AI-Generated Feedback for the Virtual Tutoring Community: Lessons Learned through Design Research

Summary of Solution

TeachFX uses artificial intelligence (AI) technology to provide K–12 classroom teachers with automated targeted feedback on their instruction, with the goal of creating more engaging and equitable classrooms. Examples of such feedback include information on student–teacher talk ratios, use of open-ended questioning, and think time. In late 2021, TeachFX partnered with Cignition, a math and literacy virtual tutoring provider, to study the usefulness and usability of the existing TeachFX offering for virtual tutors and to gather insight on how to adapt the existing offering to the broader virtual tutoring context, including teachers, tutoring program managers, and parents. In the context of this partnership, tutors used TeachFX's Zoom integration to record tutoring sessions and receive automated feedback on their instructional practices and student engagement. Cignition program managers accessed an Administrator Dashboard that summarized tutors' instructional practices and student engagement across tutoring sessions. Parents and tutors viewed mock-ups of an Individual Student Dashboard that summarized individual students' participation during tutoring sessions.

Implementation Context

TeachFX partnered with Cignition and a suburban/rural school district in the southeastern United States to pilot its tool in a tutoring context. Cignition offered its group tutoring program to students in spring and fall 2022 and offered an additional 1:1 tutoring program during the fall. Students participated in group tutoring during an intervention period during the school day, whereas students who participated in 1:1 tutoring did so after school hours. The fall group tutoring program began in September, and the 1:1 program began in October. Both programs ended in mid-January 2023. Among students who participated in tutoring, 51 percent were White, 29 percent were Black, 9 percent were Latino, 10 percent were multiple races, and 1 percent were Asian.

Methods and Limitations

TeachFX and Cignition collected two rounds of qualitative data in 2022. They conducted interviews with virtual tutors leading group and 1:1 tutoring sessions, tutoring program managers, students participating in tutoring, and their parents and teachers. Initially, interviews focused on the usability and usefulness of TeachFX's existing offering. The second round of interviews, conducted in fall 2022, focused on the perceived usability and usefulness of mock-ups of new product features and functionalities designed specifically for the virtual tutoring context. Students who participated in Cignition group tutoring completed surveys after each session, which the project team analyzed descriptively. The project team also gathered quantitative data using TeachFX, including data on tutors' use of wait time, open-ended questions, and instances of building on students' contributions, to analyze associations between tutor practice and student talk during tutoring sessions.

The project team designed this study to explore users' perspectives about applying an existing product in a new educational context. Therefore, all study analyses are exploratory.

Findings

After using TeachFX for 14 weeks in fall 2022, Cignition tutors reported TeachFX increased their awareness of their instructional practices and student participation during tutoring sessions. Tutors also reported TeachFX improved the quality of their tutoring. Parents and teachers of participating students responded positively to the Individual Student Dashboard, sharing that it provided clarity about student learning and participation in tutoring sessions. Cignition program managers reported mock-ups of the Administrator Dashboard would improve the quality and effectiveness of feedback they provide to tutors.

TeachFX also explored relationships between some of the high-leverage instructional practices its app detects and a key outcome of interest: the student–tutor talk ratio. Analyses revealed a strong, positive association between tutors' use of wait time and student talk time. This finding suggests providing wait time after a student speaks can promote student participation in tutoring sessions.

The TeachFX & Cignition Partnership

Using audio recordings of teachers' lessons, TeachFX applies artificial intelligence (AI) to provide teachers automated feedback on their use of high-leverage instructional practices and student discourse. Thousands of classroom teachers across the country have used TeachFX to record their instruction and reflect on their practice. The use of TeachFX in classroom settings shows promise for increasing student talk during class time, which research demonstrates is a key component to learning (Bianchini, 1997; Cohen et al., 1989; Lotan, 2012; Michaels, 2008; Vygotsky & Cole, 1978).

