SMARTPHONES, APPS, AND FORMATIVE ASSESSMENT: ENGAGING STUDENTS OUTSIDE OF CLASS

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Introduction

Smartphones have become an essential tool in everyday lives with apps designed for communication, information, and entertainment. It is no surprise that students love their smartphones and want to be on them all the time. This distraction makes it difficult to keep students away from their phones for a 50-minute class. We want to leverage their desire to use smartphones to help increase their engagement with mathematical content. This is beneficial because now we are trying to meet students where they are and connect their education with the devices that they already use in their everyday lives. In addition, we want to gather information from these smartphone interactions to formulate a plan of action for use in the classroom. We describe how we used this process for formative assessment.

Formative Assessment

There are two basic types of assessment: summative assessment and formative assessment, with each of these having different goals. Summative assessment is the traditional type of assessment (e.g., end-of-the-unit tests) where we are evaluating what students have already learned. One definition of this from Popham (2020) is that "Summative assessment takes place when educators collect test-based evidence to inform decisions about instructional activities already completed" (p. 286). In other words, we have completed a unit of instruction and wish to find out what the students have learned. These are usually high-stakes assignments worth a lot of points. We want to focus our discussion on the second type called formative assessment. Popham defines formative assessment as "a planned process in which assessment elicited evidence of students' status is used by teachers to adjust their ongoing instructional procedures or by students to adjust their current learning tactics" (p. 285). Formative assessment is not just a test, it is a *process* that we use to help our students learn better and improve our teaching *before* we reach the end of a unit. The goal of summative assessment is to find out what students have learned while the goal of formative assessment is to figure out what to tweak in our teaching to help students learn a current topic better (Popham, 2020; Keely & Tobey, 2011).

Formative Assessment can be characterized by what it is *not*. It is not a formal test itself and it is not a high-stakes assignment. Any questions, quizzes, or other activities used for formal assessment are not high pressure. Formative tasks are meant to help the students and instructors identify gaps in students' understanding. Instructors can then create learning opportunities to support student progress. Formative assessment is also not "off-the-cuff" alterations to class instruction. Such alterations are important in class, but they are not considered formative assessment. Formative assessment is also not used for every topic. It is used to gauge students' knowledge of intermediate steps for a unit where the ultimate goal is two to three weeks down the road. The key thing about formative assessment is that you are making deliberate decisions about what these key topics are and then formulating ideas and questions to move forward.

Example from Precalculus

Let's look at an example from a pre-calculus class concerning trigonometric notation. The class had started to talk about some identities and trigonometric equations. A deliberate decision was made to check students' understanding of basic notation and identities. The following Microsoft Forms quiz question (Figure 1) was sent to students via the Remind app outside of class and they had 36 hours to respond:

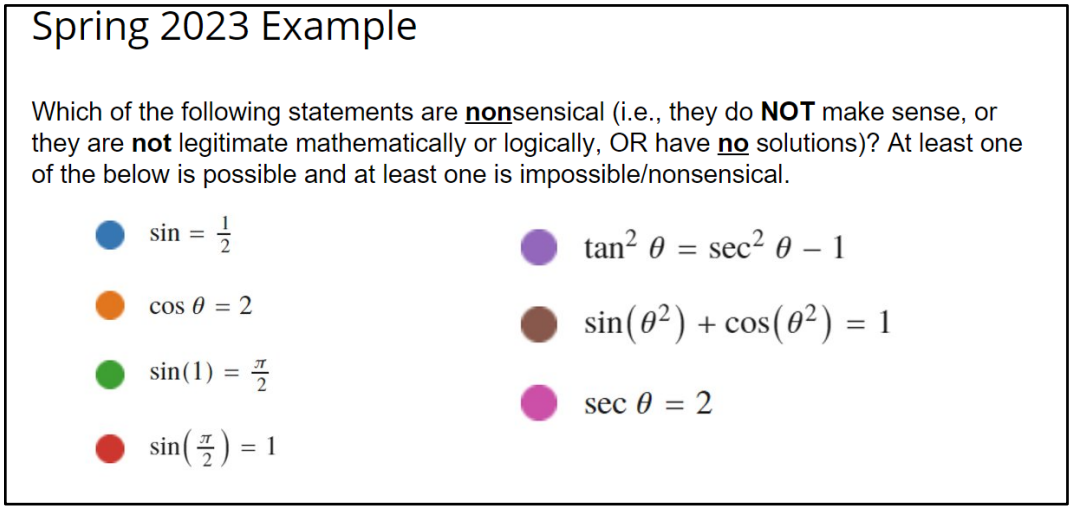

Figure 1: Trigonometric Example

In this example students were supposed to select all impossible or nonsensical answers. The correct choices were based on common mistakes that students make (e.g., leaving an argument off of a trig function). Students were allowed to resubmit an answer. They were also able to get feedback based on the answers they selected which is a key part of formative assessment. Students were able to see for themselves where they were wrong and make adjustments. In Microsoft Forms, you can add feedback to explain why a particular answer should or should not have been selected. In addition, students were engaged in a quick question outside of class to make them think about math at a time when they were not trying to think about it. When the question appears on their smartphone, they are more likely to engage in the content.

Consider the student responses (Figure 2):

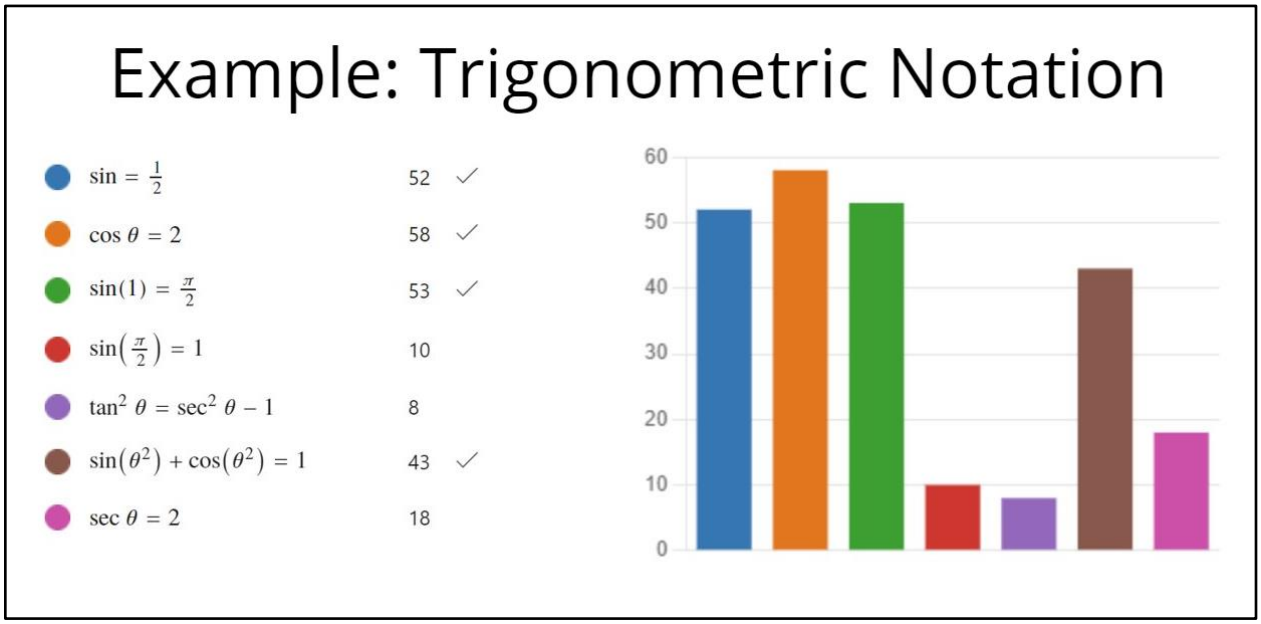

Figure 2: Student Responses to Trigonometric Question

Check marks indicate correct answers, and the display shows the number of students who picked each choice. These numbers reflect both the original and resubmitted answers. As the teacher, you can see the answers that they gave and identify possible misconceptions. For example, several students did not select $\sin(\theta^2) + \cos(\theta^2) = 1$ at first. They thought that the square meant we were dealing with the Pythagorean identity, but in this situation only theta is squared.

