DO STUDENTS THINK WHEN THEY ARE ENGAGED? STUDENT ENGAGEMENT IN A THINKING CLASSROOM

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This study examines how student engagement is observed in an inexperienced Building Thinking Classroom (BTC) teacher's practice. The analysis draws on four dimensions of engagement—behavioral, cognitive, emotional, and social—and indicates that the BTC may encourage each of these in different ways. The BTC structure was found to foster active and social participation, but it did not reliably produce deeper mathematical thinking. Students often stayed in procedural routines and appeared behaviourally engaged, showing that cognitive engagement requires deliberate teacher actions such as clear goals and responses that prompt further exploration.

INTRODUCTION

In recent years, many teachers have eagerly adopted Liljedahl's (2021) practices of "Building Thinking Classrooms" (BTC). BTC encourages collaborative problem solving and emphasizes student engagement. Liljedahl and Giroux (2024) claim: "If students are thinking, they are engaged. And if they are engaged, they are thinking" (p. 60). In contrast, although researchers agree that engagement is vital to learning (e.g., Fung et al., 2018; Maamin et al., 2022), studies indicate that student engagement is multi-faceted (e.g., Fredricks et al., 2016). In this study, we analyze a lesson taught by a teacher who is getting started with BTC, to learn more about the kinds of engagement that can be observed, and to explore if students think when they are engaged. We ask:

> What forms of student engagement are visible in a mathematics lesson by a teacher who is new to BTC?

Our analysis builds on Fredricks et al.'s (2016) four dimensions of engagement: behavioral, cognitive, emotional, and social. We elaborate on these in the next section.

THEORETICAL BACKGROUND

Student engagement

Christenson et al. (2012, p. 816) define engagement as "the student's active participation in academic and co-curricular or school-related activities and commitment to educational goals and learning." Research shows a positive link between student engagement and mathematics achievement (Fung et al., 2018; Maamin et al., 2022), and engagement is also crucial for school success and completion (Fall & Roberts, 2012). However, some highlight cognitive engagement (e.g., Fung et al., 2018), while others emphasize emotional engagement (e.g., Maamin et al., 2022).

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The literature distinguishes four types of engagement (Fredricks et al., 2016; Reschly & Christenson, 2022):

- Behavioral: active participation, posing and responding to questions, sustained effort.
- Cognitive: critical thinking, problem solving, organizing information, assessing strategies.
- Emotional: attitudes and feelings toward school and mathematics, from curiosity and enjoyment to frustration.
- Social: teamwork, attentive listening, building on and extending peers' ideas.

Problem-solving tasks can foster all four forms of student engagement; they invite cognitive effort, spark emotional responses, and encourage social interaction. Practices such as sharing group strategies on vertical boards make engagement visible and support further mathematical exploration (Liljedahl & Cai, 2021).

Practices in BTC

Liljedahl (2021) outlines 14 practices for building a "thinking classroom", including task selection, group formation, workspace design, and formative assessment. These practices aim to foster independent thinking, inquiry, and collaborative problem solving. Teachers' choice of mathematical tasks influences student engagement and learning, as some tasks invite deeper reasoning than others.

Different from Fredricks et al. (2016), Liljedahl and Giroux (2024) present a narrow view of engagement—if students are engaged, they think. Some of their BTC practices might, however, connect to the four forms described by Fredricks et al. (2016).

- Task selection (Practice 1): Students need tasks that are accessible yet challenging, and such tasks might invite cognitive engagement. How tasks are presented matters (Practice 6). Liljedahl and Giroux (2024) recommend giving tasks orally, supported by gestures or modelling, while trusting students to think independently might invite both behavioral and cognitive engagement.
- Group work and workspace (Practices 2–4): Students work in random groups at vertical boards, with desks arranged away from the front. Visible work surfaces and collaboration spread knowledge across the classroom, which might foster social engagement (Liljedahl, 2021; Liljedahl & Giroux, 2024).
- Responding to questions (Practice 5): Liljedahl (2021) identifies three types of student questions: close-by, stop-thinking, and keep-thinking. Only the last type sustains inquiry and contributes to BTC. Teachers must avoid giving hints that end students' reasoning, instead encouraging further exploration.