Cignition tutors are experienced educators who deliver math (K-12) and literacy (K-8) virtual tutoring, and studies have demonstrated that Cignition is successful at producing student learning gains (Roschelle et al. 2020; Pratt et al. 2023). Thousands of students across the United States participate in Cignition's High-Impact Tutoring Program. Cignition's research-based approach focuses on data-informed instruction and collaborative learning that encourages student-to-student interaction to build deep conceptual understanding of mathematics and literacy content. In Cignition's tutoring sessions, students solve open-ended tasks and are encouraged to explain their thinking, agree and disagree with their peers, and build on each other's ideas. Cignition's collaborative approach to learning promotes the development of core academic, critical-thinking, and communication skills, all of which are vital to long-term success.

In late 2021, TeachFX partnered with Cignition to explore applications of TeachFX in tutoring contexts. Both partners were motivated by their belief that better quality and access to data within the tutoring ecosystem can improve tutoring quality and support student learning. With the increased demand for high-impact tutoring in recent years, this partnership sought to understand the usefulness and usability of TeachFX's existing offering for Cignition's virtual tutors and for keeping students, parents, and teachers informed of students' participation and progress in tutoring. TeachFX and Cignition believe that providing the tutoring community with holistic, objective data on student engagement and tutors' instructional practices can improve tutoring quality to better support student learning. Insights from their partnership yielded a new network of data and support (Figure 1).

Design Research Process

TeachFX and Cignition partnered in late 2021 to conduct a design research study in a suburban/rural school district in the southeastern United States in which Cignition provided both individual and group tutoring and with whom Cignition has a strong working relationship.

The project team, which included staff from TeachFX, Cignition, and Mathematica, identified tutors, program managers, parents, and students who would participate in research activities. Research questions included:

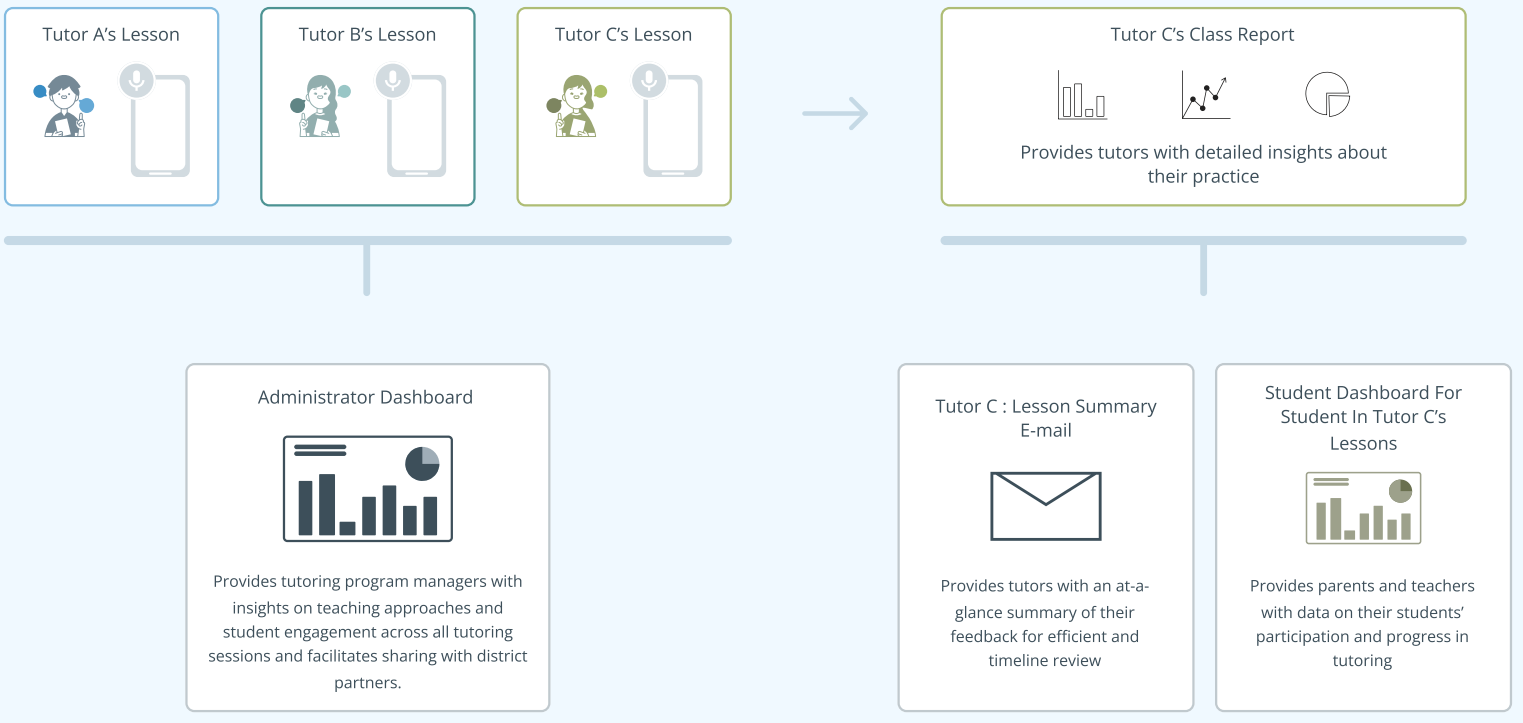
1. What motivates Cignition tutors and the program management team, and what are their needs? How might TeachFX be useful to

