




# Operationalizing engaged learning in secondary mathematics through Amplify Activity Builder: A systematic literature review

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## ABSTRACT

This paper reports on a systematic literature review on how the Amplify Activity Builder supports engaged learning in secondary mathematics classrooms. Student engagement is important for effective mathematics learning, yet many teachers struggle to sustain students' thinking, participation, and motivation. Amplify Activity Builder is an interactive digital platform that enables teachers to design step-by-step lessons in which students explore mathematical ideas, respond to prompts, and receive feedback, while teachers monitor progress in real time. Guided by PRISMA 2020, the review synthesizes findings from 23 studies. The analysis examines how the platform features support cognitive, emotional, and behavioral engagement. The review was guided by two research questions: how is the Amplify Activity Builder used to support cognitive, emotional, and behavioral engagement in secondary mathematics classrooms? and which platform features are most consistently associated with engaged mathematics learning? Studies published between 2015 and 2025 were identified through searches in ERIC, ScienceDirect, and SpringerLink. The findings show that interactive representations, sequenced questioning, real-time feedback, and teacher guidance promote active reasoning, sustained attention, and meaningful participation. These findings suggest that activity-building platforms can support engagement-focused mathematics instruction when used with intentional lesson design and responsive teaching. The review offers practical guidance for teachers and researchers on using digital activity builders to support engagement-focused mathematics instruction.

**Keywords:** Amplify Activity Builder, behavioral engagement, cognitive engagement, digital mathematics learning, emotional engagement, student engagement

## INTRODUCTION

Engaged learning is widely seen as essential in secondary mathematics classrooms, particularly because many students struggle to connect mathematical ideas to meaningful contexts or to understand abstract concepts clearly (Gómez-Chacón et al., 2024; Ní Shé et al., 2023). Student engagement refers broadly to “the attention, interest, and persistence of students in their work” (Hill & Uribe-Florez, 2020, p. 7). Research by Fredricks et al. (2004) shows that student engagement is multidimensional, involving cognitive effort, emotional involvement, and behavioral participation.

Studies report that higher levels of engagement are associated with improved mathematical understanding, persistence, and long-term interest in mathematics (Ní Shé et al., 2023). Despite this evidence, disengagement remains a persistent challenge in secondary mathematics education. Students frequently report low motivation and difficulty sustaining attention during lessons that emphasize step-by-step procedures with limited opportunities for exploration or interaction (Hill & Uribe-Florez, 2020; Madden, 2018). Even in classrooms where digital technologies are available, their presence does not automatically lead to improved engagement. The impact of technology depends on how it is integrated into lesson design and classroom practice (Hoyle, 2018; Trgalová & Tabach, 2023).

The COVID-19 period increased the use of digital tools in mathematics education and attention to online and classroom-based instruction (DeGilio, 2022; Dy, 2024; Russell & Potratz, 2023). This shift showed that teachers need digital lessons that keep students engaged through interaction, feedback, and guidance, not only through task completion (Davis & Witt, 2022; Liu & Buchbinder, 2024; Trouche & Drijvers, 2014).

Within this context, the Amplify Activity Builder, formerly known as Desmos Activity Builder, has gained attention in secondary mathematics education as a platform for designing interactive, teacher-guided learning sequences. The platform enables teachers to structure lessons that incorporate dynamic representations, sequenced prompts, and opportunities for students to explain

their thinking, while allowing them to monitor responses in real time and adjust instruction as needed (Bulakh & Coombs, 2020; Chorney, 2022; Danielson & Meyer, 2016). Research suggests that these features support active participation and conceptual understanding when intentionally used in classroom instruction (Fye & Fletcher, 2024; Kristanto, 2019).

Although individual studies have examined the use of activity builder in mathematics classrooms, there remains a need for a systematic synthesis of how its features contribute to different dimensions of student engagement in secondary mathematics. This paper addresses that gap through a PRISMA-guided systematic literature review (SLR). The review examines how Amplify Activity Builder features align with cognitive, emotional, and behavioral engagement, and how these features are used to inform lesson planning, classroom implementation, and teacher reflection. The aim is to provide guidance, based on research, for secondary mathematics teachers seeking to use digital activity builders to support engaged and student-centered learning.

This review advances beyond existing engagement and technology syntheses by focusing specifically on how Amplify Activity Builder features are operationalized to support cognitive, emotional, and behavioral engagement in secondary mathematics classrooms (Fredricks et al., 2004; Hoyles, 2018; Trgalová & Tabach, 2023). By bringing studies together, the review gives clearer guidance on how interactive tasks, real-time feedback, and teacher support help promote engaged mathematics learning (Chorney, 2022; Danielson & Meyer, 2016).

## Problem Statement

The Amplify Activity Builder provides a range of interactive features that support lesson design and real-time teacher decision-making, including dynamic representations, live student responses, and formative assessment tools (Bourassa, 2015; Bulakh & Coombs, 2020). Studies indicate that these features can encourage student reasoning and participation when used intentionally (Dani & Ashok, 2025; Kristanto, 2019; Russell & Potratz, 2023). However, the existing literature remains fragmented, with studies often examining individual features or isolated classroom implementations rather than offering a clear overall picture of engagement-focused use. Also, despite the increasing use of the Amplify Activity Builder in secondary mathematics lessons, its potential to support student engagement is not always fully appreciated. Research indicates that many mathematics teachers use ready-made activities without adapting the task design to align with learning goals and student needs (Chorney, 2022; DeGilio, 2022). As a result, classroom use of the platform may focus on task completion rather than deeper engagement with mathematical ideas. Consequently, there is limited clear guidance on how features of the Amplify Activity Builder are used to support cognitive, emotional, and behavioral engagement in high school mathematics lessons. If this gap is not addressed, teachers may continue to use the platform in fragmented or surface-level ways, which limits its capacity to support sustained engagement and meaningful learning. This gap highlights the need for a systematic review that brings together existing research to clarify how engagement is put into practice through the design and classroom use of the Amplify Activity Builder in secondary mathematics education.

