

EXECUTIVE SUMMARY

Finding a Path for Equitable Mathematical Student Discourse: Targeted Universalism Meets Human-Centered Design

Profound things happen when one human being lets another human being know that their voice matters. For students, the more they feel their voice is heard, the greater their opportunity to learn. These sentiments were the driving force for the project team that created the prototype for the *5 Practices Pathfinder*, a teacher-facing app designed to support the implementation of the 5 Practices for Orchestrating Productive Mathematics Discussions (Smith & Stein, 2011).

Through a partnership between Amplify and the Bill & Melinda Gates Foundation, this project aimed to create a prototype for a digital tool to support teachers in operationalizing the pedagogical model of the 5 Practices. The findings and conclusions of the project are those of the authors and do not necessarily reflect positions or policies of the Gates Foundation.

Teachers experience challenges using the 5 Practices in their classrooms (Smith & Sherin, 2019). These challenges can specifically affect Black and Latinx students, who are disproportionately more likely than

white students to attend mathematics classrooms that have fewer opportunities for rich mathematical discourse and are more likely than white students to engage in learning that is rote-oriented and remedial (Delpit, 2012; Noguera, Darling-Hammond, & Friedlaender, 2015; TNTP, 2018). At the same time, research has shown that these priority students benefit from discourse-focused mathematics instruction, but that these assets are currently under-leveraged in most classrooms (Archer, 1993; Darragh, 2016; Gray, Hope, & Matthews, 2018).

The project team hypothesized that *creating a useful digital teacher-facing tool for the 5 Practices would increase teachers' self-efficacy with the 5 Practices. With this digital teacher-facing tool, teachers of Black and Latinx students would perceive the 5 Practices as being less challenging, and this work would benefit teachers of all students.*

Process

Ongoing mixed methods research with project advisors Margaret (Peg) Smith and Michael D. Steele and a six-member Teacher Advisory Board composed of teachers of priority students informed the creation of the digital solution. The high-quality instructional material and open education resource *Illustrative Mathematics* (IM) curriculum was used as a basis for the instructional materials. The goals of the project were to (1) create a proof-of-concept prototype of a digital tool that supports the implementation of the 5 Practices with the IM curriculum, (2) solve the top challenges teachers of priority students face while implementing the 5 Practices, and (3) incorporate Targeted Universalism with Human-Centered Design to include equity in the design process.

The project team based their work on the theory of Targeted Universalism tested with Human-Centered Design and design thinking protocols, centering the design of the prototype on ongoing mixed methods research with teachers of priority students on the Teacher Advisory Board.

The key idea of Targeted Universalism is that better understanding the unmet needs for priority users may provide insights that improve usability and value-add for all, while Human-Centered Design calls for starting product design with understanding the needs of the users you are creating for and ensuring that the ongoing design process is continually based on users' perspectives.

The project team used a combination of the Google Ventures Sprint protocols (Knapp, Zeratsky, & Kowitz, 2016) with Agile Scrum development framework protocols (Schwaber & Sutherland, 2018) to create an evolution of Human-Centered Design through which to test the targeted universalist hypothesis: seven two-week iterative design sprints incorporating feedback from teachers of priority students gathered through both qualitative and quantitative methods, each followed by a two-week development sprint building and developing what had emerged from the design sprints as strongly meeting those teachers' needs.

Outcomes

Smith and Sherin (2019), with collaboration from Victoria Bill and Michael D. Steele and based on the group's collective experiences in working with teachers and the 5 Practices for the past decade, identified 19 challenges teachers may encounter while implementing the 5 Practices in a classroom setting.

Initial qualitative and quantitative research identified the top challenges from this list of 19 that are faced by teachers of priority students and of all students and potential means to address these top challenges.

Ongoing qualitative feedback from the Teacher Advisory Board and an ongoing literature review on equity and discourse in mathematics education coalesced around four main themes for needed features to address these Challenges. Figure 1 shows selected qualitative feedback quotes from the Teacher Advisory Board about features created to address each of the four main themes.

Theme One:

Support Equity: Help teachers to engage with all students in the classroom

"When you're in the monitoring phase, you can select the specific kids who are engaging with each other or with you and your questions. And it [the app] highlights it [the student] yellow. [That's a] big boost to my ability to reach all the kids" (Guillermo Post-Interview, 10/6/2020).

Theme Two:

Support Pedagogy and Curricula: Help teachers use productive 5 Practices approaches

"I love the helpful hints...to help me implement, with fidelity, the best instruction with the 5 Practices" (Shannon Post-Interview, 10/7/2020).

