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Positive Shifts In Teacher Instructional Practices With Use Of CueThink

A recent 2021-22 study shows that teacher instructional practices shift in meaningful ways with the use of the CueThink application.

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EXECUTIVE SUMMARY

A recent 2021-22 study shows that teacher instructional practices shift in meaningful ways using the CueThink application. Embedded product features in conjunction with curated learning materials supported the teachers' implementation of effective teaching practices, enumerated by the National Council of Teachers of Mathematics (NCTM). This study was a culmination of the Small Business Innovation Research (SBIR) grant from the National Science Foundation (NSF) which comprised of three key goals:

1. Build embedded supports for teachers into the CueThink application.

2. Curate learning materials for teachers that are aligned to the effective use of CueThink and to the NCTM (2014) effective teaching practices.

3. Conduct a study to examine the ways in which the use of CueThink and engagement with the learning materials influenced the teachers' use of four of the effective teaching practices.

This paper reports the results of the multiple case study that was conducted during the 2021-2022 school year with seven teachers from three different school districts in varying geographical locations.

After analyses of teacher interviews, surveys, and videos of classroom instruction, **the study found that the combination of using CueThink with the associated learning materials led to significant positive changes in teacher instructional practices.**

While a more robust description of findings is included below, key findings are summarized here.

Specifically, the study found that every teacher in the study increased the degree to which their instruction aligned with the measured effective teaching practices (see NCTM, 2014).

These changes included:

- Increased attention to and use of high-quality problems.
- Increased opportunities for students to share their thinking and participate in class discussions.
- Increased support of students in making sense of problems and a corresponding decrease in the use of ineffective keyword strategies.
- Increased occurrence of teachers asking purposeful questions such as those that elicit student thinking or encourage discussion around important mathematical concepts.

Although every teacher demonstrated significant shifts in one or more of the effective teaching practices, **the observed changes were the greatest for teachers who had high engagement with the learning materials and who routinely used CueThink with their students.**

Conclusion: These results suggest coupling student use of CueThink with associated educator learning materials supports teacher implementation of NCTM's effective mathematics teaching practices.

This report is based upon work supported by the National Science Foundation under Grant No 1660216

CUETHINK

CueThink is an innovative web application focused on improving math-problem solving and collaboration skills

1

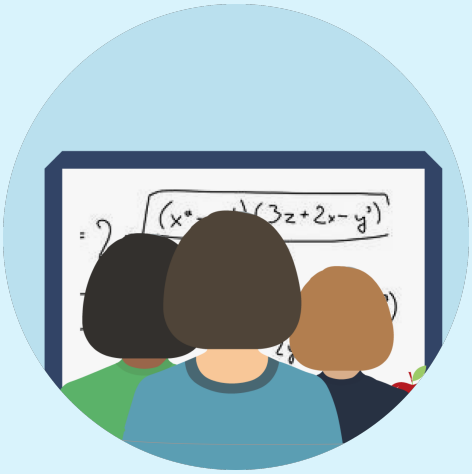
All voices heard

A safe space for students to share their work and thinking. It allows teachers to intentionally select, sequence and compare student work and implement the 5 Practices.

2

Promotes math discourse

A dedicated space in CueThink allows students to write questions and comments about peers' work. As students consider different ways of solving, embedded prompts help start the discussion.



3

Captures visible thinking

Digital whiteboard work and voice recording captures 'in the moment' student thinking. Interactive tools give students choices to model solution pathways.

Together we can shift classroom culture.

Positive Shifts In Teacher Instructional Practices With Use Of CueThink

INTRODUCTION

The National Council of Teachers of Mathematics (NCTM) has long advocated for designing and implementing instruction around eight effective teaching practices (2014). Within these practices, NCTM suggests that mathematics teachers should allow problem solving and student thinking to drive instruction, creating a need for increased support and professional development (PD) as teachers work to implement these practices in their classrooms. Unfortunately, few high-quality studies have explored mathematics PD (see Gersten et al., 2014; Yoon et al., 2007). What is known, however, is that it is important for PD to be embedded within classroom practice (Ball & Cohen, 1999).

Building from this base, CueThink undertook an NSF-funded grant aimed at supporting teachers in implementing four of the effective teaching practices. Specifically, CueThink expanded their product – a web application that scaffolds the problem-solving process – by adding embedded supports for teachers, and by curating external PD materials that teachers could access when using CueThink in their classrooms. In coupling these materials together with the use of CueThink, the goal was to explicitly tie PD to classroom practices, thereby supporting teachers in effectively teaching problem solving.

CueThink then conducted a study which examined the ways in which the application and the associated PD influenced:

1. The tasks teachers select for instruction
2. The ways in which teachers elicit or share evidence of student thinking
3. The ways in which teachers facilitate meaningful mathematical discourse
4. The ways in which teachers pose purposeful questions
5. The ways teachers envision classroom instruction related to problem solving

This paper reports on high-level findings from the study.

Funded by The National Science Foundation, CueThink is an innovative application focused on improving math problem-solving and collaboration skills.

