UNDERSTANDING STUDENT AGENCY IN MATHEMATICS: A CRITICAL DIALOGUE BETWEEN EDUCATIONAL PSYCHOLOGY AND MATHEMATICS EDUCATION

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Student agency has become a central construct in contemporary educational research, yet its meaning and operationalization remain fragmented, particularly in mathematics. This theoretical essay analyses how student agency in mathematics is conceptualized and investigated within educational psychology and mathematics education. Through a dialogic analysis, we highlight convergences and tensions between psychosocial and disciplinary perspectives, with particular attention to proactivity, resistance, authority, and epistemic norms. We propose an integration of the two perspectives, arguing that this can guide a more comprehensive definition of student agency in mathematics and inform the development of methodological tools sensitive to the specificities of mathematical teaching and learning.

INTRODUCTION

Education plays a fundamental role in helping students develop the skills needed to navigate an increasingly vulnerable, uncertain, complex, and ambiguous world (Taguma et al., 2023). With the aim of supporting the development of education systems that empower students to actively shape their learning and engage as informed and responsible agents in society, the OECD developed the Learning Compass 2030. The role of students' agency in the Learning Compass is crucial as it is supported by the metaphor of the compass itself which underlines the "need for students to learn to navigate by themselves through unfamiliar contexts and find their direction in a meaningful and responsible way, instead of simply receiving fixed instructions or directions from their teachers" (Taguma et al., 2023, p.489).

In mathematics classrooms - where teaching and learning are often organized according to traditional structures in which teachers retain authority over the transmission of knowledge and students are positioned as largely passive recipients - the notion of student agency becomes crucial (Boaler, 2002; Brown, 2020). Fostering student agency in mathematics is essential for the development of mathematical competencies: when instructional practices move beyond transmissive approaches based on the application of pre-explained procedures and algorithms, and learners are supported in seeing themselves as capable problem solvers (Boaler, 2002; Woods & Salem, 2024) students are better equipped for lifelong learning and ongoing development beyond formal schooling (Leijen et al., 2024).

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In recent years, students' agency has gained increasing attention in both mathematics education and educational psychology. Although these fields draw on different theoretical traditions, their perspectives are potentially complementary and could jointly inform teaching practices and educational change. However, there is still no shared definition of student agency and there's a lack of clarity in the operationalization of this concept, particularly with respect to students' agency in mathematics (Taguma et al., 2023). The concept is framed and investigated in diverse ways across the two fields, sometimes even introduced as a colloquial word rather than a scholarly concept (Nieminen & Hilppo, 2020) resulting in conceptual fragmentation and raising critical questions about how agency is understood and fostered in mathematics classrooms. This paper aims to critically examine how students' agency in mathematics is conceptualized and investigated within educational psychology and mathematics education, with the goal of offering a comprehensive perspective and proposing an integrated approach that can ground future collaborative research across the two fields. Thus our research question is: What theoretical and epistemological tensions emerge in the ways student agency in mathematics is conceptualized and investigated in educational psychology and mathematics education, and what are their implications for research and practice?

STUDENT AGENCY IN EDUCATIONAL PSYCHOLOGY

In broad sense, agency is defined as an individual capacity to intentionally influence their social environment and its power relations through autonomous decision-making (Etelapelto et al., 2013). In the school context the construct of student agency has been extensively examined and recently, Bae et al. (2025) proposed a synthesis of the three major, complementary approaches to the study of this construct. The sociocultural perspective views agency as relational and situated within social interactions and activity systems. The critical approach emphasizes students' capacity to challenge and transform power relations and inequities in educational contexts. The psychosocial perspective focuses on individual intentionality, motivation, and proactive behaviors in classroom practices. Integrating these different perspectives, student agency is thus considered as a dynamic interplay between individual, relational, and structural dimensions. It is often operationalized starting from the psychosocial perspective considering students' "agentic engagement" and thus considering actions undertaken to modify and improve the learning environment. Student agency is thus intended as a form of engagement different from behavioral, cognitive, and emotional engagement (Reeve & Jang, 2022) due to three traits: it is *proactive*, as students intentionally shape their learning environment; *reciprocal*, as it unfolds through interaction with teachers who may *accept*, *negotiate*, or *reject* student-initiated contributions; and *constructive*, as it is oriented toward improving learning conditions. While much quantitative research operationalizes agentic engagement as students' *actions aligned* with teachers' instructional purposes (desirable forms of agentic behavior, e.g. expressing views and needs, seeking guidance, and contributing ideas), qualitative studies indicate that students may enact agency also by challenging teachers' purposes, thus proposing

