THE THEORY OF DIDACTICAL SITUATIONS AND ARTIFICIAL INTELLIGENCE: A FIRST STUDY

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Abstract – We explore AI-powered chatbots as milieux in didactical situations, focusing on formulation and validation in TDS. We raise questions and perspectives for future research on the structuring of the milieu to better understand their role in learning environments.
Keywords: AI, Chatbot, TDS, Milieu
Résumé – Nous explorons les chatbots IA comme milieux en situations didactiques, en nous concentrant sur la formulation et la validation dans la TSD. Nous soulevons des questions et perspectives pour des travaux futurs sur *la structuration des milieux* afin de mieux comprendre leur rôle dans les environnements d'apprentissage.
Mots-clés : IA, Chatbot, TSD, Milieu

KEY ELEMENTS

The emergence of chatbots has led to their spontaneous and often unstructured use in classrooms, raising questions about their integration in mathematics education. Since we neither know nor can generally intervene in how they produce their responses, which are moreover not guaranteed to be valid, chatbots are often referred to as black boxes (Emprin & Richard, 2023). Their unpredictability is likely to create unexpected situations when used in the classroom, requiring teachers to make micro-decisions (Comiti et al., 2009). Our initial study (Nieddu et al., 2024) also noted that chatbots appear to adapt to the context and user's requests, showing a dynamic similar to a didactical contract between the user and the chatbot. Finally, they are not specifically designed for mathematical or educational purposes.

AI AND STRUCTURING OF THE MILIEU

According to Brousseau's TSD, a didactical situation should include elements that constitute an adidactical *milieu*, devoid of didactical intentions, which acts as an antagonist to the students, modifying their knowledge in ways beyond their direct control. The interaction with the milieu can trigger, through a process of devolution, a situation that is perceived as adidactical by the student. We ask whether an AI-powered chatbot, not specifically designed for education or mathematics and inherently unpredictable, could serve as (part of) an adidactical *milieu* in a didactical situation. In a pilot experiment with undergraduate students, we observed students' deep engagement in dialogue with a chatbot, which we analyzed employing the *analyse ascendante a posteriori* as described by Comiti and colleagues (1995). The interaction with the chatbot seemed to have triggered sequences of unfinalised questions by students as their first, natural reaction, as a devolution of the problem to the chatbot, that we identified as S_{-3} phases. When students regained ownership, reflecting critically on the chatbot's responses, the

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devolution was restored (in this case without teacher's intervention), and formulation processes at S_{-2} level followed. Formulation, which requires students to articulate their actions through interaction with a *milieu* that provides feedback, is defined by Brousseau as the exchange of information coded into a language (Brousseau, 2002). We observed in the students' groups rapid and repeated shifts between the phases S_{-3} and S_{-2} described above, and therefore defined this alternation as a double devolution dialectic, in which responsibility shifts at different moments from the chatbot to the student—who reclaims it—and vice versa. To fully control these processes, teachers need to establish macro-decisions during *a priori* curriculum design (*analyse descendante*), while also making micro-decisions to restore devolution in real time.

FUTURE PERSPECTIVES

An adidactical situation needs a validation (at least empirical) *milieu*, which shows whether the goal has been achieved, without teacher intervention; since we noticed, in our pilot experiment, that students tried to use the chatbot as a milieu for validation, while at the same time not fully trusting its answers—leading to frustration and moments of impasse—we believe it is important to explore the use of chatbots in combination with a dedicated (empirical) validation tool and to address other settings relevant to classroom activity design. We also intend to explore double devolution dialectics; we believe that changes in how devolution is activated will lead teachers to make different kinds of demands on students, with significant implications for the didactical contract. The growing presence of chatbots in schools requires teachers and researchers' reflection on macro-decisions in curriculum planning for the emerging AI era.

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