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STUDY OVERVIEW

Using a multiple-case study design, researchers collected data from each participant at three distinct times: 1) prior to the use of CueThink; 2) after approximately 10 weeks of use of CueThink; and 3) at the end of the approximately 5 month study period. At each period of time, teachers were interviewed using a semi-structured protocol that addressed the five research questions listed above. In addition, each teacher was asked to videotape and submit a lesson of their instruction related to problem solving. Finally, teachers completed monthly surveys about their engagement with the PD materials which was supplemented with usage data pulled from CueThink and the Learning Management System (LMS) which housed many of the PD materials. Data from these sources were then triangulated to create participant profiles at each distinct period in time, which were then compared across time to determine what (if any) changes in teacher beliefs or instruction occurred.

Participant Background and Engagement

Seven teachers from three different school districts across the United States participated in the study. The participants taught grades 3-8 and had 2 to 36 years' experience prior to the study. Participants had varied levels of engagement during the study. Five out of the seven teachers viewed at least 73% of the learning materials, with two teachers viewing less than 33% of the materials and two teachers viewing more than 97% of the materials. The teachers met the requirements for minimum number of problems to assign - their assignments ranged between 9 to 20. The percentage of students starting the assignments varied from 42% to 100%, with the students in four classes starting the problem-solving process on 100% of the assignments, as summarized in Table 1 below.

Teacher	% of Canvas Materials Viewed	Problems Assigned	% of Assignments Completed	% of Assignments Started
Ms Williams	0%	15	33%	67%
Ms Johnson	33%	9	83%	89%
Ms Harris	73%	20	42%	100%
Ms Clark	85%	12	100%	100%
Ms Miller	88%	12	100%	100%
Ms Jackson	97%	11	24%	42%
Ms Smith	100%	14	89%	100%

Table 1: Teacher Background and LM Engagement Data

STUDY FINDINGS

Every teacher in the study demonstrated meaningful shifts in their instruction, suggesting that the combination of the use of CueThink and the associated PD was effective in supporting teachers in implementing the effective teaching practices. High-level summaries of findings associated with each identified practice are provided below. It is important to note, however, that teachers who did not shift their practices in a given area tended to also have lower engagement with either CueThink and/or with the PD.

The tasks teachers select for instruction

Effective problem solving instruction necessitates starting with high-quality problems that afford students opportunities to engage in sense-making and to talk about their thinking with their teacher and their peers. Promisingly, data collected from six out of the seven teachers suggested positive changes in how the teachers selected problems, with all observed changes resulting in increased alignment with the NCTM (2014) teaching practices. Specifically, the teachers began looking for problems that were more rigorous, that had multiple solutions or pathways, that allowed for sense-making, and/or that created opportunities for students to talk about their thinking.

The ways in which teachers elicit or share evidence of student thinking and facilitate meaningful mathematical discourse

Many of us can recall or picture mathematics classrooms in which students sit in rows, quietly taking notes or working individually. However, research has shown that providing students with opportunities to talk to each other may lead to a myriad of positive outcomes for students such as increased mathematical understandings and the ability to transfer their knowledge to new concepts (e.g., D'Ambrosio et al., 1995; Resnick et al., 2010). Moreover, doing so empowers students to build new understanding off of their existing funds of knowledge. Thus, it is unsurprising that NCTM (2014) continuously emphasizes the importance of creating opportunities for students to share and discuss their thinking.

Encouragingly, five of the seven teachers who participated in the study exhibited positive shifts in how they elicited student thinking. Additionally, five of the teachers exhibited shifts in their classroom discourse. Examples of teachers' shifts varied and included providing additional avenues for students to share their thinking and talk (e.g., through turn and talks), and replacing questioning techniques that funneled student thinking or gathered information with questions that encouraged students to explain how they were thinking about solving the problem.