resistant actions, representing not-aligned yet constructive forms of agency (Mameli et al. 2023). Teachers may then accept, negotiate, or reject such contributions, thereby enabling or constraining students' opportunities to transform the learning environment.

Importantly, different methods tend to foreground different aspects of agency: while some quantitative questionnaires have been designed to account for both aligned and resistant forms of agency (Mameli & Passini, 2019), self-report and interview-based studies often primarily access students' *agentic experiences* rather than agency as enacted in practice. Different methods do not merely capture different facets of the same construct but enact different understandings of agency, often privileging either enacted agency or students' sense of agency (Nieminen & Hilppö, 2020).

Student agency in mathematics from an educational psychology perspective

Literature on student agency has addressed it at a general level of school experience but there are several studies grounded in the educational psychology perspective focusing the construct in the specific field of mathematics. In this context, psychological approaches typically adapt existing models and measurement tools while retaining their original assumptions. Several studies investigate student agency in mathematics by revising scales originally developed to measure agency across school subjects. For instance, the longitudinal study by Grazia et al. (2025), based on an adaptation of Mameli and Passini (2019) scale and focused on student agency as an individual perceived capacity consistently with the psychosocial approach, shows a decrease of student agency in mathematics during the first year of lower secondary school, with a steeper decline for females and no significant effect of personality traits.

Drawing on an ecological model of agency, Leijen et al. (2024) propose a domain-specific scale and conceptualizes student agency in mathematics through three interrelated dimensions: *iterational*, *projective*, and *practical-evaluative*. This framework highlights the role of students' past experiences with mathematics, their future-oriented goals, and features of the immediate learning environment in shaping agency. Empirical evidence further indicates that teachers' beliefs play a central role: teachers' self-efficacy and constructivist views of mathematics are positively associated with multiple dimensions of student agency, whereas viewing mathematics as a static discipline is negatively related to students' agency (Leijen et al. 2024). Despite their focus on mathematics, these studies largely conceptualize agency as a psychosocial construct, emphasizing students' intentions, perceptions, and proactive engagement within instructional contexts. As a result, agency in mathematics is primarily framed in terms of students' alignment/resistance with pedagogical practices and learning goals, while less attention is paid to the epistemic specificity of mathematical activity and to how disciplinary norms and authority structures shape what forms of agency become possible or legitimate.

STUDENT AGENCY IN MATHEMATICS EDUCATION

In contrast to educational psychology, research in mathematics education approaches student agency as a phenomenon that is inherently tied to the epistemic nature of mathematics, mathematics classroom norms, and the distribution of authority over mathematical knowledge rather than as an individual trait or disposition. Early influential work by Boaler and Greeno (2000) conceptualized agency in mathematics classrooms in close relation to identity, authority, and forms of participation. In traditional instructional settings, where mathematical knowledge is presented as fixed and external to learners, students' participation is largely regulated by textbooks, procedures, and teacher demonstrations. In these instructional settings, students' inventiveness, interpretative activity, and decision-making are rarely recognized as legitimate, resulting in limited opportunities for agency. In contrast, discussion-oriented and reform-based classrooms redistribute epistemic authority and invite students to participate in meaning-making processes. Here, students are expected to propose conjectures, justify strategies, critique peers' ideas, and contribute to decisions about the direction of mathematical work. This shift entails not merely a change in instructional techniques but a reconfiguration of what it means to know and do mathematics. As Boaler (2002) argues, classroom practices shape qualitatively different forms of mathematical knowing and learner identities also in relation to mathematics as a discipline. A key theoretical contribution which draws most of mathematics education literature is the notion of the "dance of agency" of mathematicians (Pickering, 1995). This metaphor captures the dynamic interplay between human/conceptual agency and disciplinary agency. Disciplinary agency refers to the constraints and affordances imposed by established mathematical structures, conventions, and procedures, while conceptual agency involves decision-making and interpretation. In traditional classrooms, disciplinary agency dominates, positioning students as passive followers of prescribed methods. In reform-oriented classrooms, students are gradually inducted into the dance, learning when to rely on established procedures and when to exercise conceptual agency by constructing meanings, bridging ideas, and filling gaps in understanding.