How was this process used to inform class instruction? At the beginning of the next class, we displayed the results of the above example on the screen and students were asked to think about the reasoning behind the various choices. We asked the class to consider what a student was thinking who did *not* select the first equation? This discussion relieved some of the pressure from students and gave them an opportunity to think about their own thinking and to share their thoughts and ideas. Because this was low pressure, students in the class began to speculate as to why they thought a student might have selected a particular choice. It did not isolate one student who did not answer correctly, but it gave them all a chance to reflect on their answers. All students (both with correct and incorrect responses) could comment. They were more willing to do so because of the lack of pressure and because the results displayed were anonymous.

Technology Used: Microsoft Forms and Remind

We now shift to describe our process and review the necessary technology we used to implement this kind of formative assessment. The accessibility of the technology implies that instructors can quickly adapt or incorporate it into their teaching practice. We chose to use the Remind (www.remind.com) text alerts, but instructors can choose other means to

reach their students (including typical email). Remind is a free Internet software (and smartphone app) that allows individuals to receive text or push notifications on their smartphones. We chose Remind because the service is free, and students can access Remind from their smartphones. Remind is a convenient way to communicate with students on their smartphones without sharing cellphone numbers. We hypothesized that students may be more likely to engage in the process if they could do so on their smartphones. (All students had their own smartphones, but students without smartphones could still participate with typical email accounts.) We also found that many students used Remind in high school, which meant they were already familiar with the application.

We began the semester by requiring students to create a Remind account for our courses. (For purposes of the course syllabus we stated students were required to join Remind or "request an alternative" in the unlikely event they could not join Remind.)

Instructors who wish to use Remind need to create a free (at the time of publishing) account if necessary (see Figure 3).

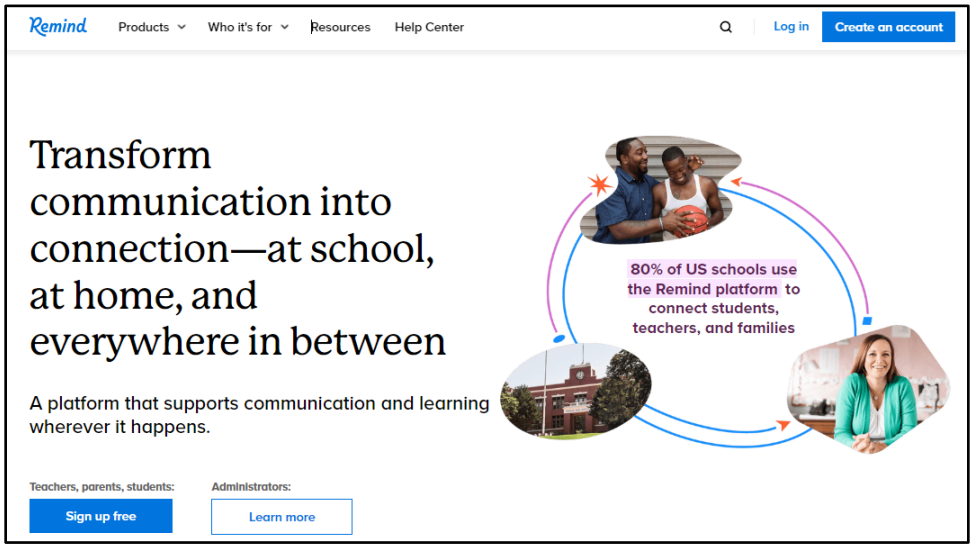

Figure 3: Remind Website Example

Instructors can add students to the Remind "class" by sending an invitation link to students or instructors can manually enroll them into the class (see Figure 4). Students were presented with a specific link to the Remind class and asked to join on the first day of class.