them?

2. What information about tutoring sessions is useful for parents and math teachers? How would they like to receive information on tutoring sessions?
3. How useful do Cignition tutors find TeachFX for their tutoring?
4. How can math tutors create an environment where students feel comfortable participating and feel supported and successful in tutoring sessions?
5. How useful do Cignition program managers find TeachFX as an addition to their tutoring program? How easy is it to navigate the TeachFX Administrator Dashboard? How challenging was it to incorporate TeachFX into an existing tutoring system?
6. Are there changes over time in tutor instructional practices and student talk time when Cignition tutors use TeachFX?
7. What is the association between select high-leverage instructional practices and the student–tutor talk ratio?

The project team collected qualitative data in two phases during spring and fall 2022 and conducted interviews with Cignition's virtual tutors and program managers, classroom teachers and interventionists from the participating school district, and students who participated in Cignition tutoring and their parents. Initially, interviews focused on the usability and usefulness of TeachFX's existing offering (research questions 1 through 4). The second round of interviews, conducted in fall 2022, focused on the perceived usability and usefulness of mock-ups of new product features and functionalities designed specifically for virtual tutoring context (research questions 3 through 5). All interviews were conducted remotely and recorded using Zoom. The project team analyzed transcripts for common themes across each respondent group and research question. In tandem with the qualitative design research described in this report, TeachFX conducted exploratory analyses of the associations between high-leverage instructional practices and the student–tutor talk ratio measured by TeachFX (research questions 6 and 7). TeachFX used data collected during Cignition's fall 2022 group tutoring program for these analyses.

Figure 1. TeachFX and Cignition's virtual tutoring and the reports designed during this research



Designing for Tutoring Program Staff: Key Findings

The project team interviewed four tutors—the primary users of the original TeachFX class report—during both spring and fall 2022. Interviews in the spring focused on Cignition tutors' motivation and their data needs and perceptions of TeachFX's usefulness and usability. Findings from the first phase of interviews led to the development of new product features, including "Featured Moments," which identifies the top five moments from a tutoring session that showcase strong instructional practices and student engagement (for example, student contributions lasting 7 seconds or more). This feature intends to reduce the time required for tutors to glean useful insights from a class report. For the second round of data collection, Cignition tutors used TeachFX for 14 weeks before participating in an interview. In this set of interviews, the project team sought to better understand the usefulness and usability of TeachFX, both with the added features like "Featured Moments" and with more experience using the tool.

Virtual tutors found TeachFX useful for understanding their instruction and student participation in their sessions.