Subsequent research has further elaborated the relationship between agency and authority in mathematics classrooms. Drawing on sociocultural perspectives, Gresalfi et al. (2009) conceptualize agency as "the way in which he or she acts, or refrains from acting, and the way in which her or his action contributes to the joint action of the group in which he or she is participating" (p. 53). It thus emerges from participation in classroom and group activity, emphasizing that students do not "have" or "lack" agency but enact it differently depending on contextual conditions. Central among these conditions is the distribution of authority: who is entitled to interpret tasks, evaluate the reasonableness and legitimacy of solutions, and determine what counts as legitimate mathematical knowledge. When authority is centralized in the teacher or in expert peers, students' agency may be constrained to disciplinary compliance. When authority is shared or revised, students are afforded greater opportunities to exercise

conceptual agency. This line of inquiry has been particularly productive in studies of collaborative problem solving and mathematical argumentation and the study of language used allows an indirect analysis of students agency (Wagner, 2004). Research by Mueller et al. (2012) analyzes how agency is constructed through discourse during group work: agency is enacted not only through proposing ideas but also through interpreting, modifying, or integrating others' contributions. These studies highlight that agency is not uniformly distributed within groups and may be shaped by affective factors, prior experiences, cultural backgrounds, and beliefs about mathematics and call for future research that examines the interplay between individual variables and the ways in which students enact agency within collaborative mathematical activity.

More recent work has extended these insights by examining how open-ended and real-life tasks afford diverse forms of student agency in collaborative mathematical activity. However, this line of research also reveals a lack of consensus regarding what should count as agency in mathematics classrooms, particularly with respect to resistant or non-aligned forms of participation. While some scholars in mathematics education explicitly conceptualize agency as a situationally constructed phenomenon that includes resistance and opposition to teachers' and peers' contributions (Nieminen et al., 2022), other studies implicitly retain a normative view of agency as necessarily aligned with epistemic or instructional goals. As a result, agency is variously framed in the mathematics education field as participation, voice, authority, or discursive positioning, without converging toward a shared definition.

Methodologically, research on student agency in mathematics education has been dominated by qualitative and discourse-analytic approaches, which have been crucial for revealing the situated and interactional nature of agency but offer limited leverage for systematically examining how individual variables - such as affect, cultural background, self-confidence, or beliefs about oneself as a mathematics learner - interact with classroom practices. Consequently, despite explicit calls for research agendas addressing the interplay between individual and social dimensions of agency (Mueller et al., 2012), existing methodological approaches often remain insufficient to fully address this challenge, and the body of mathematics education research explicitly focused on student agency remains relatively limited.