Instructors can message students once they are enrolled in the Remind class. Note that students may also reply to the instructor's message or announcement, but only the instructor will see the reply. Students who use the Remind app will see "push notifications" while students without the app will view the alert as a text message on their phones. These instructor-generated messages serve as the initial component of the formative assessment.

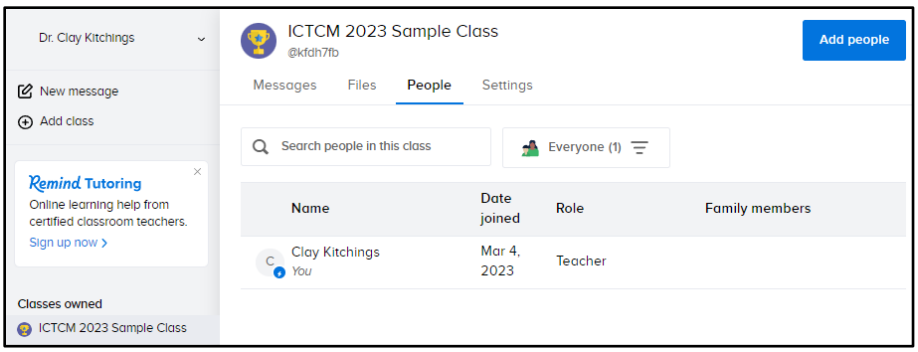

Figure 4: Remind Class Page

The formative assessment prompts we provided students arrived on their smartphones via the Remind push alerts app or via text messages. The prompts were in the form of hyperlinks that directed students to a Microsoft Forms quiz that contained questions about the mathematical content.

Microsoft Forms

The formative assessment tasks were created with Microsoft Forms because our institution uses Microsoft Office products. We now describe how to use Microsoft Forms to create a quiz to send to students.

Begin by accessing the "Forms" tab from the Microsoft 365 webpage. The Forms menu has an option to create a form or a quiz. Select the option for a New Quiz (see Figure 5).

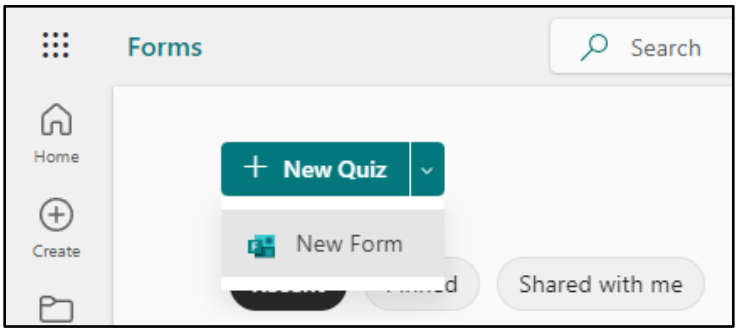

Figure 5: Microsoft Forms Quiz Menu

The quiz will open in a new tab in the web browser. Quiz authors may then title the quiz and begin adding various types of questions including free-response, multiple-choice, Likert, and ranking questions (see Figure 6). You can also require a student to upload a file (such as a photo of written work).