Together, these practices show how engagement—behavioral, cognitive, emotional, and social—might emerge when students are given meaningful tasks, space to

collaborate, and opportunities to pursue their own thinking. But this is a gap in the research literature and demonstrates the need for this study.

METHODS

This study is part of the *Partners in Practice* research and professional development project, where twelve lower secondary mathematics teachers and three teacher educators engaged in 12 workshops over 18 months. The first eight workshops addressed curriculum perspectives on problem solving, textbook tasks, approaches to presenting tasks that foster engagement, and strategies for whole-class dialogue. In the last four workshops (Fall of 2024), teachers collaboratively planned, taught, and reflected on BTC lessons. All workshops were video recorded, transcribed, and accompanied by classroom observations. For this paper, we analyze data from one of the BTC lessons using theory-driven content analysis (Hsieh & Shannon, 2005) of field notes and pictures, applying deductive coding based on four forms of engagement (Fredricks et al., 2016). Two teachers taught a Grade 8 class organized into seven groups. Both (pseudonyms: Nelly and Bea) were experienced teachers, but they were new to BTC. The task (Figure 1) focused on adding fractions to achieve a sum as close as possible to 1.

Figure 1: The task worked on.

Below you see six fractions:

$\frac{1}{6}$ $\frac{1}{25}$ $\frac{3}{5}$ $\frac{3}{20}$ $\frac{4}{15}$ $\frac{5}{8}$

Choose some of the fractions and add them together. You may use as many of the fractions as you like, but each only once. Can you get a sum that is close to 1? How close to 1 can you get? (What if you could subtract, multiply, and/or divide in addition to add?)

*The question in parentheses was presented when the students had worked on adding for about 15 minutes.

A prerequisite for the task is that students understand fractions with identical numerator and denominator equal 1. They must also compare the difference between numerator and denominator and consider the size of the denominator to judge which sums are closest to 1. For instance, both $\frac{31}{30}$ and $\frac{61}{60}$ are "one away from a whole [wording from the students]," but $\frac{61}{60}$ is closer since $\frac{61}{60} < \frac{31}{30}$. Similarly, "four away from a whole" can be closer than "one away" (e.g., $\frac{604}{600}$ is closer to 1 than $\frac{31}{30}$).

The task can stimulate different forms of engagement. It supports behavioral engagement through addition practice. In the lesson, the task was extended to finding differences, products, and quotients close to 1, encouraging cognitive engagement as students reasoned about proximity to 1. Emotional engagement depends on how tasks are presented and whether students can verbalize their mathematical thinking.

Collaboration fosters social engagement, allowing students to build on each other's ideas. Thus, engagement depends both on the task itself and how students are invited to work on it—something the BTC approach facilitates (Liljedahl, 2021).

For analysis, we applied theory-driven content analysis (Hsieh & Shannon, 2005), using deductive coding based on four forms of engagement (see Table 1).

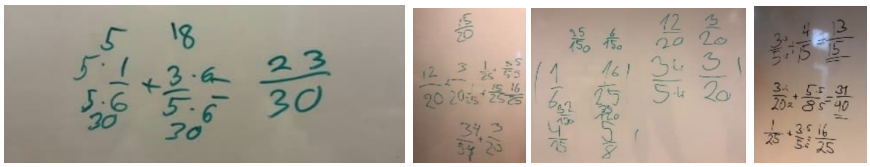
Table 1: Engagement examples in the data.

Form of Engagement	Examples from the data
Behavioral	Students add, subtract, multiply, and divide fractions continuously.
Cognitive	Students systematically choose fractions, considering numerator–denominator differences and fraction size to judge closeness to 1.
Emotional (positive)	Students join the class community with laughter and good humor.
Social	Students collaborate to find sums, differences, products, and quotients near 1.

RESULTS AND DISCUSSION

In the lesson, Nelly was the main teacher and Bea assisted. Nelly introduced the session by saying that they would first have a "standing mathematics task." After some organization and clarifying of responsibilities, she presented the task (Figure 1). The students then went to the boards. All groups quickly started adding pairs of fractions (shown in Figure 2), demonstrating behavioral engagement (Fredricks et al., 2016).