## Purpose of the Study

The purpose of this paper is to clarify how teachers can use Amplify Activity Builder to design lessons that promote active thinking, meaningful participation, and positive learning experiences in mathematics. By consolidating findings across studies, this paper intends to provide insight into how engagement-focused lesson design is enacted through Amplify Activity Builder. In line with this purpose, the study seeks to answer the following research questions:

- How is the Amplify Activity Builder used to support cognitive, emotional, and behavioural engagement in secondary mathematics classrooms?
- Which features of the Amplify Activity Builder are most consistently associated with engaged mathematics learning in secondary mathematics education?

## LITERATURE REVIEW

This section reviews the literature on student engagement in secondary mathematics and the use of the Amplify Activity Builder in classroom instruction. It outlines key dimensions of student engagement defined in mathematics education research and examines how features of the Amplify Activity Builder are reported in studies to support engagement in secondary mathematics lessons.

### Dimensions of Student Engagement in Secondary Mathematics

Student engagement is widely recognized as central to effective learning in secondary mathematics (Fredricks et al., 2004; Ní Shé et al., 2023). Engagement is commonly understood as comprising cognitive, emotional, and behavioral dimensions that operate together to shape how students interact with mathematical content and classroom activities (Fredricks et al., 2004). As Fredricks et al. (2004) maintain:

*Behavioral engagement* draws on the idea of participation; it includes involvement in academic and social or extracurricular activities. *Emotional engagement* encompasses positive and negative reactions to teachers, classmates, academics, and school, and is presumed to create ties to an institution and influence willingness to do the work. Finally, *cognitive engagement* draws on the idea of investment; it incorporates thoughtfulness and willingness to exert the effort necessary to comprehend complex ideas and master difficult skills (p. 60).

**Table 1.** Amplify Activity Builder features associated with student engagement in secondary mathematics

<b>Amplify Activity Builder feature</b>	<b>Description</b>	<b>Engagement dimension supported</b>
Dynamic representations	Interactive graphs, sliders, and manipulatives that allow students to explore mathematical relationships	Cognitive
Card sorts	Tasks where students classify, match, or order representations and statements	Cognitive/behavioral
Open-ended responses	Written explanations that allow students to explain reasoning in their own words	Cognitive/emotional
Real-time feedback	Live teacher dashboard showing student responses during lessons	Behavioral/emotional
Teacher pacing controls	Screen sequencing and control of lesson flow by the teacher	Cognitive/behavioral

These dimensions provide a useful lens for examining how instructional approaches support meaningful learning rather than surface participation. Cognitive engagement refers to the extent to which students invest effort in understanding mathematical ideas, applying strategies, and making sense of representations and relationships (Davis & Witt, 2022; Madden, 2018). In secondary mathematics, this includes analyzing patterns, comparing multiple representations, and explaining reasoning. Learning environments that encourage exploration and sense-making are associated with stronger problem-solving and a deeper understanding of mathematical ideas (Hoyles, 2018; Trgalová & Tabach, 2023).

Emotional engagement relates to students' interest, enjoyment, and sense of value during learning (Gómez-Chacón et al., 2024). When students experience curiosity and confidence, they are more likely to persist with challenging tasks and to engage productively with mathematical ideas. Positive emotional experiences are linked to improved attitudes towards mathematics and greater willingness to participate in learning activities (Fredricks et al., 2004).

Behavioral engagement involves observable actions, including participation in tasks, sustained attention, and collaboration with peers (Ní Shé et al., 2023; Trgalová & Tabach, 2023). In technology-supported mathematics classrooms, behavioral engagement is often reflected in students' on-task interaction, responsiveness to prompts, and contribution to shared discussions. When students feel included and encouraged, they are more likely to demonstrate persistence and reduced off-task behavior (Fredricks et al., 2004).

Research consistently emphasizes that these dimensions are most effective when considered together rather than in isolation (Davis & Witt, 2022; Madden, 2018; Trgalová & Tabach, 2023). Evidence from studies on interactive digital response platforms in high school mathematics classrooms suggests that when tasks are designed to promote active student involvement, students show higher levels of attention, participation, and persistence (Muchuweni et al., 2025). Studies also indicate that digital learning environments can strengthen engagement when they integrate visual representations, structured interaction, and opportunities for explanation and feedback (Viberg et al., 2023). These conditions help create mathematics lessons that encourage active thinking, sustained involvement, and positive student experiences.

Although engagement theory provides a strong foundation for understanding student participation in mathematics learning, there remains limited synthesis linking these dimensions to the design and use of specific digital platforms in secondary mathematics lessons. In particular, existing studies rarely examine how engagement is shaped through platform features and instructional decisions in an integrated way. To avoid repeating theory, this section briefly introduces engagement dimensions, while we next explain how engagement theory is used as the main analytical lens for the review (Fredricks et al., 2004). This section, therefore, establishes the engagement framework used to examine how the Amplify Activity Builder promotes cognitive, emotional, and behavioral engagement in secondary mathematics learning.