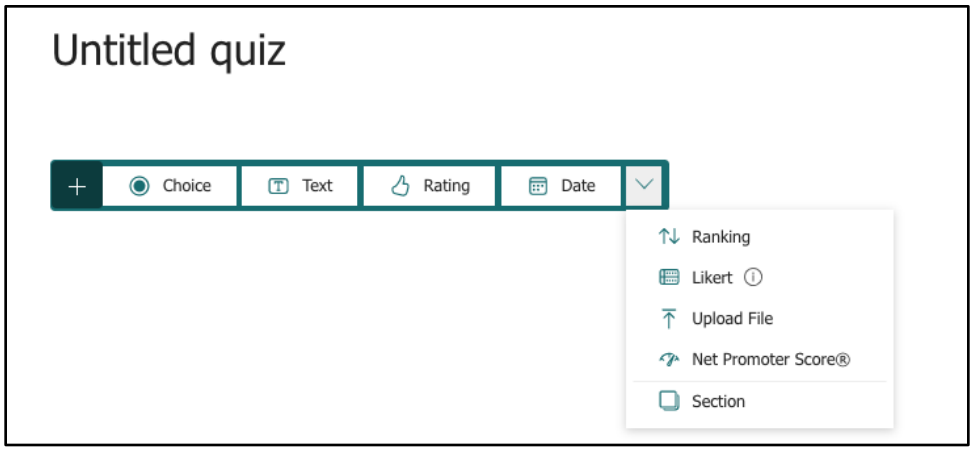

Figure 6: Microsoft Forms Quiz Question Options

The "Text" option contains a "Math" switch that allows mathematical expressions and an option to create equations or expressions using LaTeX. The earlier example with trigonometric equations was a multiple-choice question that allowed more than one response. The author may decide whether to include a correct answer key. When the Math option is active, students will see a mathematical expression pallet appear, like what they see in many online platforms (see Figure 7).

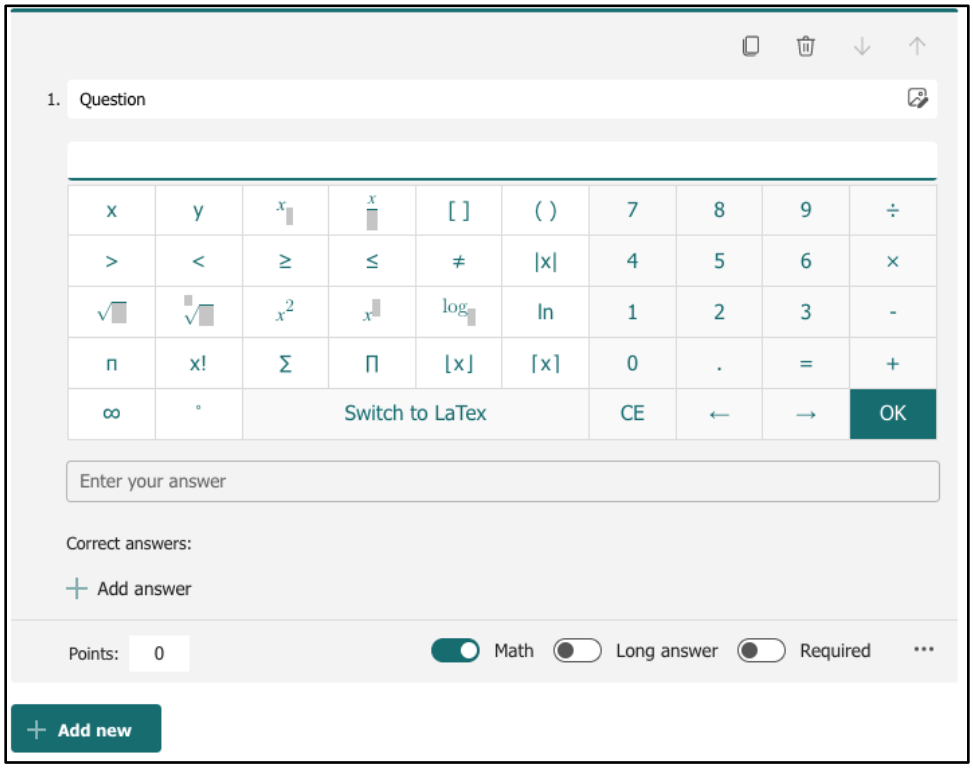

Figure 7: Microsoft Forms Question Editor and Mathematics Pallet

Microsoft Forms will grade and score questions based on the correct answer given by the question author. We were more interested in obtaining students' answers and ideas than we