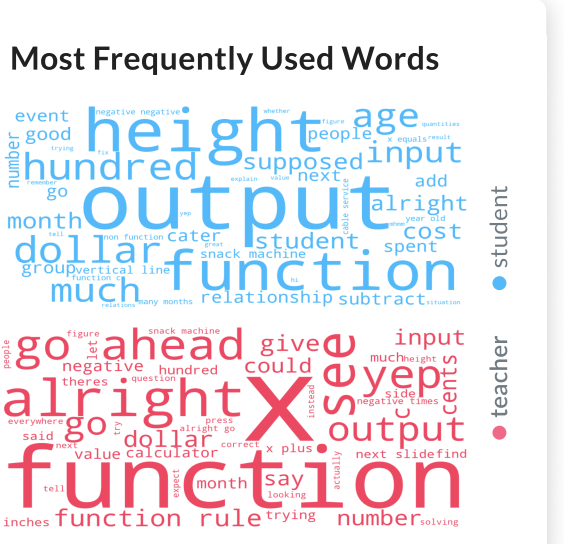
All four tutor respondents shared that TeachFX was useful and that viewing the student–tutor talk ratios was particularly helpful in reflecting on their sessions. Two tutor respondents shared that word clouds of the most frequently spoken words by tutors and students helped them gauge the extent to which students used math vocabulary in sessions (Figure 2). When asked about how they used TeachFX, one tutor shared, "TeachFX made me completely more aware of how much time I talk. I've found it extremely "TeachFX made me completely more aware of how much time I talk. I've found it extremely beneficial."

Early in the research process, the project team learned that tutors have multiple tutoring sessions each day and may not have the time to review each TeachFX class report in depth. Tutor respondents noted the summary email TeachFX delivers after a tutoring session provides helpful metrics for each session including student–tutor talk ratios and word clouds of the most frequently spoken words by tutors and students. Two tutor respondents noted the summary email includes sufficient feedback to assess their tutoring sessions. In contrast, two respondents shared that reviewing the email prompts them to review the complete class report and conduct a deeper review of data from the session. One respondent shared, "It is useful to get emails that have just a snapshot of the data and then I'm like, oh yeah, I need to look, and this is interesting and can look in there."

Virtual tutors believed TeachFX helps them improve their instruction and student engagement.

Tutor respondents said TeachFX helps them improve their instruction and student engagement. One tutor shared, "It was easy to take the TeachFX information and integrate it into what I'm doing and to have it help me to be better." All tutor respondents noted efforts to reduce their talk time during sessions, including efforts to "to speak more slowly and more intentionally." Three of the four tutors identified wait time—both after asking a question and after a student responds—as targeted areas for improvement after using TeachFX. One tutor noticed that through providing more wait time, a student in a recent session was able to effectively build on a response and demonstrate his understanding: "He was