Theme Three:

Save Teachers Time: Maximize in-classroom interactions and practices

"The app has really improved the ability to do all of these things that are time-intensive from a teacher's perspective. My overall comfort with the 5 Practices in general...I feel better because of the app" (Mark Post-Interview, 10/6/2020).

Theme Four:

Enable Teacher Superpowers: Make it possible for teachers do things they could not do before

"Before the app, I was like, I don't know where to start [with Selecting and Sequencing]. But the app gives you those bridging things to follow, gives you suggestions of how to link productive and non-productive strategies...to help students make sense of the problem...the app gives you suggestions that you can alter or change" (Deja Post-Interview, 10/7/2020).

Figure 1: The four main themes and an example of feedback that supported each theme. **Note:** Quotes from semi-structured feedback interviews with Teacher Advisory Board members.

Post-project research measured the degree to which the prototype ameliorated the top challenges the Teacher Advisory Board faced with the 5 Practices through a quantitative survey and qualitative semi-structured interviews. Table 1 compares the number of Teacher Advisory Board members who responded via quantitative surveys that a top challenge would be a moderate or major challenge before the project and post-project with the prototype.

Table 1. Number of Teacher Advisory Board members who said a top challenge would be a moderate or major challenge before project and post-project with prototype

Challenge	Before Project	Post Project With Prototype
Keeping track of group progress	4	0
Involving all members of a group	4	0
Deciding what work to share when the majority of students were not able to solve the task and your initial goal no longer seems obtainable	4	2
Moving forward when a key strategy is not produced by students	4	3
Determining how to Sequence errors, misconceptions, and/or incomplete solutions	3	0
Keeping the entire class engaged and accountable during individual presentations	3	1
Making sure that you do not take over the discussion and do the explaining	4	1
Running out of time	5	5

Note: Data from Pre- and Post- 5 Practices Survey. Challenge names from Smith & Sherin, 2019.

As shown in Table 1, the number of Teacher Advisory Board members who rated a challenge as moderate or major decreased for seven out of the eight top challenges.

The usefulness of specific features created to align with the four main themes were tested at the conclusion of the project with the Teacher Advisory Board and a larger sample of teachers of both priority and non-priority students through a survey based on the Technology Acceptance Model (Davis, 1989).

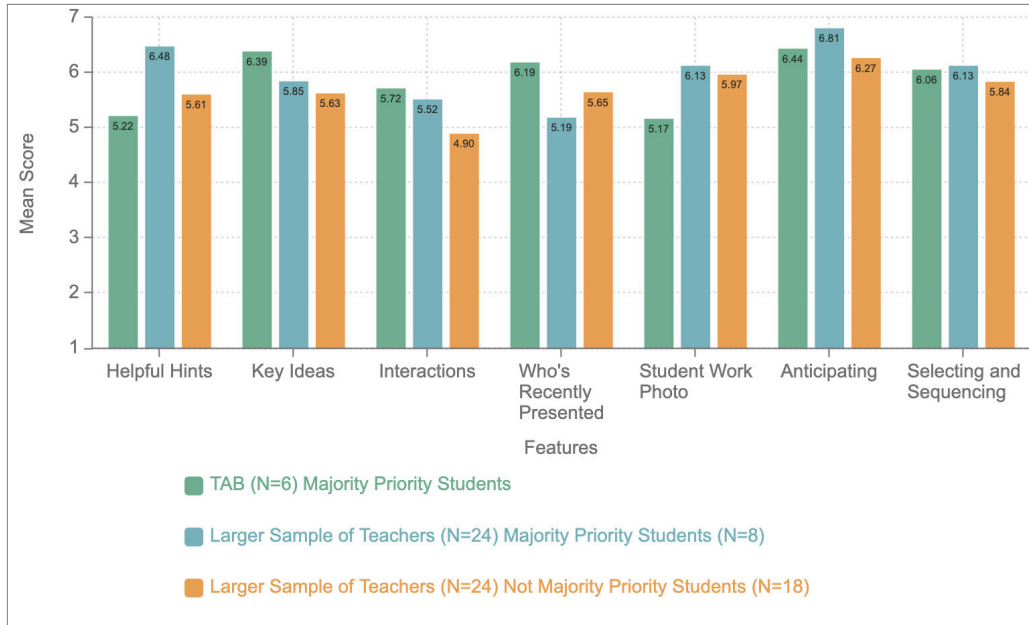


Figure 2: Mean usefulness scores for each feature from Teacher Advisory Board members and from the larger sample of teachers. **Note:** 1 = strongly disagree, 2 = moderately disagree, 3 = slightly disagree, 4 = neither disagree nor agree, 5 = slightly agree, 6 = moderately agree, and 7 = strongly agree. Data from Post-Project Technology Acceptance Model Survey.

