From Theory to Practice: Leveraging Didactic Engineering in STEM Classrooms

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In the STEM didactics course (LeBlanc, Lirette-Pitre, & Richard, 2023; LeBlanc & Lirette-Pitre, 2022), we planned a learning activity for 15–16-year-old New Brunswick students in the grade 9 science course for the Ecosystem Sustainability module. This project, designed to foster collaboration between students in the mathematics and science didactics courses, led us to plan a STEM activity grounded in research from our respective fields and was built on the foundations of didactic engineering (Artigue, 2002). The following is a reflection on how our experience took shape.

Preliminary analyses

In this project, we worked both individually and in pairs (one student from the mathematics education course and one student from the science education course). Together, we identified concepts that aligned with our constraints for classroom implementation. We chose the concept of wetlands, relevant to the ecosystem module (Ministère de l'Éducation et du Développement de la petite enfance, 2011). Then, individually, we carried out preliminary analyses to identify misconceptions in science, as well as errors students make or difficulties they encounter when learning certain mathematical concepts. For mathematics, the error identified was the validation of results using real data, and for science, the misconceptions concerned the influence of students' origin on the identification of wetlands. Each team member then created a network of conceptual interconnections explaining how concept learning (associated with the error or misconception) becomes more complex from grade 9 to grade 12. We demonstrated how learning progresses from concrete to abstract, from surface to depth, or from specific to general.

Design

Back in our team, we developed a STEM activity that actively engages students in their learning through hands-on manipulation of materials, reflective questioning, and data diagramming. Our activity integrated different concepts from each STEM discipline:

- Science – 1) Biology (interactions within ecosystems in a wetland area, the filtration process by plants and microorganisms, and the formation of organic matter); 2) Chemistry (chemical reactions in the natural filtration of water impurities, composition of matter, and mixtures); 3) Physics (fluid mechanics).
- Engineering – Conducting an inquiry-based process to observe the effects of different layers of organic matter on filtration and retention.
- Mathematics – Data collection (percentages of composition, volumes, measurements) and data visualization.
- Technology – Reading and recording of data collected by a PASCO soil moisture probe and iPad.

We created tools to collect data on students' errors and misconceptions. Next, we met with the classroom teacher to discuss our activity and make any necessary adjustments. We then gathered the materials: local organic matter, model-building supplies, and measuring instruments. Finally, we anticipated the behaviours and responses we expected from the students based on the environment we had created.

Experimentation

We visited a Grade 9 science classroom to conduct our bottled marsh activity, which involves creating a marsh in a bottle to study its various functions, such as water filtration and retention. The students were actively engaged and asked numerous questions. Due to external constraints that posed significant time management challenges, most of our data was collected through our objectification questions rather than our data collection tool. Each of us worked with a small group of students to gather key information, identify their difficulties, and then collaborate with them to propose solutions for overcoming these challenges.

Analysis and Evaluation

The final stage of our work involved reflecting on our experience, both pedagogically and didactically. We identified the elements that were less effective and suggested modifications to our activity. Additionally, we analyzed the difficulties related to the target concept, drawing connections between our observations and the ideas from the authors discussed in the preliminary analysis.

Thanks to didactic engineering, this project introduced us to didactic research, both theoretically and practically, while also establishing connections with other STEM disciplines. This presentation focuses on the training process we underwent in our STEM didactics course, highlighting the professional and personal lessons we gained. Based on our experience, we will suggest ways to integrate this type of practice in other initial didactics training contexts.

Type of presentation: in person

Type of communication: practical examples of interdisciplinary teaching and learning

References

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