Beyond Flipped Classrooms: Learning Experiences in an Undergraduate Physics course

Dominic Manuel, Faculté Saint-Jean, University of Alberta
Marc de Montigny, Faculté Saint-Jean, University of Alberta
Lamyae Fahim, Teacher at Edmonton Public Schoolboard and research assistant
Martine Pellerin, Faculté Saint-Jean, University of Alberta

Students are regularly exposed to complex situations governed by our global community. It thus becomes crucial for students, not only in schools but also in post-secondary education, to grasp a thorough understanding of the complexities of our world so they can develop necessary competencies to be productive and innovative citizens by using critical thinking, and making effective decisions (Lesh & Zawojewski, 2007), especially in the Science, Technology, Engineering and Mathematics (STEM) fields since our society is becoming more dependent on technology (Lappan, 2002). This raises teachers' expectations in classrooms as they must create effective learning conditions to support students in developing such competencies that often go beyond the curriculum.

Over the past decades, STEM educators have proposed a shift from teacher-centred approaches for which teacher presented the content with lectures and students did exercises, to more student-centred approaches where students play a greater role in their learning. In student-centred approaches, students are engaged in various tasks and interact with their peers and the teacher to construct new knowledge and develop competencies (Munter et al. 2015). However, student-centred approaches remain rarely used in classrooms, likely less in post-secondary settings. We argue that this is problematic in university settings not only for students studying specific fields but also for those enrolled in the secondary teacher education program who also take these courses as well as courses in education. How can these students develop the necessary competencies to be productive employees or teachers in the future if content courses are more teacher-centred? Moreover, how can these future teachers implement student-centred approaches in their future classrooms when they are not exposed to them in their content courses? We suggest that there should be an alignment between education and content courses to better support future teachers' professional development.

Our goal is to improve the university-level teaching context in a physics course by implementing two student-centred approaches that are highly recommended in the science teaching and learning orientations (National Research Council, 1996, 2000, 2011): inquiry-based learning (IBL) and using technologies in learning, particularly flipped classrooms (FC). IBL is loosely defined as a teaching approach in which students develop knowledge and competencies by working in ways like scientists (Aulls & Shore, 2008), while FC is an approach where students learn the content from home by watching videos and then work on problems in classrooms (Lebrun & Lecoq, 2016). FC is shifting the time and space of learning activities (Lecoq & Lebrun, 2017). We suggest that combining the two approaches will not only foster deep conceptual learning but will help students in science programs to work from the start within the framework expected in their employment. For students in the secondary education program, this will permit them to experience student-centred teaching approaches as learners in content courses, which could give them a richer professional development. We believe that using these approaches in physics courses, which naturally lend themselves to these approaches, may stimulate them outside the education courses to think deeper about their future teaching practices in classrooms.

We conducted a pilot study in a first-year undergraduate Physics course (PHYSQ 124 — Particles and waves) taught by de Montigny during the semester from September-December 2021. Twelve out of the 15 students (9 in education programs) agreed to participate in this study. Throughout the semester, the research team (the authors) designed activities to be enacted in class that implemented both IBL and FC. We used Marshall et al. (2009)'s 4E x 2 IBL instructional model as well as Lebrun and Lecoq (2016)'s three types of FC as theoretical foundations to design the activities. We collected data throughout the semester: via students' responses to reflection forms via Google Form every week, and semi-structured online interviews conducted on Zoom with four participants at the end of the semester. The interviews were audio-recorded and transcribed. We analyzed the data using a thematic analysis (Braun & Clark, 2006).

Results revealed four major themes related to students' learning experiences. First, they noted that the approaches, mostly IBL, have great potential to make better sense of the content and promote opportunities to discover various resources. Second, participants mentioned that using videos better support their learning compared to in-class lectures. Third, using these approaches pushed students to take more responsibility in their learning by being more engaged and having to interact with their peers during the activities. Fourth, students mentioned that the expectations towards the videos used in the activities were not clear.

Although this pilot study focused on students' perception of their learning experiences, results seem to show some potential for combining IBL and FC in improving undergraduate students' learning experience. But, for this to happen, we acknowledge the importance of using effective teaching practices in classrooms, mostly setting clear expectations about the approaches, so students clearly know what is expected of them (Windschitl et al. 2012). An important limit to this study is that most of the content taught in this physics course were covered previously in students' high school physics course.

We plan to conduct a more thorough study on students' learning in the upcoming years by including the second first-year physics course for which the content has not been learned in high school to be able to better compare students' learning experience between content that they previously learned and new content. We also plan to include the ancillary laboratory of the physics course. Based on the results of these future studies, we hope to implement these approaches in other science courses as well as other content courses offered at the Faculty Saint-Jean.

As for theoretical foundations, our experience in this project seems to reveal that combining IBL with FC goes beyond the three types of flipped classroom proposed by Lebrun and Lecoq (2016) as we were not always able to classify our activities in one specific category. We hope to propose a teaching and learning model for including IBL and FC in classroom activities based on results of our future studies.

References

Aulls, M. W., & Shore, B. M. (2008). *Inquiry in education, Vol. 1. The conceptual foundations for research as a curricular imperative*. Lawerence Erlbaum Associates.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77-101. https://doi.org/10.1191/1478088706qp063oa

Lappan, G. (2000). A vision of learning to teach for the 21st century. *School Science and Mathematics*, *100*(6), 319-326. https://doi.org/10.1111/j.1949-8594.2000.tb17326.x

Lebrun, M., & Lecoq, J. (2016). *Classes inversées : Enseigner et apprendre à l'endroit!* Réseau Canopé.

Lecoq, J., & Lebrun, M. (2017). *La classe à l'envers pour apprendre à l'endroit : guide pratique pour débuter en classe inversée*. Louvain Learning Lab.

Lesh, R. A., & Zawojewski, J. S. (2007). Problem solving and modeling. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 763-804). Information Age Publishing.

Marshall, J. C., Horton, B., & Smart, J. (2009). 4E x 2 instructional model: Uniting three learning constructs to improve praxis in science and mathematics classrooms. *Journal of Science Teacher Education*, *20*(6), 501-516. https://doi.org/10.1007/s10972-008-9114-7

National Research Council. (1996). *National science education standards*. National Academy Press.

National Research Council. (2000). *Inquiry and the national science education standards: A guide for teaching and learning*. The National Academies Press.

National Research Council. (2011). *A framework for k-12 science standards: Practices, crosscutting concepts, and core ideas*. National Academy of the Sciences.

Windschitl, M., Thompson, J., Braaten, M., & Stroupe, D. (2012). Proposing a core set of instructional practices and tools for teachers of science. *Science Education*, *95*(5), 878-903. https://doi.org/10.1002/sce.21027