We suggest that student reflections are beneficial for both student learning and guiding curriculum improvements. We also suggest that design- and project-based learning experiences are imperative to helping students achieve the learning outcomes recommended by the AAPT. This suggestion is based on our findings that most students were satisfied with their experimental project and achievements, experienced functional team dynamics, described numerous learning outcomes unique to this experience, learned some modeling skills, and were able to assess how an improved experience could better support their learning. We intend for our findings to be useful for other course redesign initiatives incorporating project-based learning and student reflections.

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Selected References:

1. AAPT Committee on Laboratories, "AAPT Recommendations for the Undergraduate Physics Laboratory Curriculum" (2014). https://www.aapt.org/Resources/upload/LabGuidlinesDocument_EBendorsed_nov10.pdf
2. J. Corbin and A. Strauss, *Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory*, Newbury Park, CA: SAGE, 4th edition (2015).
3. TRESTLE (Transforming Education, Stimulating Teaching and Learning Excellence) is an international teaching and learning network. http://trestlenetwork.org/