Tinkering in the primary school: from episode to science practice

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Abstract. This study examines the integration of tinkering, a constructivist practice, into formal education, highlighting its potential and challenges. Through the "Officina degli Errori", researchers and educators sought to blend tinkering's open exploratory nature with structured learning in primary school classrooms, focusing on Physics Education. Despite pandemic-induced limitations, feedback from 20 teachers and analysis of fishbowl protocols revealed tinkering's positive impact on classroom dynamics, teacher engagement, and student inclusion. However, teachers are often uneasy conducting scientific research with their students. These findings will guide our future co-designs to enhance learning experiences and address the complexities of incorporating tinkering into formal education.

Tinkering: a constructionist practice in primary schools

Tinkering, a constructivist practice traditionally rooted in informal settings is gradually finding its way into formal educational environments, albeit with specific challenges [1, 2, 3, 4]. One of the most significant and complex issues is that tinkering lacks predefined disciplinary objectives [2, 5]. Within the structured context of schools, this characteristic poses the risk of either distorting the essence of tinkering by confining it within specific disciplines or treating it as an isolated experience—a singularly engaging yet ultimately self-contained event that stands apart from the broader educational journey. In our decade-long collaboration with educators, we have observed that the value of tinkering as a knowledge-construction practice extends beyond its benefits for students. Tinkering, and more importantly, the facilitation techniques associated with it, can profoundly transform educators' classroom dynamics. This practice enhances teachers' ability to perceive and engage with students' inquiries, mitigating the challenge of maintaining an open-ended dialogue aimed at co-constructing answers. Moreover, it fosters a greater receptivity to bottom-up learning approaches, which are generally less prevalent in formal educational settings [6, 7].

Tinkering, therefore, not only enriches students' learning experiences by fostering creativity, critical thinking, and problem-solving skills but also serves as a valuable professional development tool for teachers. By integrating tinkering into the classroom, educators can cultivate a more dynamic, responsive, and inclusive learning environment that accommodates diverse learning styles and encourages a deeper, more collaborative exploration of knowledge. However, to fully harness the potential of tinkering in education, it is imperative to address the challenges mentioned above by developing strategies that seamlessly integrate tinkering into the curriculum without compromising its open-ended, exploratory nature.

Our collaborative team, comprising researchers and educators, endeavoured to conceptualize an educational pathway that synergizes tinkering workshops with the methodologies commonly employed in school contexts, from hands-on experiments to books, textbooks, and audiovisual resources. The aim was to craft a learning journey favourable to the collective knowledge construction by the classroom community. This initiative led to the "Officina degli Errori - workshop of mistakes" that draws inspiration also from the perspective of pedagogical activism and its view of the teacher's role [8].

Those Officinae are designed to integrate the spontaneous, exploratory essence of tinkering with a more structured approach. We decided to develop our first more structured experimentation focusing on Physics Education, mainly to work on the broad theme of light, colour and vision.

In this contribution, we describe an experimental project from September 2022 that involved 13 primary school classrooms and 24 teachers in Bologna. The original design, including tinkering, supplemental materials, and documentation protocols, had to be revised because of the pandemic, so we can only partially answer our initial research question. Still, we can draw some conclusions to help design the next steps. We examined a questionnaire completed by 20 teachers in the program, focusing on their thoughts about tinkering in the school environment regarding pupils' engagement and access to science depending on their attitude toward school learning. We also analyzed a recorded fishbowl protocol focusing on teachers' attitudes regarding science teaching and their possible uneasiness in accepting and relaunching scientific questions when they do not feel prepared enough. Embracing children's questions means opening an investigation and accepting a temporary inadequacy. We also see an essential feature brought by the documentation protocol we implemented. Shared documentation among teachers has made the issues they were facing visible.

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