TOWARD A DIALOGIC UNDERSTANDING OF STUDENT AGENCY IN MATHEMATICS

A productive starting point for a dialogue between educational psychology and mathematics education is the definition of agency proposed by Reeve and Jang (2022), which foregrounds three core features of agency proactivity, reciprocity, and constructiveness, that highlight key theoretical tensions in how student agency in mathematics has been conceptualized across the two fields. The *reciprocal nature of agency*, emphasized in Reeve and Jang work, opens conceptual space for both *aligned and resistant actions*. However, in both educational psychology and mathematics education, empirical studies differ in whether they explicitly recognize resistant forms

of agency. Some approaches operationalize agency primarily as students' proactive alignment with instructional goals, whereas others include actions that challenge or negotiate those goals. Importantly, the requirement that agency be constructive does not imply conformity: research in educational psychology shows that resistant actions may be *constructive* when they aim to improve learning conditions. The *proactive* dimension of agency is particularly emphasized in educational psychology, where agency is often examined through students' intentional contributions in interaction with teachers. Teachers are thus positioned as central mediators who can accept, negotiate, or reject students' agentic initiatives. Mathematics education research similarly highlights the importance of *teachers' role*, but it extends the focus to students' *interactions with peers* in collaborative activities and, crucially, to *interactions with mathematics* as a discipline. This disciplinary dimension is captured by the metaphor of the "dance of agency" introduced by Pickering (1995), widely adopted in mathematics education. From this perspective, agency emerges through the dynamic interplay between students' conceptual decisions and the constraints and affordances of mathematical structures, procedures, and norms. Agency in mathematics therefore involves learning when to rely on established conventions and when to exercise interpretative freedom.

Furthermore, while the three dimensions of student mathematical agency proposed by Leijen (2024) offer a valuable psychological framework, their potential becomes particularly evident when they are reinterpreted through the epistemic and didactical specificities of mathematics education. The *iterational dimension*, referring to students' past experiences, aligns with mathematics education research on beliefs about mathematics, views of mathematical knowledge, and participation trajectories. Students' histories of success, failure, or exclusion in mathematics shape what forms of agency they perceive as available or legitimate. The *projective dimension*, oriented toward future goals, resonates with the well-documented role of mathematics as a gatekeeper subject shaping educational and professional aspirations. Finally, the *practical-evaluative dimension*, which concerns features of the immediate learning environment, connects directly to didactical practices specific to mathematics classrooms. Research contrasting reform-oriented and traditional approaches (Boaler, 2002) shows how didactical practices in mathematics shape students' possibilities for agency. To better understand student agency in mathematics, it is crucial to complement psychological perspectives with constructs that foreground the epistemic and normative dimensions of mathematical activity. In mathematics education, the *distribution of epistemic authority* has been extensively examined in relation to student agency, as it concerns who is entitled to propose and evaluate mathematical ideas within classroom activity. Closely related to authority are, for instance, *socio-mathematical norms* (Yackel & Cobb, 1996), that is, classroom norms specific to mathematical activity. These norms shape students' opportunities to participate in mathematical meaning-making and thus directly condition the forms of agency that can be enacted.

The multifaceted nature of student agency calls for research approaches sensitive to its multiple dimensions. While studies may use questionnaires or observations focusing on teachers or students, they should capture the full range of agentic expressions. Conceptualizing agency as an individual trait allows investigation of its relationships with variables such as gender, achievement, or metacognition, whereas resistant forms of agency and its link to authority are better examined through qualitative and discourse-analytic methods. Together, these insights highlight the need for integrative designs that account for both individual and situated dimensions of student agency in mathematics.

CONCLUSIONS

This dialogic integration highlights the necessity of developing a new definition of student agency in mathematics that accounts for the individual, relational, and disciplinary dimensions emphasized across educational psychology and mathematics education. Such an integrated perspective may overcome conceptual fragmentation and better capture the specificity of mathematical teaching and learning processes. Moreover, it opens promising avenues for the development of new methodological tools, including quantitative scales grounded in the epistemic, didactical, and socio-mathematical characteristics of mathematics classrooms, capable of capturing both aligned and resistant forms of agency. A promising direction for future research is the design of a quantitative instrument based on mathematics-specific classroom situations identified in the literature, which could exemplify diverse forms of student agentic behavior in relation to the discipline, thereby providing a tool that is both psychometrically robust and sensitive to the realities of mathematics learning.

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