### **Amplify Activity Builder Features and Student Engagement**

The literature identifies several instructional features of the Amplify Activity Builder that are associated with engaged learning in secondary mathematics classrooms (Davis & Witt, 2022; Madden, 2018; Trgalová & Tabach, 2023). These features are commonly discussed in relation to how they support students' thinking, participation, and learning experiences. Across studies, the most frequently examined features include dynamic representations, card sort tasks, open-ended responses, real-time feedback, and teacher pacing controls, all of which are linked to active engagement with mathematical content (Carneiro et al., 2022; Chechan et al., 2023). These features and their links to different dimensions of student engagement are summarized in **Table 1**.

Dynamic representations, particularly interactive graphing with sliders and adjustable parameters, are widely reported as central to student engagement (Kristanto, 2019; Wynn et al., 2024; Yusoff & Wan Mamat Pauzam, 2023). These tools allow students to manipulate values and observe immediate changes in graphical output, enabling exploration of mathematical relationships. Kristanto (2019) and Wynn et al. (2024) describe how this form of interaction encourages deeper reasoning by prompting students to identify patterns, test ideas, and connect symbolic expressions with visual representations. Visual and interactive representations are reported to make abstract concepts more accessible and to clarify mathematical ideas in secondary mathematics learning (Carneiro et al., 2022).

Open-ended response features are also highlighted for their role in encouraging engagement by allowing students to explain their thinking and reflect on their reasoning (Bulakh & Coombs, 2020). The literature (Chorney, 2022; Nuri et al., 2023) reports that written explanations provide insight into students' understanding and misconceptions, while also encouraging students to explain strategies in their own words. When students are invited to share reasoning rather than select fixed answers, they are more likely to develop a sense of ownership over their learning and to participate actively in mathematical discussion (Chorney, 2022; Nuri et al., 2023).

Real-time feedback through teacher dashboards is another feature frequently associated with engagement in activity builder-based instruction (Danielson & Meyer, 2016). Teachers can view student responses as they are submitted and respond during the lesson by pausing activities, highlighting common errors, or prompting further discussion. Studies suggest that this immediate feedback supports sustained attention and productive adjustment of thinking, while also contributing to positive student attitudes by reducing uncertainty and frustration during problem solving (Glaze & Moyer-Packenham, 2021; Russell & Potratz, 2023). Teacher pacing controls are discussed as an important feature for managing lesson flow and encouraging inclusive participation (Chorney, 2022). By controlling students' progress through activity screens, teachers can create opportunities for whole-class discussion, reflection, and clarification. Research reports that structured pacing is associated with sustained engagement by preventing students from rushing ahead or becoming disengaged, particularly in classrooms with diverse learning needs (Kassel, 2022).

However, studies on the Amplify Activity Builder also show some methodological limitations. Several studies rely on small classroom samples or short-term lesson interventions, which limit how widely findings can be applied (Chorney, 2022; Kassel, 2022). Other studies describe teacher experiences but provide limited quantitative evidence of engagement outcomes (Bulakh & Coombs, 2020; Maher & Nguyen, 2021). These limitations suggest the need for stronger and more consistent research designs in this area (Trgalová & Tabach, 2023).

The literature also reports some mixed findings. While many studies highlight increased participation and reasoning through interactive tasks (Danielson & Meyer, 2016; Kristanto, 2019), other studies note that engagement depends strongly on how teachers structure activities and guide discussion (Chorney, 2022; Trouche & Drijvers, 2014). In some cases, students may complete tasks quickly without deeper explanation if activities are not carefully paced or supported (Russell & Potratz, 2023). This shows that the platform does not guarantee engagement on its own but works best when combined with intentional teaching practices (Hoyles, 2018; Trgalová & Tabach, 2023). Although these features are well documented individually, the literature often examines them in isolation rather than considering how they work together to promote engagement. As a result, there is limited synthesis explaining how combinations of activity builder features are used to facilitate engaged learning across different phases of instruction. This review therefore brings together evidence across studies to clarify both the strengths and the limits of current findings on engagement through the Amplify Activity Builder (Hoyles, 2018; Trgalová & Tabach, 2023).

## THEORETICAL FRAMEWORK

This study is guided by engagement theory as articulated by Fredricks et al. (2004) to examine how cognitive, emotional, and behavioral dimensions of engagement are conceptualized and supported in research on Amplify Activity Builder in secondary mathematics education. Engagement theory was selected because the main purpose of this review is to understand how students' thinking, participation, and learning experiences are supported through digital lesson design. The framework provides a clear and widely used structure for examining engagement in secondary mathematics classrooms (Fredricks et al., 2004; Madden, 2018). Other perspectives, including TPACK and instrumental genesis, also explain how technology is used in mathematics teaching. However, this review focuses specifically on student engagement outcomes rather than teacher knowledge development or tool appropriation (Hill & Uribe-Florez, 2020; Trouche & Drijvers, 2014). Engagement theory, therefore, offers the most direct lens for analyzing how Amplify Activity Builder features relate to students' engagement during learning.