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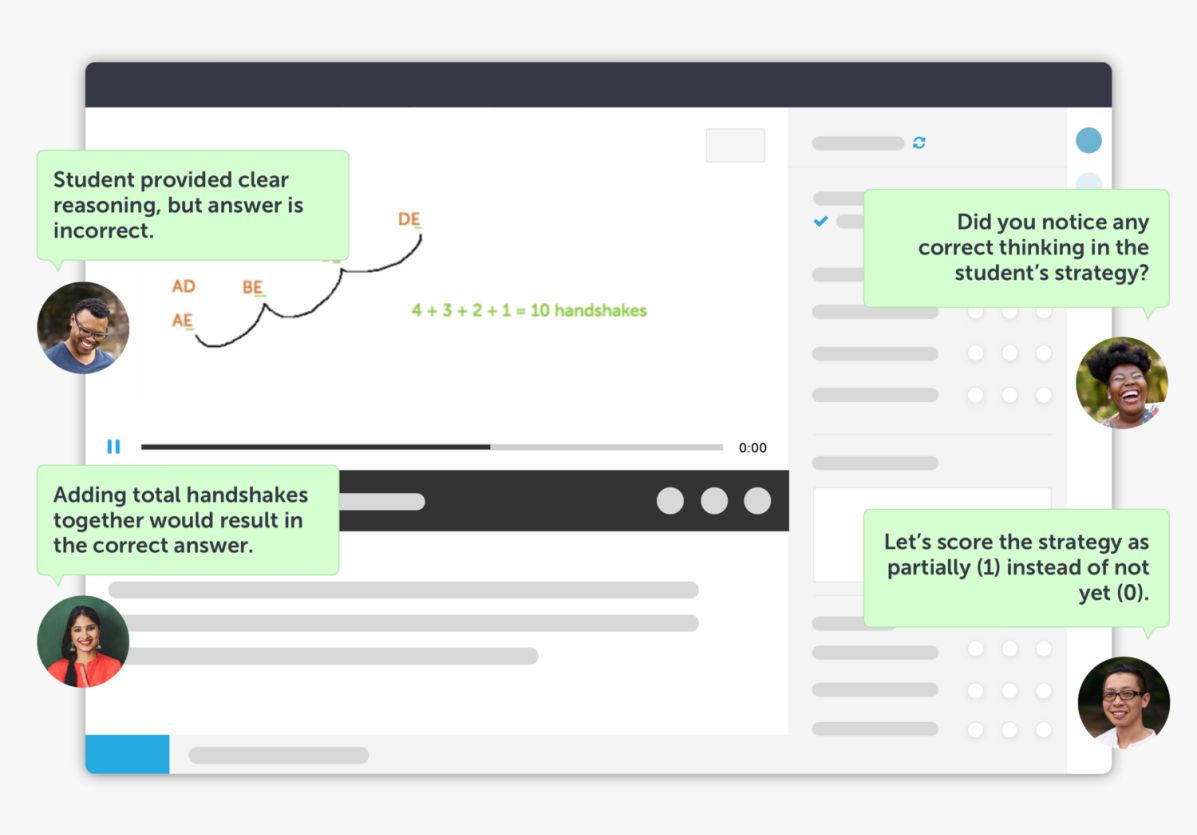
Moreover, some teachers noted that the study had given them an increased appreciation of student discourse. When asked about these changes in their instruction, teachers attributed their personal shifts to having seen the value of student thinking and to seeing what their students were capable of. In other words, CueThink supported teachers in changing their perceptions of student knowledge and potential by providing a window into their students' thinking process through features such as the planning journal and recordings of students explaining their thinking.



The ways in which teachers pose purposeful questions

Asking questions is a key part of teaching mathematics. However, it is important to recognize that not all questions serve the same purpose. While questions aimed at gathering information about what students can recall, for example, are certainly important, it is equally important to ask questions that create opportunities for students to share their thinking, reflect, or make connections between mathematical ideas (NCTM, 2014).

At the start of the study, most of the teachers tended to ask a number of questions aimed at gathering information or funneling student thinking, meaning that there was a dearth of questioning related to the other areas. However, data from the study suggested that all seven teachers shifted in the questions that they posed. Within this, nearly all of the teachers began to ask fewer questions aimed at gathering information or funneling student thinking, opting instead to ask questions that made student thinking visible or that helped facilitate student discourse.

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For six of these teachers, this consisted of asking students about their thinking, their ideas, what they noticed or wondered, or asking questions to encourage students to engage with the ideas of their peers. For the remaining teacher, they began to increase the number of open-ended questions they asked, causing students to respond with more robust answers. In these ways, the study was extremely effective in supporting teachers in asking purposeful questions.

The ways teachers envision classroom instruction related to problem solving

The final way in which study data was analyzed was related to the ways in which the teachers approached problem-solving instruction. Within this, shifts were noted in six out of the seven teachers. Critically, teachers were observed de-emphasizing or eliminating the use of keyword strategies–which are often cited as ineffective in research studies and are in contradiction to the NCTM (2014) effective teaching practices. Instead, teachers began to support students in making sense of the problems by asking them what they notice and wonder, and by prompting them to draw on their personal experiences to connect with and understand the mathematics.

In addition, the teachers increased the degree to which they valued the thinking involved in problem solving, with some teachers being more explicit in modeling their own thinking, while others began to create opportunities for students to do more of the thinking and explaining. Within this, teachers spent longer unpacking the process of problem solving, working to develop their students' critical thinking and reasoning skills.

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SUMMARY

Although causal relationships are difficult to assess, the data from this study suggests that the combination of the use of CueThink and PD materials resulted in the significant shifts in practice. The most significant shifts appeared to occur within the ways in which teachers facilitated mathematical discourse and elicited or shared student thinking, particularly for teachers with higher engagement with the product and the teaching materials. Within these areas, teachers began to intentionally ask questions to elicit student thinking or encourage peer to peer discourse. Although many teachers admitted that they had yet to realize their ideal classrooms in either regard, they attributed the strides they had made (and their students had made) to seeing what their students were capable of through the use of CueThink and to the PD helping them overcome past barriers to implementing best practices.

Significantly, the shifts in these areas appear to have prompted shifts in other areas, as teachers began to look for problems that allow for the sharing and discussion of student thinking, began to ask more questions to elicit thinking and encourage discourse, and began to move away from ineffective keyword strategies in favor of sense-making. Consequently, the use of CueThink appears to be an effective tool for shifting teacher practices in positive ways, particularly when coupled with professional development materials targeting these practices.

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