As shown in Figure 2, all features were rated above neutral for usefulness for all three groups of teachers. These features, developed for teachers of priority students, were also scored useful by teachers of all students.

Both quantitative and qualitative research showed that teachers of both priority students and all students felt their challenges with the 5 Practices would be less of a barrier with the Pathfinder prototype and that the features in the prototype would be useful in their classrooms.

Implications

Since COVID-19, quarantines, and school shutdowns occurred concurrently with the project, the project team was unable to test the prototype in classrooms. The project team focused on measuring how and if the choices made in the process of creating the prototype had the potential to impact what occurs in the future in in-person classrooms. In-classroom testing of the ideas is needed. In advance of such testing, the project team found the following implications:

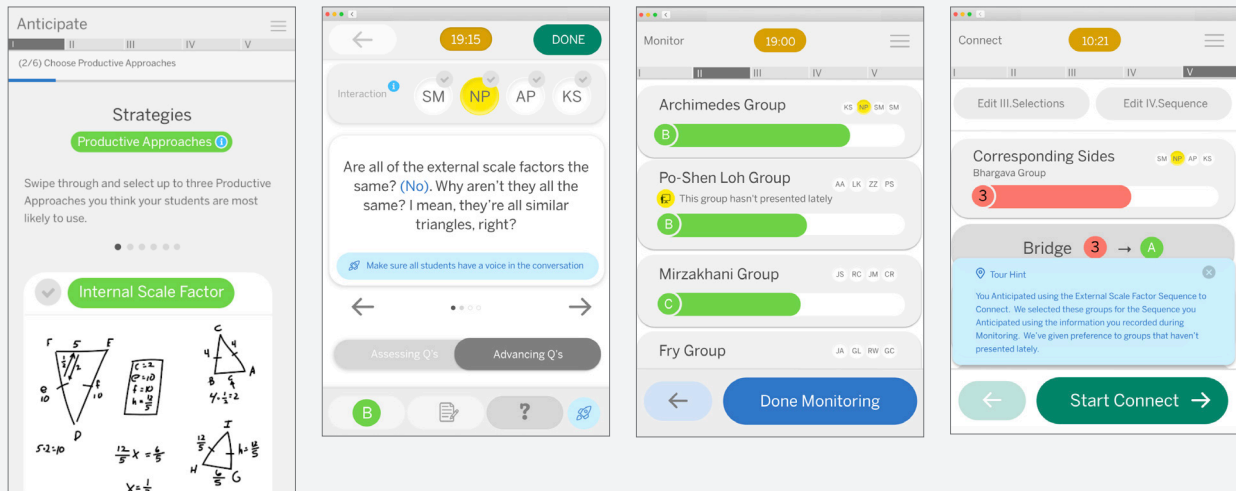
1. *Targeted Universalism tested through Human-Centered Design and design thinking processes can be used successfully in edtech product development to include equity in the design process by focusing research on priority students and checking for universal application.*
2. *Technology has the potential to be useful in the classroom for supporting mathematical discourse and making curriculum-based pedagogical practices for mathematical discourse, such as the 5 Practices, less challenging for teachers.*
3. *The themes uncovered in this project—supporting pedagogy, supporting equity, saving teachers time, and enabling teacher superpowers—may be applicable to other edtech product development projects.*

Conclusion

The work of ensuring that High-Quality Instructional Materials are leveraged with high level pedagogical strategies to achieve true equality of all students' voices is never complete. In this regard, the project team views the current 5 Practices Pathfinder prototype as the first of many stages of iteration with profound possibilities. It is the project team's goal to help teachers to help their students, to make it easier to incorporate a high quality pedagogical strategy, to identify and target their own personal implicit biases, and to see the inherent beauty in a classroom with a diversity of voices.

Exploring the 5 Practices Pathfinder prototype

Visit <https://five-practices.prod.learning.amplify.com>



- Take on the mindset of a teacher planning and teaching with the 5 Practices for Orchestrating Productive Mathematics Discussions
- The prototype is designed for tablets.
- If exploring on a phone or computer, note:
 - The prototype may not display properly screens smaller or larger than tablet size.
 - When viewing on a computer without a touchscreen, you will not be able to swipe left-right or up-down; at those moments, you can click and drag to explore those features.
- Since it is a prototype, not all buttons will work.
- You will see the names of sample students with which to explore the app.
- You have been jumped ahead in time so that you can see some information about the students that you can imagine you have collected during prior lessons.
 - For example, keep an eye out for student initials highlighted in yellow—these are students you have not noted as recently interacting with classmates, teacher, and or the math.