Figure 2: Four groups bord work – at the start of the lesson.

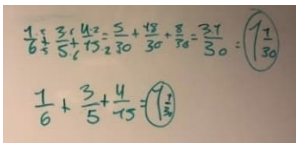


In some groups, one student took the lead while others watched, indicating that not everyone was behaviorally engaged. The groups added only two random fractions, which suggested limited cognitive engagement. Nevertheless, they worked together and appeared socially engaged. All groups seemed to understand that a fraction has the value of 1 when numerator and denominator are equal. When asked how close to 1 they had come, one student pointed to $\frac{13}{15}$ and said, "two away at the top here," meaning that 13 in the numerator is two less than 15 in the denominator. When asked why $\frac{13}{15}$ was closer than $\frac{31}{40}$, a student answered, "It is nine away," referring to the difference between numerator (31) and denominator (40). Several groups gave similar answers,

which indicated that they did not consider the importance of the denominator's size. The students responded quickly to questions and calculated eagerly. Their cognitive engagement (Fredricks et al., 2016) was intangible; highlighting the difference between numerator and denominator may reflect a lack of understanding of the task's focus rather than a lack of cognitive engagement.

Some groups collaborated and added many fractions, while others only added a few. Some wandered around without talking. In two groups, one student did the calculations while the others watched. Many were behaviorally engaged, but this engagement decreased. After a while, Nelly hinted that they could add more than two fractions. Some did so, as shown in Figure 3. By expanding the task for groups that thought only two fractions could be added, Nelly increased behavioral engagement—the number of calculations rose significantly.

Figure 3: Adding more than two fractions.



In conversations with two other student groups, it became clear that they still thought in terms of "distance from 1" and not denominator size. They claimed that $\frac{31}{30}$ was closest to 1 "because it is only one away." After half an hour, Nelly asked if anyone wanted to explain their reasoning. Behavioral engagement was evident as many wanted to answer. One group concluded that "$\frac{31}{30}$ was closest to 1 when we added three fractions." Nelly responded positively and then referred to another group that had also identified $\frac{31}{30}$ as the fraction closest to 1. She showed that they had reached the same result but did not invite cognitive engagement by challenging their reasoning with "keep-thinking" questions (Liljedahl, 2021).

Since no group had reached exactly 1, they were given an extension of the task: "All operations are allowed." Behavioral engagement was again evident as the students quickly began calculating. After a few minutes, Nelly said, "The closest we have come is $\frac{31}{30}$." No students responded, but the researcher noted that one group had found $\frac{61}{60}$. Nelly asked why this was closer to 1 than $\frac{31}{30}$. No one replied. She asked them to turn and talk. Several argued that both were "one away," and when Nelly asked for an answer, one student said, "$\frac{31}{30}$ is closest." Another added, "$\frac{31}{30}$ is $\frac{62}{60}$." Nelly confirmed but did not challenge them further about whether $\frac{31}{30}$ or $\frac{61}{60}$ is closer to 1. Thus, only behavioral engagement was evident here (Fredricks et al., 2016). The students

answered the teacher's questions. Nelly praised their participation, but she did not push them to understand the underlying mathematical idea, which would have been necessary for cognitive engagement.

Later, Nelly asked everyone to continue with tasks in the textbook. No one did, but some continued eagerly with the fraction task. One group found that $\frac{604}{600}$ was closer to 1 than their earlier results, showing that they recognized that a difference of four between numerator and denominator could be closer to 1 than "one away," which had previously dominated their reasoning. Another group celebrated finding $\frac{601}{600}$, which was the closest to 1.

The teachers were satisfied after the session, and Nelly said that some students "achieved much more than I would have thought." Behavioral engagement is about participation. Throughout the lesson, most students followed what the teacher said and did, answered questions, asked questions, added, and later multiplied fractions, and were therefore behaviorally engaged. However, they mostly solved routine tasks by following known procedures, such as adding two fractions after finding a common denominator. The analysis indicated that students chose fractions to add randomly. A few did not participate and were therefore not behaviorally engaged. Behavioral engagement was most prominent.