were in generating scores for answers (consistent with some of the goals of formative assessment). Quiz authors may also select the option on multiple-choice questions to provide feedback for answers students select. Because the feedback is author generated, it may provide positive affirmation or corrective reminders depending on whether students select correct or incorrect answers. Such feedback is also "formative" feedback for students, and it can help correct misunderstandings from the comfort of their smartphones.

Once questions are added to the quiz, customize the settings from the ellipsis menu in the upper-right corner of the browser page (see Figure 8).

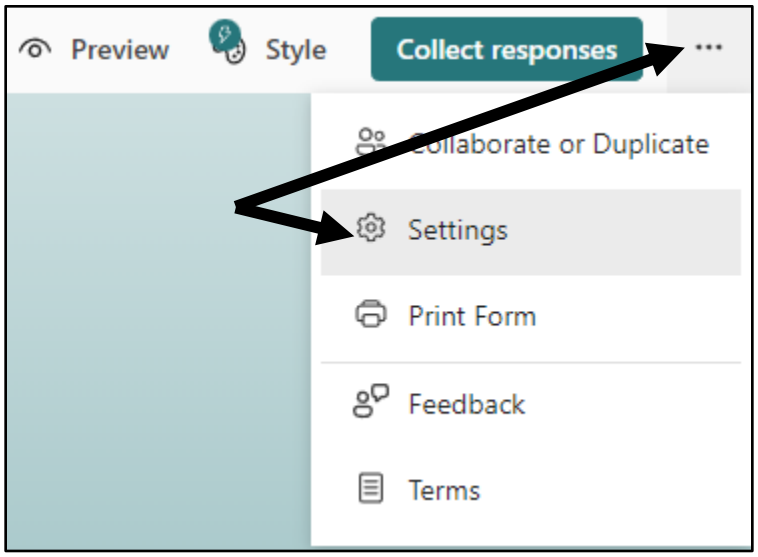

Figure 8: Microsoft Forms Settings

Some of the setting considerations are as follows:

- Must students sign in using their institutional email, or will the quiz be available to anyone with a link? Are anonymous responses acceptable or appropriate for the quiz?
- During what time frame should the quiz accept responses?
- May students enter more than one submission, and may they edit their responses?

After adjusting any desired settings, the quiz is ready for distribution to students. The "Collect responses" tab generates distribution options (see Figure 9). Consider the "Shorten URL" option to generate a link to the quiz. (Note there is also an option to generate a QR code if desired.) You may find it more efficient to allow anyone to respond to the quiz as opposed to only people in your organization. Copy the link in preparation to send to students via Remind.