Figure 2. Example word cloud



REFLECT

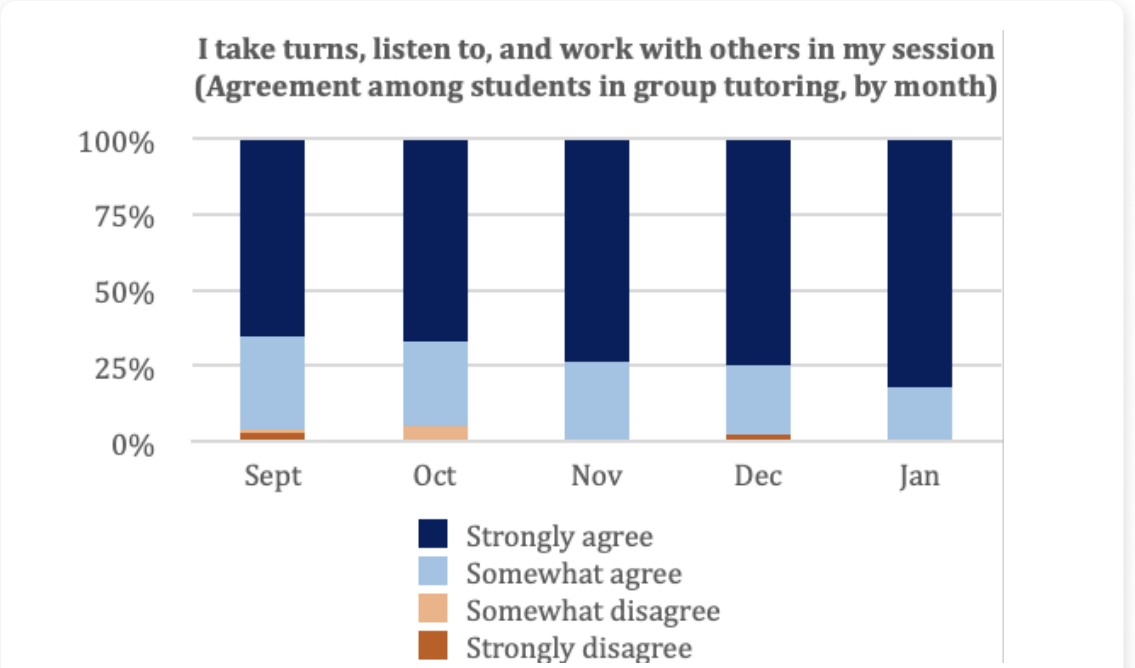
Does this vocabulary reflect your objectives for this lesson?

able to come to a better understanding than if I had interrupted him during his think time and during his processing time."

Two tutors reviewed their TeachFX class reports to identify the questions they used in previous lessons that were most successful in eliciting student responses. They included these questions in subsequent lessons to increase student engagement.

Student survey data, which Cignition collected weekly, also suggest increased equity of student voice over the course of the group tutoring program, which is a key goal of Cignition's tutoring techniques (Figure 3). At the beginning of the tutoring program in September, 5 percent of students somewhat or strongly disagreed that they take turns, listen to, and work with others in their sessions, but at the conclusion of tutoring in January, all students surveyed agreed (81 percent strongly and 18 percent somewhat) that they participate in that way.

Figure 3. Students survey responses from fall 2022 tutoring program



> High-leverage instructional practices tracked by TeachFX, such as providing think time after a student speaks and building on student contributions, were positively correlated with student talk time.

The study identified a strong, positive association between tutors' use of wait time 2 (the amount of time spent waiting after a student speaks) per hour and student talk time (0.60, $p < .001$). This suggests that providing wait time after a student speaks can encourage student participation in tutoring sessions, consistent with Rowe's (1986) findings that wait time 2 is particularly powerful for increasing the probability of student elaboration in classroom settings.

The team also identified a small but positive association between tutors' use of uptake (building on student contributions) and student talk time (0.33, $p < .001$), which aligns with findings from prior research that showed a positive relationship between uptake and student discourse (Sharpe et al., 2008). TeachFX plans to conduct additional research to validate these findings in larger controlled experiments and to understand the impact of TeachFX in other tutoring contexts.

Designing a Student Dashboard for Parents and Teachers

The project team also included the perspectives of parents and teachers in qualitative research activities. Parents and teachers are members of students' communities who are not always present during virtual tutoring sessions, and so the team aimed to understand what information about tutoring sessions is most useful to them.

The first round of interviews with parents and teachers (one parent, two interventionists, and one classroom teacher) brought up a variety of preferences for both the content and frequency of information about tutoring sessions across respondent groups. Based on these findings, TeachFX designed the Individual Student Dashboard, which displays insights from tutoring sessions at the individual student level. These insights include measures of attendance and engagement, student–tutor talk ratio, questions and answers, collaborative moments, and long student contributions, lasting 7 seconds or more. (see Figure A.1 in Appendix A).