To understand the underlying mathematical ideas—that $\frac{604}{600}$ is closer to 1 than $\frac{31}{30}$, or that one must consider both the difference between numerator and denominator and the size of the denominator—cognitive engagement is essential. Yet, the task remained a series of routine calculations throughout the session. The students were not challenged to think, organize information, look for patterns, make connections, evaluate different approaches, or assess their findings. When one student said "$\frac{31}{30}$ is $\frac{62}{60}$" after another had said "$\frac{31}{30}$ is closest," and the fractions $\frac{31}{30}$ and $\frac{61}{60}$ were highlighted as "one away from a whole," this was a sign of cognitive engagement. However, the class was not invited into this student's thinking, nor challenged on which fraction was closest to 1. The teachers' satisfaction with the session suggested that cognitive engagement about what it means for a fraction to be close to 1 was not their goal, but rather behavioral engagement. Cognitive engagement does not arise automatically in a BTC, it depends on how the teacher leads the lesson. The fraction task had the potential to give students something to think about, but eliciting such thinking requires predicting student responses and setting clear goals for guiding them. Observing the students' calculations showed that they knew fractions with equal numerator and denominator equal 1. However, the idea that one must consider both the difference between numerator and denominator and the size of the denominator to determine which sums are closest to 1 was not made explicit as a goal.

Emotional engagement, which concerns students' feelings about school and mathematics (Fredricks et al., 2016), was difficult to observe. Our analyses indicated that most students were part of the classroom community and focused on the task with much laughter and good humor. The groups that continued working on the fraction task after being asked to move on to textbook exercises showed curiosity and enjoyment of the challenge, which may be signs of positive emotional engagement. Students who did not participate may have been bored, found the task uninteresting, or felt frustrated and insecure because the task was challenging. Non-participation may therefore be a sign of negative emotional engagement. It may also reflect group dynamics, for example when one student enjoyed the task, took the pen, and excluded others. Such situations are natural when both teachers and students are learning to work in a BTC.

Our analyses further suggested that the task and the work in the BTC fostered social engagement, as most students collaborated and helped each other. The students explained their reasoning to some extent, described strategies, and argued for their choices, which showed social engagement. At the same time, there were missed opportunities, such as discussing the statement by the student who said "$\frac{31}{30}$ is $\frac{62}{60}$." Some students only observed or talked with peers about topics unrelated to mathematics.

CONCLUSIONS AND IMPLICATIONS

While BTC appears to effectively foster behavioral and social engagement, this study suggests that it does not automatically trigger mathematical thinking. Contrary to Liljedahl and Giroux's (2024) claim that engagement equates to thinking, our findings reveal a possible disconnect: students may appear busy and collaborative while remaining restricted to procedural routines. For example, although students were physically active and positive, they often bypassed deeper reasoning—such as comparing fraction proximities to a whole—in favor of repetitive calculation. Therefore, cognitive engagement remains opaque and requires deliberate teacher intention. Although the task was both accessible and appropriately challenging (Practice 1, Liljedahl, 2021) and was presented orally (Practice 6), and although group work and workspace were organized according to BTC (Practices 2–4), students displayed more behavioural and social than cognitive engagement. Moving students from behavioral and social engagement to cognitive engagement thus appears to require deliberate work—even in BTC. This deliberate work, which might involve using specific learning goals and strategic hints, is challenging and requires training and practice. For example, when responding to questions (Practice 5), teachers should do so in a way that encourages further exploration.

When referring to specific learning goals, we want to note that a teacher might facilitate a lesson like shown here with behavioral engagement and practicing routines as the learning goal. Our intention was thus not to argue that the teacher failed in this lesson. Our main claim from this case study is that behavioral and social engagement do not

necessarily imply mathematical thinking, and cognitive engagement does not emerge automatically from the structures and practices of BTC; this requires deliberate work from the teacher. Based on this, we suggest that future research on engagement in BTC should imply a more nuanced notion of student engagement.

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