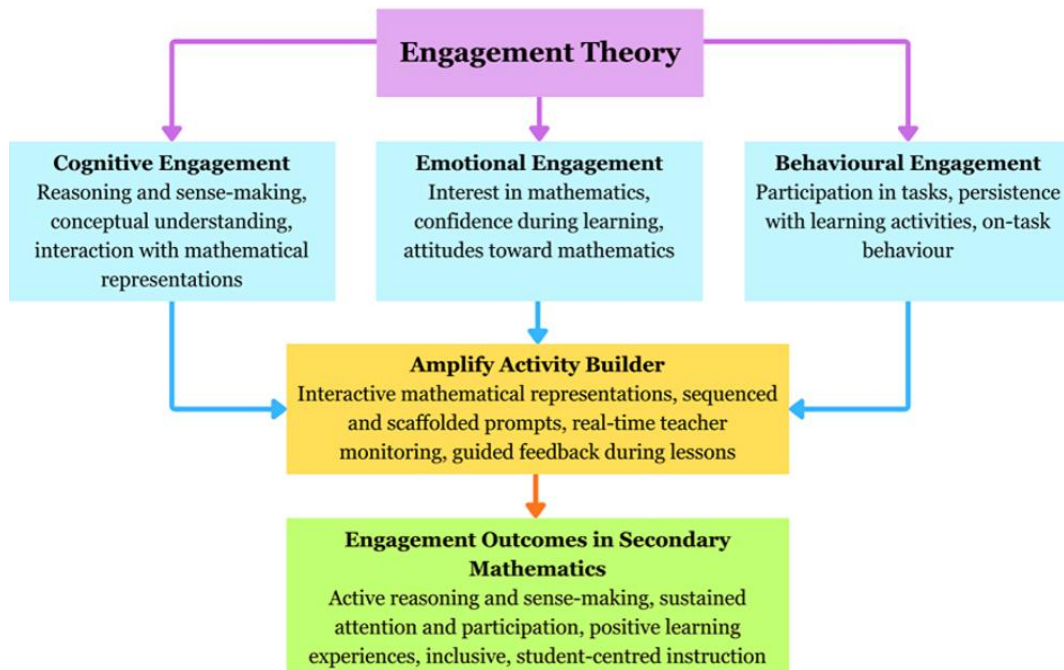
In this review, the three engagement dimensions are used to organize and interpret findings across studies. Cognitive engagement refers to students' effort to understand mathematical ideas through reasoning, exploration, and explanation (Fredricks et al., 2004; Kristanto, 2019). Emotional engagement refers to students' interest, confidence, and positive attitudes during learning, especially when interactive tasks reduce anxiety and promote curiosity (Gómez-Chacón et al., 2024; Fye & Fletcher, 2024). Behavioral engagement refers to students' active participation, sustained attention, and involvement in classroom activities supported through pacing and response tools (Danielson & Meyer, 2016; Trgalová & Tabach, 2023).

**Figure 1** presents the focused engagement framework used in this review. It illustrates how Amplify Activity Builder features, including interactive representations, sequenced prompts, real-time teacher monitoring, and guided feedback, support cognitive, emotional, and behavioral engagement. By using these connected dimensions, the review provides a structured way to examine how activity builder is operationalized to promote engaged learning in secondary mathematics classrooms (Fredricks et al., 2004; Hoyles, 2018).

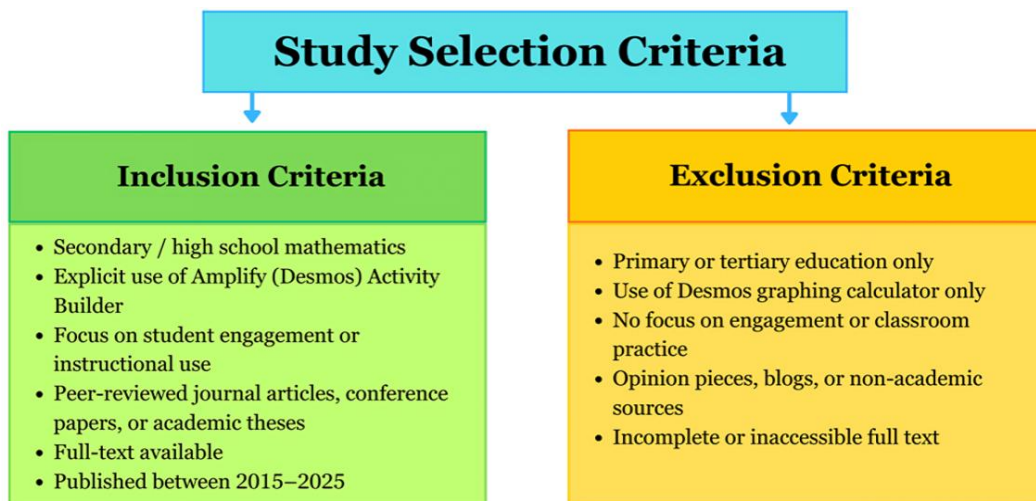
## METHODOLOGY

This study adopted an SLR approach to synthesize existing research on the use of Amplify Activity Builder to enhance student engagement in high school mathematics classrooms. The review followed the PRISMA 2020 guidelines to ensure transparency, rigor, and clarity in identifying, screening, and selecting relevant studies (Page et al., 2021). A systematic review was appropriate because the study sought to summarize and interpret existing research rather than collect new empirical data (Page et al., 2021).

The literature search was conducted across three major academic databases commonly used in mathematics education research: ERIC, ScienceDirect, and SpringerLink. These databases were chosen because they provide wide access to journal articles, conference papers, and academic theses related to mathematics education and educational technology. Searches were limited to studies published between 2015 and 2025, reflecting the period when the activity builder became widely used in secondary mathematics instruction.