During the fall interviews, the project team shared a dashboard prototype of the Individual Student Dashboard with two parents and one interventionist to understand its usefulness and usability. When reviewing the dashboard, all three respondents shared that it would be useful in tracking progress in tutoring sessions. The interventionist respondent initially shared that they already have a good read on engagement from supervising student tutoring, but after reviewing the Individual Student Dashboard remarked that it would provide "tangible data" for conversations with parents. Both parents shared that the dashboard is easy to understand and noted the attendance and engagement data were particularly useful.

Designing an Administrator Dashboard for Tutoring Program Managers

The project team also interviewed Cignition program managers to understand whether additional student and tutor data might be helpful in their work with tutors. Cignition program managers manage tutoring programs in school districts across the country. Depending on the size of a tutoring program, Cignition program managers may manage hundreds of tutors. One of the responsibilities of the program manager is to ensure tutors use a student-centered, collaborative approach to learning. To do this, a program manager can review Cignition's student engagement and student feedback data after each session and observe tutoring sessions, although this can be time-consuming. Findings from the spring interviews suggested Cignition program managers would benefit from reviewing TeachFX data. Thus, TeachFX developed the Administrator Dashboard for program managers to view aggregated TeachFX data across multiple tutors and tutoring sessions simultaneously (Figure 4). The project team reengaged two of the Cignition program managers who participated in previous interviews to share their thoughts on the usefulness and usability of the dashboard prototype.

After engaging with a mock-up of the Administrator Dashboard, the two Cignition program manager respondents shared it would be a useful support that has value for their work. Both respondents noted that with hundreds of tutor supervisees, the dashboard enables them to "observe" more sessions than would otherwise be possible, and that it provides practical data to share with district partners and to target specific feedback to tutors. One respondent noted that although reviewing additional data might require additional time, "It's gonna make me more effective."

Next Steps

Based on this research, TeachFX sees implications for its work, both in terms of future product development and in areas for future research.

- **Continue developing tutoring offering.** TeachFX was designed for classroom teachers, and this was the first time TeachFX piloted its

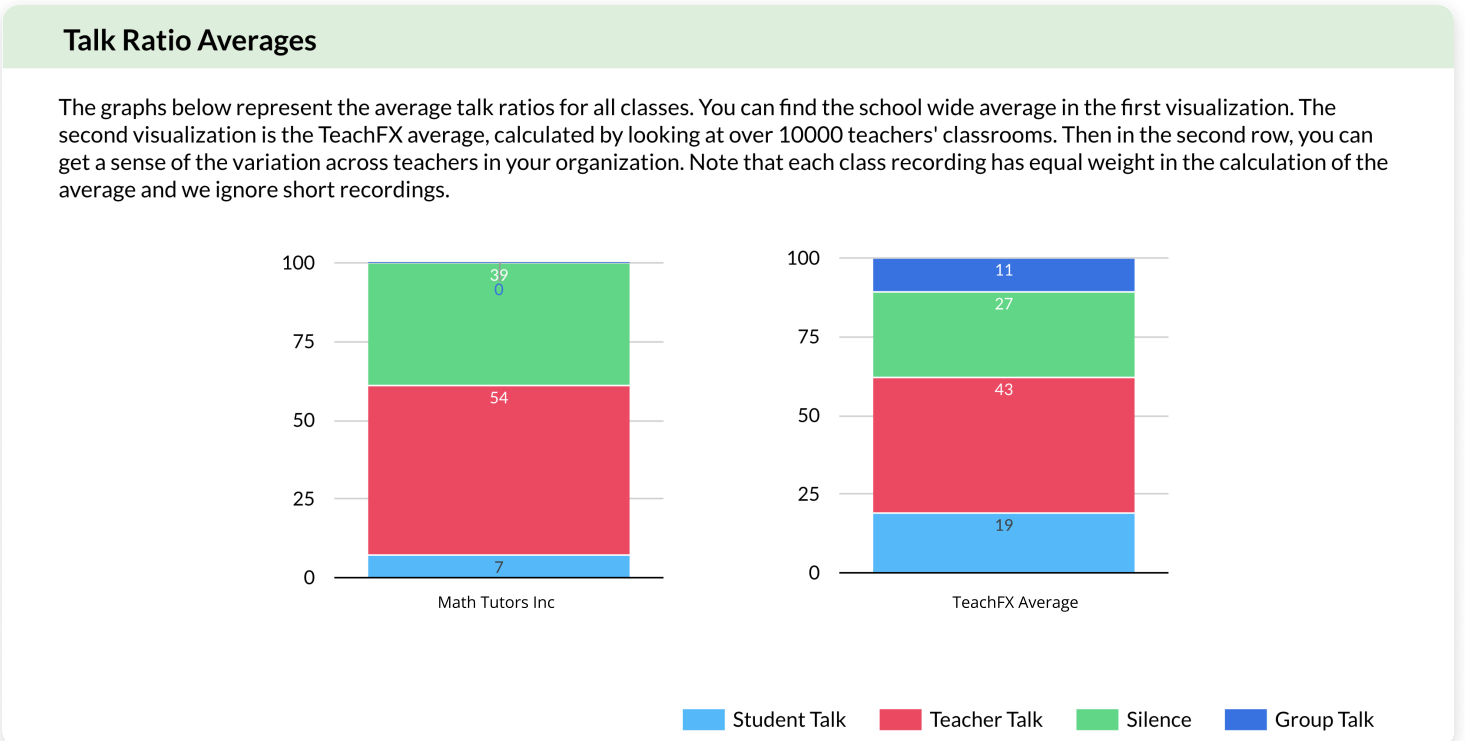
product with virtual tutors. Feedback from tutors indicates that TeachFX is a high-value addition to the virtual tutoring context. TeachFX plans to conduct additional user testing with more tutoring providers to continue to corroborate findings about the features designed based on the feedback collected in additional tutoring settings.

