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A Case Study on the Pedagogical Alignment between Science and Makerspace Teachers

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Abstract: Using a case study methodology, this paper presents strategies to foster pedagogical alignments between science teachers and makerspace teachers, including ensuring time to plan and reflect on the results together, defining the role of each teacher both in the planning process as in the classroom, and discussing students' learnings to reflect on opportunities for improvement in future implementations.

Introduction

This paper comes from a very particular place of positionality, emancipation, and inclusion. The first author is a POC middle-school teacher in one of the poorest regions of Brazil, who decided to research his own practice, interview peers (the science teacher), and break the traditional roles and boundaries assigned to teachers in Brazil. This work, thus, is an attempt to systematize rich pedagogical practices in a public school, in which the teacher himself is both the researcher and the one implementing the project.

The recent integration of makerspaces in educational environments draws on constructionist theories, which propose that students build their knowledge better while creating and interacting with physical or technological resources (Papert & Harel, 1991). In the context of Brazil, learning in makerspaces is still little explored and lacks implementation strategies suited to the context of public schools, in which one big challenge is teachers' lack of time for planning and preparing materials (Fernandez et al., 2020). As part of a project to reformulate science teaching in a public network in Brazil that includes the implementation of makerspaces, we propose the establishment of the figure of the "makerspace teacher" (here also called lab teacher), as a viable way for makerspace integration. As research shows, in schoolwide reform initiatives, not only time and material resources are needed to promote instructional change but, more importantly, access to the expertise of others (Penuel et al., 2006). Thus, this new full-time teacher has the technical and pedagogical expertise to assist other teachers in planning and implementing curricular units using makerspaces' resources. However, a sustainable model of collaboration between these teachers is not always easy to achieve. Through a case study, this research seeks to discuss which strategies can be deployed to ensure an adequate pedagogical alignment between the lab teacher and science teachers, increasing their ability to integrate making in classrooms.

Methods

Data were collected over three years with a science teacher and a lab teacher (first author) from a public school in Brazil, and include planning and reflection documents upon curricular units, interviews and classroom observations. Curricular units were applied throughout three cycles of implementation and refinement through the design-based research approach (Barab & Squire, 2004), in which researchers and teachers co-designed lesson plans that gradually integrated resources from the makerspaces into science classes and reflected together about points for improvements. Data were transcribed and coded into dimensions of challenges and solutions, to identify and systematize strategies aimed at ensuring greater alignment between teachers in the planning, implementation, and reflection phases of their designed units.

Findings

In the beginning of the collaboration process, there was no adequate alignment between the lab teachers and science teachers, which led to issues during classroom implementations. Based on the results of each implementation cycle, teachers worked to refine their collaboration strategies to ensure greater alignment between them and, consequently, better learning outcomes for the students. Below, we present the main strategies developed by the teachers, divided into three stages: *planning*, *implementation,* and *reflection*.

Stage 1. Planning

In the beginning of the collaboration process, the lab teacher and the science teacher faced a lack of alignment in the implementation of their co-designed unit. In the first cycle, the design of the lesson plan was led by the lab

teacher, and the science teacher only validated it with no deep understanding of the strategies adopted. They also did not plan how they would share responsibilities in the classroom - thus, role conflicts arose between them in the classroom, as this science teacher says: *"There were moments in the unit when the roles got confused"*. According to the lab teacher, *"There must be a good alignment before implementation. If that doesn't happen, the unit ends up not being very effective."* To overcome this issue, throughout the subsequent cycles teachers started to hold several meetings before implementing the unit. In our model, around four 50-minute meetings are held between the lab teacher and the science teacher before the implementation of a given unit, organized in six phases: (1) Meeting #1: teachers meet to select the theme of the curricular unit, the number of classes, and the "big ideas" that will guide its development; (2) the lab teacher searches for resources that can be used during classes, related to the big ideas defined in the first phase; (3) Meeting #2: the resources found are presented to the science teacher, and learning goals are also jointly defined; (4) the lab teacher produces materials and toolkits for the unit; (5) Meeting #3, the resources produced are presented to the science teacher, and formative assessment worksheets are produced; (6) Meeting #4: A test run of the unit implementation is conducted.

Stage 2. Implementation

Our data suggest that the roles each teacher plays during the implementation phase must be well defined in advance. One of the strategies adopted to guarantee this alignment is that the science teacher work is more geared towards the pedagogical orchestration and coordination of the class, while the lab teacher, who produced the resources and toolkits, helps students and the teacher with technical knowledge. However, the lab teacher is also free and invited to make pedagogical interventions during the class, as needed.

Stage 3. Reflection

After the implementation of the curricular units, the lab teacher carries out a detailed analysis of the formative assessment worksheets filled out by students and prepares a report that is presented to the science teacher and to the school coordinators. Teachers can then use the results to redesign the unit for future applications.

As a result of the deployment of such strategies, according to the science teacher, the meeting sessions were more productive, there was a greater diversification of the activities implemented in classrooms, and students' participation and learning were improved: *"We can notice this difference during the classes (participation, commitment, attention), and also afterward when we analyze students' worksheets and the level of knowledge that they achieved."* In addition, the science teacher reported that the results shared by the lab teacher helped her to better "*evaluate herself as a professional*".

Conclusions and implications

Our findings indicate that greater alignment between science and lab teachers guarantees better results with optimization of planning time and students' learning. The strategies developed to ensure this alignment include: ensuring joint times for planning and reflecting on the results, defining the role of each teacher when planning and implementing the curricular units, and discussing the results of each unit implementation as a way to improve the outcomes of future implementations. As new makerspaces are being introduced in schools, such strategies can contribute to help teachers to develop sustainable models of collaboration and to refine their classroom practices.

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