**Figure 1.** Focused Amplify Activity Builder engagement framework (Source: Authors’ own elaboration)

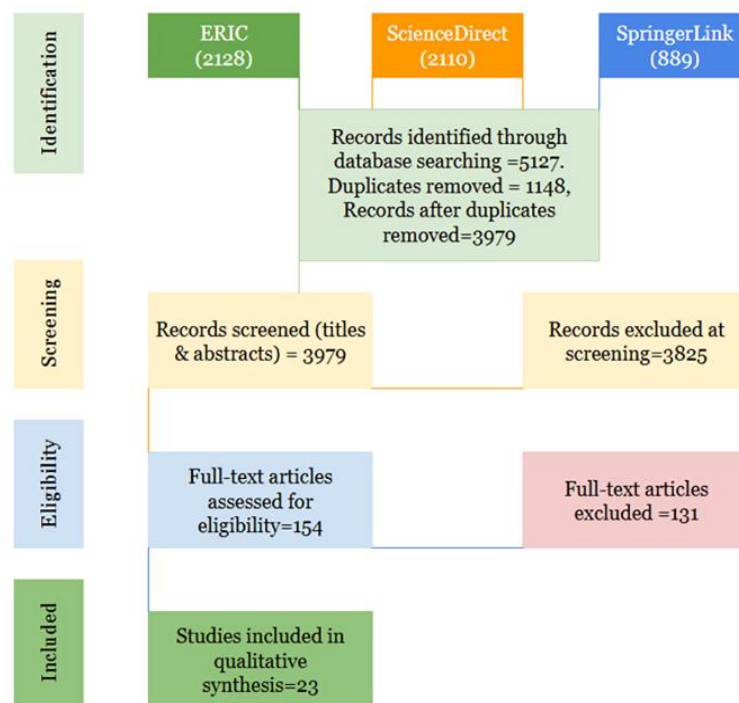


**Figure 2.** Selection criteria for studies included in the Amplify Activity Builder review (Source: Authors' own elaboration)

Search terms were developed to identify studies that clearly examined the activity builder’s impact on student engagement in mathematics. Boolean operators were used to combine keywords, and search strings were adjusted slightly for each database. The main search string was: (“Desmos Activity Builder” OR “Amplify Activity Builder”) AND (“student engagement” OR “learning engagement”) AND (“secondary mathematics” OR “high school mathematics”). Additional searches used related combinations, including (“Desmos” AND “mathematics teaching”) and (“interactive digital tools” AND “mathematics education”). These searches aimed to capture relevant studies while keeping a clear focus on engagement and classroom practice.

Clear inclusion and exclusion criteria were applied to guide study selection. Studies were included if they focused on secondary or high school mathematics, made direct reference to the activity builder (rather than only the graphing calculator), discussed student engagement or instructional use of the platform, and were published as journal articles, conference papers, or academic theses available in full text. Studies were excluded if they focused only on primary or tertiary education, did not involve activity builder features, lacked a clear link to classroom practice or engagement, or were non-academic sources including opinion pieces or blogs. The inclusion and exclusion criteria are summarized in **Figure 2**.

The study selection process followed the four stages outlined in PRISMA 2020: identification, screening, eligibility, and inclusion. After records were identified through database searches, duplicates were removed. Titles and abstracts were screened for relevance, followed by a full-text review to confirm eligibility. Articles that could not be retrieved at full-text stage were excluded, and studies that met all criteria were included in the final qualitative synthesis. This process is shown in **Figure 3**, which presents the PRISMA 2020 flow diagram indicating the number of records identified, screened, excluded, and included in the review.



**Figure 3.** PRISMA 2020 flow diagram for the Amplify Activity Builder review (Source: Authors' own elaboration)

To strengthen methodological transparency, the screening and selection process was conducted by two reviewers working independently. Any disagreements were discussed until consensus was reached. Inter-rater agreement was calculated using percentage agreement, which indicated a high level of consistency in study selection. A structured data extraction protocol was applied to all included studies. Key information was recorded for each article, including author(s), year of publication, research design, activity builder features examined, and main engagement-related findings. These extracted data were used to guide the thematic synthesis presented in the results section. A formal review protocol was not registered in PROSPERO or a similar database, which is acknowledged as a limitation, although PRISMA 2020 procedures were followed throughout (Page et al., 2021).

The included studies were analyzed using a thematic synthesis approach guided by the three dimensions of student engagement: cognitive, emotional, and behavioral (Fredricks et al., 2004). Relevant findings were extracted and organized according to how activity builder features were reported to support thinking, motivation, and participation in secondary mathematics learning. This approach allowed patterns across studies to be identified and interpreted without introducing new instructional models, ensuring alignment with the purpose and methodological scope of an SLR.

## RESULTS

The results, which bring together how the Amplify Activity Builder is reported to be associated with student engagement in high school mathematics lessons, identify common patterns linked to specific platform features. The findings are organized thematically to reflect different dimensions of engagement, and links between the use of the activity builder and mathematics learning across the reviewed studies.

### Engagement Supported Through the Amplify Activity Builder

The reviewed studies consistently show that the interactive design of the Amplify Activity Builder is linked to multiple dimensions of student engagement in secondary mathematics classrooms. Rather than relying on fixed answers or repeated procedures, the platform allows students to interact actively with mathematical representations, encouraging participation and sustained attention. Across the reviewed studies (Carneiro et al., 2022; Chechan et al., 2023), features such as sliders, draggable objects, graph overlays, card sorts, and animated visuals are identified as central to this interactive design. These features allow students to explore relationships between variables in real time (Carneiro et al., 2022; Chechan et al., 2023). According to the literature included, interactive task features were reported in approximately 15 of the 23 studies as key supports for student engagement.

