Thinking About Thinking: Using Formative Practice to Grow Metacognitive Learners

Introduction

Welcome to the Every Learner Everywhere transform learning webinar series. It's a pleasure to have you with us today. My name is Norma Hollebeke, and I'm the associate director of innovation and programs with Every Learner Everywhere. Some real quick housekeeping notes. We are recording this webinar for those of you who cannot join us today, or those who cannot join us today. I'll get it straight. Throughout the presentation, we do encourage you and welcome you to post your questions in the Q&A, and you're welcome to also have comments posted in the chat.

Before I introduce our panel moderator, I'd like to take out just a few minutes to tell you about Every Learner Everywhere and the mission of our network. Every Learner Everywhere is a collaboration of higher education organizations with the expertise in evaluating, implementing, scaling, and measuring the efficacy of education technologies, curriculum and course design strategies, teaching practices, and support services that personalize instruction for students in blended and online learning environments. Every Learner Everywhere is sponsored by the Gates Foundation, and here at Every Learner, our collaborative work to advance access to higher education centers on the transformation of post-secondary teaching and learning. We build capacity in colleges and universities to improve student outcomes with digital learning. Our mission is to partner with institutions to harness digital learning technology and drive innovation in higher education to improve outcomes for every learner.

And now to our moderator, Dr Christine Latulippe. She's a visiting associate professor at Linfield University. Throughout her faculty experiences at a public Hispanic-serving institution and at a private liberal arts college, Christine has promoted equity and worked to advance inclusive excellence, facilitating learning which applies to and enriches the lives of pre-service and in-service teachers alike. Many students have never known how strong their mathematical skills are because they were never given the permission to share their own strategies and come to their own understanding of mathematical concepts. Christine strives to change that experience, allowing for student success and opening doors to populations who may not have yet recognized themselves as part of higher education communities.

Christine.

Thank you, Norma. Welcome all to our fourth webinar hosted by Transform Learning. This project is focused on digitally enabled teaching and learning as a mechanism for improving mathematics learning across post-secondary institutions. My role on the project is community manager of the Transform Learning community. The goal of the project, in addition to being a hub for instructional examples, is to engage with the academic community.
The recently developed Transform Learning website offers resources and best practices across pedagogy, curriculum, and technology, as well as a growing body of evidence to support the use of technology in the classroom to support learning and improving equity.

Digitally-enabled, evidence-based teaching practices refer to instructional approaches that integrate technology, tools, and platforms to enhance and support teaching methods that are grounded in empirical research and data-driven insights. These practices leverage technology to collect, analyze, and apply evidence to inform and improve the effectiveness of teaching strategies, ultimately leading to more successful learning outcomes for our students.

The eight DE-EBTs are active learning, where we decrease professor lecture time and increase student participation in learning; assessing and activating prior knowledge, determining what our students already know and integrating their experiences into learning; data-informed instruction, where we adjust our instruction based on real-time student data; formative assessment and practice, deploying a frequent, low stakes way to monitor student learning, which is one that we'll be highlighting today; Fostering a sense of belonging through an inclusive learning environment, which has to do with creating safer and more welcoming spaces for learning; instructional transparency when we share the why and how behind our instructional decisions. Today, we'll also be highlighting metacognition and self-regulated learning, where we help our students learn how to learn. And our eighth DE-EBT is peer collaboration, creating opportunities for students to support each other's learning.

When we think of these digitally-enabled, evidence-based teaching practices, our implementation can take a lot of forms. We can remember to start anywhere. These practices are not sequential. We want to be sure we're taking small steps. We don't have to implement practices in full in order to make positive changes in our teaching and our students learning. And we need to keep in mind that different practices drive different outcomes. So implementing different practices will help us reach specific teaching and learning goals.

To this end, we'll be joined today by a panel of experienced educators to lead our discussion and share insights and strategies for using formative practice to grow metacognitive learners. They will introduce

themselves briefly, and if you're more interested, you can read their full bios on our website, which has just been linked in the chat. We'll start with Jessica.

Hi. I was not expecting this. So I'm Jessica Bernards. I'm very honored to be here. I'm going to try not to ramble. So I teach math at the University of Oregon as well as Portland Community College. So I'm not far from Christine. I have been teaching for 21 years now and have done a lot of research on pedagogy and how students learn.

My background is in both math and education, so very big into mindset and bringing in study skills. And just like Christine, really wanting to help students see that they can succeed in math. and anyone can be a math person is one of my mottos, so I'm really excited to be here and honored.
Thank you, Jessica. Derek, to you.
Hi, I'm Derek Bruff. I am an associate director at the Center for Teaching Excellence at the University of Virginia. I am a math educator and educational developer. I've worked at a few different places. I was at Vanderbilt University for a while and University of Mississippi. A lot of my work involves helping faculty, particularly STEM faculty, adopt evidence-based teaching practices. And in recent years, a lot of that has dealt with responding to AI as well. So happy to be here.

Thank you. Jennifer.

Hi, my name is Jennifer Byall, and I currently teach at Southeast Tech College, which is a technical college in Sioux Falls, South Dakota. I've taught at a few other technical colleges around the country, and so I primarily am interested in making the math applicable for our technical students and helping them to understand how it's going to be useful to them in their careers and in their lives.

Welcome. To you, Christina.

Hi, my name is Christina Duron. I'm an assistant professor of mathematics at Pepperdine University in Malibu, California. I'm entering my 14th year of teaching, but before I started at Pepperdine, I taught for six years at a high school in Claremont, California. And my main research here at Pepperdine is in the development of computational tools to analyze networks. But beyond my research, I'm deeply passionate about finding new ways to motivate my students, and using formative tools to help them become more self-aware and effective learners. So I'm really excited to join everyone here today.