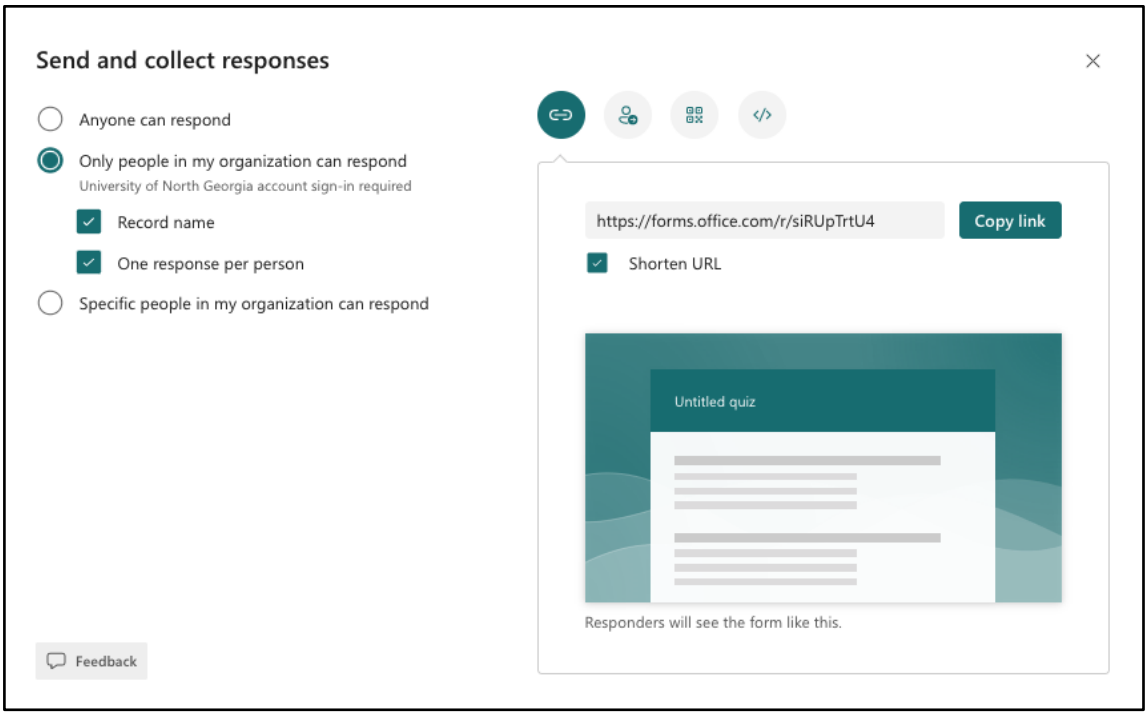

Figure 9: Microsoft Forms Response Collection Settings

Note that the grading in Microsoft Forms can be somewhat cumbersome depending on the type of question posed. The grading is not mathematically computational, and it cannot discern or detect equivalent, correct answers. For example: if the correct answer you provide for the question is $\frac{\pi}{6}, \frac{5\pi}{6}$ the automatic grading will not recognize the answer in reverse order as a correct answer unless you provide the reversed order as another possible correct answer.

As another example, suppose one of the quiz questions posed (see Figure 10) is, "Solve the following equation. Express your solution as an exact answer with no rounding."