Research by Kristanto (2019), Madrilejos (2024), and Wynn et al. (2024) links interactive elements of the Amplify Activity Builder closely to cognitive engagement. Students are required to test ideas, notice patterns, and explain changes they observe on the screen. For example, studies focusing on function tasks report that adjusting parameters using sliders helps students connect algebraic expressions with graphical behavior, enhancing understanding rather than memorisation (Kristanto, 2019; Madrilejos, 2024; Wynn et al., 2024). Through these interactions, students actively change values, compare results, and revise their thinking, which supports deeper mathematical understanding.

These same features are also linked to emotional engagement. Several studies report that students show greater interest and enjoyment when lessons include visual feedback and opportunities to explore. Interactive screens encourage curiosity and reduce anxiety by allowing students to experiment without immediate consequences for mistakes (Fye & Fletcher, 2024). When students can see the results of their actions straight away, mathematics is described as more approachable and less abstract, which encourages positive attitudes towards learning.

The literature also shows clear links between interactive design and behavioral engagement. Teachers report higher levels of on-task behavior, participation, and persistence during Amplify Activity Builder lessons compared to traditional worksheet-based instruction (Danielson & Meyer, 2016; Trgalová & Tabach, 2023). The need to interact with the activity, submit responses, and respond to prompts encourages ongoing involvement throughout the lesson.

Several studies describe the use of prediction prompts within interactive tasks. Students are first asked to predict an outcome, then test their ideas using the activity tools, and finally reflect on what happened. This sequence scaffolds engagement by combining reasoning, curiosity, and participation, and is often identified as an effective structure for promoting meaningful learning (Chorney, 2022; Davis & Witt, 2022).

The reviewed evidence shows that the interactive design of the Amplify Activity Builder is linked to cognitive, emotional, and behavioral engagement by positioning students as active explorers of mathematical ideas. Through visual manipulation, immediate feedback, and structured interaction, the platform fosters deeper thinking, motivation, and participation in secondary mathematics lessons. However, findings were not fully consistent across all studies. While many studies (approximately 15 of the 23) reported higher participation and reasoning through interactive design (Danielson & Meyer, 2016; Kristanto, 2019), a smaller number of studies (5 of the 23) noted that engagement was weaker when activities were used as ready-made tasks without strong teacher discussion or follow-up (Chorney, 2022). This suggests that the platform supports engagement most effectively when interactive features are paired with intentional instructional guidance (Hoyles, 2018; Trgalová & Tabach, 2023).

### **Scaffolding and Teacher-Guided Features Supporting Engagement**

According to the reviewed studies, several features of the Amplify Activity Builder are identified as central to strengthening structured lesson flow and responsive teaching in secondary mathematics classrooms. These features include pacing controls, live-response dashboards, and tools that enable teachers to provide timely prompts and feedback during learning activities. The literature consistently reports that these design elements help teachers plan lessons that maintain student engagement throughout (Danielson & Meyer, 2016; Trgalová & Tabach, 2023). Teacher-guided scaffolding features were reported in approximately 14 of the 23 studies as important supports for sustained engagement during instruction (Danielson & Meyer, 2016; Trgalová & Tabach, 2023).

Pacing controls are frequently highlighted as an important feature for managing how students move through an activity (Chorney, 2022). Instead of allowing students to move freely across screens, teachers can pause, release, or sequence tasks to introduce ideas step by step. Studies report that this structured pacing helps students stay focused and reduces overload, especially during lessons that introduce new or abstract concepts (Chorney, 2022). For example, research on quadratic functions describes lessons in which students first explore changes visually before being asked to explain patterns, allowing time for reflection before moving on.

The live dashboard is also widely reported as a valuable instructional feature. It gives teachers real-time access to student responses, enabling them to identify misunderstandings, partial understanding, or disengagement as they occur. Several studies note that teachers use this information to pause activities, share selected responses, or guide whole-class discussion, rather than waiting until after the lesson to address difficulties (Chechan et al., 2023). This immediate response enables continuous engagement by keeping instruction closely connected to student thinking.

The literature also describes the use of teacher-generated prompts and hints within Amplify Activity Builder lessons. Instead of giving answers, teachers use guiding questions, short cues, or follow-up screens to help students rethink their ideas and continue working through challenging tasks (Bulakh & Coombs, 2020; Davis & Witt, 2023). This type of scaffold encourages students to stay engaged while still taking responsibility for their own learning.

Several studies also report that these scaffolding features help create a classroom environment where students feel supported during exploration. When students know that teachers are monitoring progress and can step in when needed, they are more willing to try unfamiliar problems and revise their thinking (Fye & Fletcher, 2024). The combination of pacing, monitoring, and responsive prompts is therefore identified as a key strength of the Amplify Activity Builder.

However, it emerged that findings were not consistent across all studies. The finding that approximately 50 percent of the studies highlighted the value of pacing and teacher guidance for maintaining engagement, about 7 percent suggested that these features are less effective when teachers do not actively use student responses to guide discussion or provide follow-up support, which is consistent with the position of Chorney (2022) and Hoyles (2018). This indicates that scaffolding tools are most effective when combined with intentional instructional decisions rather than used as automated platform features (Trgalová & Tabach, 2023).