- **Conduct research on TeachFX's impact.** This descriptive study provided valuable insight into the user experience; however, TeachFX plans to conduct additional research to validate quantitative findings in larger controlled experiments and to further understand the impact of TeachFX in other tutoring contexts not studied in this research study. Areas of interest for further study include in-person tutoring, 1:1 tutoring, tutors with less professional classroom experience (including near-peer tutoring), tutoring offered after school, and on-demand tutoring.

- **Explore additional use cases for the Individual Student Dashboard.** The project team spoke with students to understand the conditions in which they feel comfortable participating and being supported in their tutoring sessions. The Individual Student Dashboard was designed primarily for parents and tutors. However, prior feedback TeachFX received suggests students might enjoy and find motivation in viewing the Individual Student Dashboard. In the second phase of research, the project team shared a mock-up of the Individual Student Dashboard with six students for feedback. One student expressed interest in reviewing their own data in the dashboard format, but the other respondents were indifferent. TeachFX seeks to further understand how providing students with objective data affects their engagement in tutoring sessions.

- **Explore developing automated measures to assess relational dynamics in virtual tutoring.** Student respondents shared that tutoring practices that sought to build trusting student–tutor relationships make them feel more comfortable participating in sessions. Routine ice breaker activities and non-academic questions that allow students to share information about themselves with their tutors helped students feel more comfortable participating in tutoring sessions. This finding suggests virtual tutoring providers might consider structures to strengthen student–tutor relationships. Given the importance of relational dynamics in student learning, TeachFX is interested in developing automated measures to assess and track the student–tutor relationship over time.

Figure 4. Example talk ratio from the Administrator Dashboard



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This publication is based on research funded by the Bill & Melinda Gates Foundation. The findings and conclusions contained within are those of the authors and do not necessarily reflect positions or policies of the Bill & Melinda Gates Foundation.

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Appendix A. Individual Student Dashboard Mock-Up

The Individual Student Dashboard provides parents, interventionists, teachers, program managers, and tutors with important insights from tutoring on the individual student level. The dashboard was developed based on findings from the spring 2022 interviews with parents who expressed interest in learning more about their child's tutoring.

Figure A.1. Individual Student Dashboard mock-up