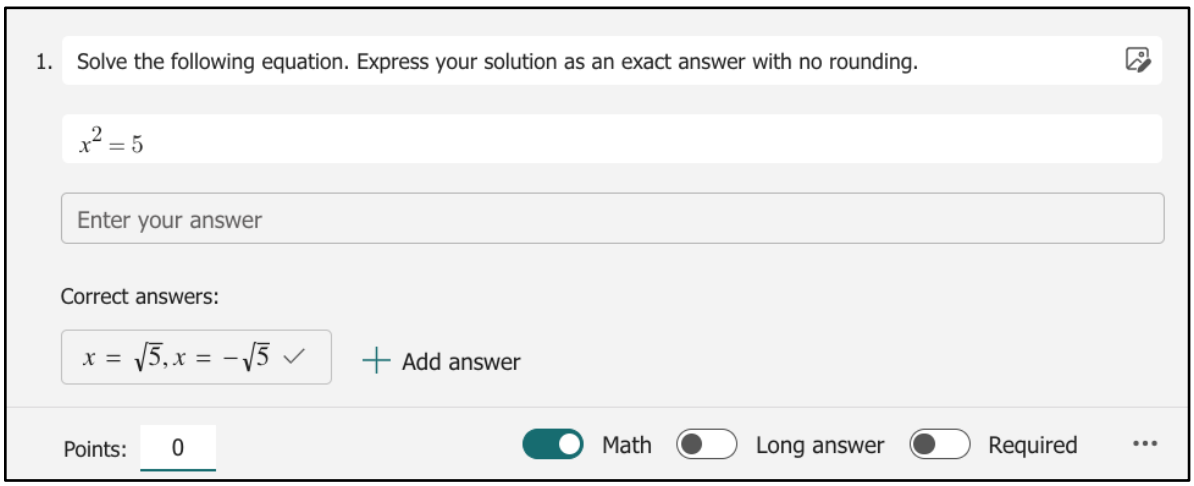

Figure 10: Microsoft Forms Question/Answer Example

Students need clarity on how you wish them to provide the solution set. The order of the answers matters in Microsoft Forms, as well as the existence of the "$x =$" syntax. To provide maximum flexibility to students in the automatic grading process, enter additional, acceptable versions of what you consider a correct response in your course (or provide more specific formatting instructions inside each question).

Responses to these kinds of questions give us an opportunity to see what students are thinking, which is the main goal of formative assessment. This process is a purposeful plan to give students mathematical engagement via their smartphones so we can get better insight into their thinking, identify and address possible misconceptions, and then make a plan of action based on what we see in those responses.

To send the quiz to students from the Remind app or the Remind website, click the "New message" icon, and select the desired recipients. Paste the URL into the message and send the message to the students. Students may click the link that appears on their smartphones and access the quiz immediately. If necessary, send additional quiz instructions via Remind.

Based on our early experiences using Remind and Microsoft Forms, we conjecture that students seem to be willing to engage in the quizzes from their phones. Our goals were to 1) engage students in more content outside of class, and 2) attempt to better inform our instruction by looking for and identifying points of confusion in the content. We suspect this type of engagement may generate additional reflection of the content in their minds outside of class. We are curious about how more consistent activities in these forms may impact students' metacognition related to mathematical content. These tasks were low stakes in that no punitive grades were assigned, except when students chose not to participate. The Microsoft Forms responses tab (Figure 11) provides a convenient way to collect and view all students' responses to evaluate their understanding and make decisions about how to support them moving forward.

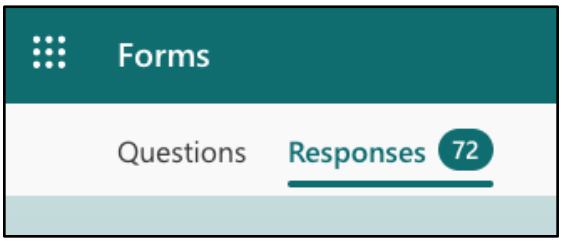

Figure 11: Microsoft Forms Responses Tab

Additional Technology Options

Several other websites also provide similar options. For example, Google Forms has a similar quiz feature. (At the time of publishing, Google Forms did not have an option for mathematical expressions.) Other commercial products exist, including Pearson's Learning Catalytics (which is included with MyLab products, and may also be integrated directly into a MyLab gradebook). Learning Catalytics may also be purchased as a stand-alone

package for students who do not use MyLab. Poll Everywhere is also a popular platform that allows students to submit responses in a similar manner.

Future Plans for Co-requisite Classes

We have been focusing on using smartphones to engage students outside of class. But it is totally feasible to use this inside of class and see the poll results in real-time on your screen. If you do this in real time, you could use that to inform your instruction right there in the class. We are especially interested in incorporating this in learning support co-requisite situations as opportunities to create discussion about math content. For example, we can push a quiz to students' phones in the learning support class, have students give their submissions pressure free, and we can see their results on the screen. From that point, we can look at everyone's submissions on the screen and create a discussion in the class about what we see. We could ask questions such as, "Why do you think some people gave this particular answer? What do you think someone was thinking when they gave this answer?" We believe it provides many opportunities for rich discourse in the learning support co-requisite environment. We want to increase engagement in co-requisite learning support situations, and we believe this formative assessment holds great promise.

References:

Keely, P., & Tobey, C. R. (2011). *Mathematics formative assessment: 75 practical strategies for linking assessment, instruction, and learning*. Corwin: Thousand Oaks, CA

Popham, J. W. (2020). *Classroom assessment: What teachers need to know*. Pearson: New York.