The reviewed evidence indicates that teacher-guided features of the Amplify Activity Builder play an important role in shaping how engagement is operationalized during instruction. By enabling structured progression, real-time monitoring, and responsive guidance, these features help teachers manage learning experiences that are focused, inclusive, and sustained across secondary mathematics lessons. These findings address research question 1 by showing how activity builder supports cognitive, emotional, and behavioral engagement, and research question 2 by identifying pacing, monitoring, and feedback as consistently reported engagement-related features across the reviewed studies.

## DISCUSSION

This section discusses the findings of the study. The findings are considered alongside the engagement theory and research in digital mathematics education.

### Interpreting Engagement in Secondary Mathematics Learning

The findings of this study show that engagement in secondary mathematics learning is stronger when students are active in exploring mathematical ideas, rather than only following procedures. We show that the interactive design of the Amplify Activity Builder enables engagement by asking students to interact with representations, make predictions, and respond to prompts during lessons. Engagement theory (Fredricks et al., 2004) helps explain these findings by showing that engagement involves how students think, feel, and participate during learning. These findings are consistent with broader systematic review evidence showing that digital and technology-enhanced mathematics resources can strengthen engagement when they promote interaction, reasoning, and feedback (Ní Shé et al., 2023; Viberg et al., 2023). Similar reviews emphasize that engagement gains depend on purposeful instructional design rather than technology access alone (Hoyle, 2018; Trgalová & Tabach, 2023).

From a cognitive engagement perspective, the reviewed studies show that students are more engaged when they use interactive tools, for instance, sliders, draggable objects, and graphs. As shown before, these tools help students test ideas, notice patterns, and change their thinking based on what they see on the screen (Kristanto, 2019; Wynn et al., 2024). Engagement theory describes cognitive engagement as the effort students put into understanding ideas. The findings suggest that Amplify Activity Builder scaffolds this effort by requiring students to explain and make sense of mathematics rather than just give answers.

The findings also show the importance of emotional engagement. We report that students show more interest and confidence when lessons include visual feedback and opportunities to explore. These activities help reduce anxiety because students can try ideas without fear of being wrong (Fye & Fletcher, 2024). According to engagement theory, positive feelings during learning help students continue working on challenging tasks. The results suggest that Amplify Activity Builder enhances emotional engagement by making mathematics feel more accessible and less intimidating.

Behavioral engagement is also supported through task design. We show that students are more likely to stay on task and take part in lessons when they are required to interact, submit responses, and reflect on predictions (Danielson & Meyer, 2016; Trgalová & Tabach, 2023). Engagement theory describes behavioral engagement as active participation in learning activities. The findings suggest that Amplify Activity Builder facilitates this by keeping students involved throughout the lesson rather than having them work passively.

Overall, the findings show that engagement in secondary mathematics learning is shaped by lesson design and classroom practice, not solely by students. When Amplify Activity Builder is used to promote thinking, positive learning experiences, and regular participation, it supports cognitive, emotional, and behavioral engagement together (Fredricks et al., 2004). This shows that the platform works best when used as a teaching tool to support learning goals, rather than as a digital worksheet. The applicability of these findings may also depend on classroom context. Teacher experience with digital tools, access to reliable technology, and differences in student needs and backgrounds can influence how effectively the activity builder supports engagement (Hill & Uribe-Florez, 2020; Trgalová & Tabach, 2023). This suggests that engagement outcomes may vary across schools and instructional settings.

### Interpreting Amplify Activity Builder Features Associated with Engaged Mathematics Learning

The findings on scaffolding and teacher-guided features show that teachers play a key role in keeping students engaged when using the Amplify Activity Builder. While interactive design supports student exploration, the reviewed studies show that sustained engagement depends strongly on how teachers structure lessons, guide activity flow, and respond to student thinking. Features like pacing controls, live dashboards, and timely prompts allow teachers to stay actively involved in the learning process rather than stepping back once an activity begins (Chechan et al., 2023; Danielson & Meyer, 2016).

From an engagement theory perspective, these features work together to promote cognitive, emotional, and behavioral engagement (Fredricks et al., 2004). Structured pacing strengthens cognitive engagement by guiding students through mathematical ideas, step by step. By controlling when students move forward, teachers can focus attention on key concepts, reduce cognitive overload, and create time for reflection. This is especially important when students are learning new or abstract mathematics.

Teacher monitoring through live dashboards also plays a key role in sustaining engagement. Viewing student responses in real-time allows teachers to identify misconceptions, partial understanding, or disengagement as they occur. Teachers can then pause the lesson, highlight responses, or adjust instruction immediately rather than waiting until the end of the activity. This helps maintain behavioral engagement by keeping students on task and contributes to emotional engagement by helping students feel noticed and supported during learning.

The use of teacher-generated prompts and hints further shows how engagement is shaped through guided support rather than direct instruction. When teachers use questions and cues instead of providing answers, students are encouraged to persist, rethink their ideas, and take responsibility for their learning. This form of scaffolding promotes cognitive engagement by promoting reasoning and sense-making, while also reducing barriers to emotional engagement by reducing frustration and fear of failure.

These findings show that engagement with Amplify Activity Builder lessons is not driven by technology in isolation. Instead, engagement is shaped by how teachers orchestrate learning experiences using the platform's tools, a pattern also noted in

research on technology-supported mathematics instruction (Chorney, 2022; Danielson & Meyer, 2016; Maher & Nguyen, 2021). By controlling pacing, monitoring responses, and providing timely feedback, teachers create the conditions that support thinking, confidence, and active participation. This reinforces the view that the Amplify Activity Builder functions most effectively as a teacher-guided learning environment, where engagement is shaped through instructional decisions rather than through unstructured student interaction.

### Limitations

This study has some limitations that should be considered when interpreting the findings. First, the review included only journal articles, conference papers, and academic theses published between 2015 and 2025. As a result, relevant practitioner reports or unpublished classroom studies may not have been included. This introduces the possibility of publication bias, as studies with positive findings are more likely to be published than studies reporting limited or negative outcomes. In addition, only English-language publications were included, which may have resulted in language bias, as relevant studies published in other languages may not have been captured. The literature search was also conducted using only three databases (ERIC, ScienceDirect, and SpringerLink). Although these are widely used in mathematics education research, additional studies may exist in other databases that were not searched, potentially limiting the completeness of the evidence base. Furthermore, although the review focused on secondary mathematics education, the included studies were conducted in different educational contexts. This variation may affect how the Amplify Activity Builder is used and how student engagement is supported. Finally, while methodological quality was considered during synthesis, a formal critical appraisal tool was not applied systematically to all included studies, which may affect the strength of conclusions drawn from studies with weaker designs or small samples. These limitations suggest that the findings should be interpreted cautiously. While the review provides useful evidence on how Amplify Activity Builder is linked to student engagement, further research with broader database coverage, stronger study designs, and more diverse contexts is needed to confirm and extend these conclusions.

## CONCLUSION

This SLR examined how the Amplify Activity Builder supports engaged learning in secondary mathematics classrooms. Guided by engagement theory, the review synthesized evidence from 23 studies published between 2015 and 2025. The findings show that the platform is most strongly associated with student engagement when lessons are designed to promote active exploration, reasoning, and participation rather than procedural task completion. In relation to research question 1, the review found that Amplify Activity Builder supports cognitive, emotional, and behavioral engagement through interactive lesson features. Students are more engaged when they can manipulate representations, test ideas, explain their thinking, and receive timely feedback during learning activities. These conditions encourage deeper reasoning, sustained attention, and more positive learning experiences in secondary mathematics.

In relation to research question 2, the review identified several platform features that are consistently linked to engaged mathematics learning. Interactive representations, prediction prompts, open-ended responses, pacing controls, and real-time teacher monitoring were frequently reported as supporting engagement across the included studies. The evidence also suggests that these features are most effective when combined with intentional teacher guidance and structured classroom discussion. This review highlights that Amplify Activity Builder is not simply a digital tool, but a teacher-guided learning environment that can strengthen student engagement when used purposefully. The review contributes to research and practice by clarifying how specific platform features align with key dimensions of engagement and by providing evidence-based guidance for supporting engaged learning in secondary mathematics classrooms.

The strength of conclusions should be evaluated in light of the methodological quality of the included studies. While many studies reported positive engagement outcomes, several relied on small samples or short-term interventions (Chorney, 2022; Kassel, 2022). This means that evidence is promising but still limited, and more robust research designs are needed to confirm long-term effects (Trgalová & Tabach, 2023).

### Implications and Recommendations

The findings of this study suggest that effective use of the Amplify Activity Builder in high school mathematics lessons requires more than simple access to the platform. Mathematics teachers need focused professional development, time for lesson planning, and opportunities for reflection to use the tool in ways that genuinely enhance student engagement. Moving beyond reliance on ready-made activities and towards adapting tasks to curriculum goals and student needs is important for strengthening cognitive, emotional, and behavioral engagement.

Based on the evidence across the reviewed studies, teachers should prioritize the use of interactive representations, open-ended prompts, and prediction tasks, as these features were most consistently linked to cognitive engagement and deeper reasoning. Teachers can also use pacing controls to slow down instruction and create time for discussion, especially when introducing new or abstract mathematical concepts.

Professional learning should focus on how teachers can use key features of the Amplify Activity Builder, including open-ended prompts, pacing controls, and live dashboards, to guide instruction and respond to student thinking. Teachers are encouraged to review student responses during and after lessons, select examples for class discussion, and use feedback to address misconceptions immediately. Confidence and consistency in classroom practice can be strengthened through shared planning and peer learning.

School leaders play a key role in creating conditions that support effective implementation. This includes providing time for collaboration and ensuring access to reliable digital infrastructure. Considering that engagement outcomes depend strongly on teacher guidance, schools should support lesson design time and professional communities where teachers share activity builder strategies.

At a broader level, curriculum developers and policymakers should embed platforms such as the Amplify Activity Builder into curriculum guidance and assessment practices, rather than treating them as optional additions.

### Directions For Future Research

The evidence on Amplify Activity Builder and student engagement remains promising but still limited in scope. Future research should prioritize stronger methodological designs, including experimental and quasi-experimental studies, to examine whether engagement gains lead to sustained achievement outcomes over time.

Longitudinal studies are also needed to understand how student engagement develops across repeated use of activity builder lessons, rather than short-term interventions. In addition, more research is required in diverse cultural, institutional, and demographic contexts, as most existing studies were conducted in specific settings and may not fully represent under-resourced or varied secondary mathematics classrooms.

Future studies should also examine emotional engagement in greater depth, as fewer studies focused on student confidence, anxiety reduction, and motivation compared to cognitive outcomes. Research that includes student voice, classroom observations, and mixed-method approaches would strengthen understanding of how engagement is experienced and sustained in practice.

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