Panel Discussion

Well, welcome, everyone. Thank you for being here. And we will start our conversation with a question for Jessica. This one has to do with designing to support metacognition in our students. So the question is, how do you intentionally design low stakes, structured learning experiences that make students thinking visible and support building metacognitive habits over time?

Yeah, so I think one of the biggest things is really starting from an honest place and realizing that a lot of the times, innately, humans, we don't automatically reflect in a lot of productive ways. And sometimes that happens a lot in math. A lot of students end up interpreting struggle as a sign that they're not capable, rather than understanding that that's just a part of learning. And especially in math, struggling is where your brain grows. And so really helping them see that happen.

And so I don't assume that my students will automatically reflect on their work. I instead build it into the design. So I'll share two specific ways how I do this. So the one is how I structure for my online asynchronous courses, how I structure our labs. And then the second is through explicitly teaching growth mindset and math study skills and intentionally bringing those in to my classes.

So first is the labs. So I'm going to give an example from my calculus class. There is a link that you can find the rubric for this and how the directions are at the Every Learner website. But basically the way that I do these labs is, every week, they have a lab that's due.

And so what these labs are are really conceptual questions. Can students really get into what does this mean or the heart of the concept that they're learning, not just computation? There will be some computation in there where if there's common misconceptions that students have, I add those in there as well.

And so the labs have three parts. So the first part I call draft and discuss. And so this is where they attempt these problems on their own before seeing anyone else's work. And they have to explain their reasoning and show all of their steps, not just give an answer.

So then these drafts are basically really low stakes. They're worth five points. They're just graded for participation rather than accuracy. So total for the labs is 20 points. But the initial draft is only five points. It's just getting in and on time. And then the other part of that is, the five points, is them giving peer reviews.

So I intentionally did that because students know that they're expected to try their best. Sorry. We want the students to realize that they just need to try their best, that it's OK to make mistakes here, and that

this is where that intellectual risk-taking is as possible. So this is where you really want to show what you know not what AI knows, which really helps lower that anxiety for them to actually really attempt it on their own instead of feeling that pressure of, I have to get it right the first time.

So they'll post their drafts on Friday, and once they've post, then they're able to see other classmates' responses. And this is posted in the discussion board area in our LLMs. And that timing really ensures that they commit to their own thinking first. And then between Friday and Saturday, they'll respond to at least two peers in the class using specific criteria for meaningful feedback. So I have a very specific, detailed rubric that they follow to ensure I'm not just having someone say good job. I liked your notation, but actually giving solid feedback.

And so they have to-- the other part of that is, I notice when I used to do these, I'd have the last couple people that posted their initial draft, they'd be the ones that got all the feedback. And the people that posted originally, like first, never got feedback from peers. So I changed the rubric, where now it states you have to be one of the first responders to that person. So that way every single person will have at least two students give really thoughtful feedback to their lab. And what this has really allowed in an online asynchronous class is to emulate peer interaction, which has been pretty incredible.

So we also teach this class in person and do these labs in person. And the conversations that we're seeing that are happening in our online class and the discussion board area are actually the same conversations that they're having in person, which is really powerful because we don't have a way to have them meet in groups. But now we can do this asynchronously.

So they're not just completing these tasks independently. They're actually reading each other's reasoning, comparing approaches, challenging their assumptions, and refining their ideas a lot more together. And then after they get that feedback, students refine their labs. So they're going to look at that feedback, and then they have until Sunday night to refine their labs based on that. And that part of the lab is worth 15 of the 20 points. And that's graded for accuracy.

And so part of that is including a reflection explaining how they incorporated their peer feedback, what they learned, and what changed in their thinking. So the structure is super intentional. They try on their own. They engage with their peers, they revise their thinking, and they reflect on what's changed and then revise.

So because this routine is like every single week, students really start to begin to internalize it and they will end up planning a lot more carefully in the draft stage because they know their peers will read it,

they end up monitoring more during that discussion part. And it's actually been really cool to see some of these relationships develop in my online class, where these kids have never actually talked to each other live.

But they build these relationships on this discussion board of really helping each other out. And I'm seeing it when they're replying the next week like, oh, hey, Ellie, that was really helpful, the feedback you gave me last week. Thank you so much. Here's some feedback for you.

And so now, I have students that are actually taking classes together, like future math classes together, and have built these relationships, which is pretty cool. But what's nice is since this happens every single week and they're evaluating their own reasoning during the revision and reflecting on their process, it ends up making this metacognition a lot more of a habit than it would if I just did this twice a term.

And then the second way that I do this is through– I created this OER study skills program. You can find the link for it. I talk all about it in the Every Learner Everywhere. The link for the YouTube is on there as well.

And so what I try to do with that is in that program just really explicitly teach students, especially math students, how to manage their learning. So we talk about time blocking, Eisenhower method for time management so they can prioritize intentionally instead of reacting to deadlines, test taking strategies that really focus on analyzing errors and not just memorizing procedures, and then group work strategies so that collaboration is purposeful and productive.

Really, the most important thing that's in there is growth mindset, especially in math, because so many students think, I'm just not a math person. And my goal is to have them all leave being like, oh, I can be successful. So they learn that ability is not fixed. And then improvement really comes from strategy, feedback, and persistence.

So I try to also have that throughout every single video in the series where we end with, you can do it. And then I'm constantly bringing that back in when I'm having them do their reflections on these labs and talk about how they changed and how they improved. So again, that message of you can do it is super intentional because metacognition also requires that confidence. And effort and strategy really matter.

So the labs are like the structure in low-stakes practice. And then the study skills really helps with mindset and tools. And together, they really create a system where online and in-person students are not just learning the math, but they're learning how to think about learning.

Wow, what a thorough structure to that.

Sorry, that was a lot.

No, it's so interesting. There was a question, though, about the sizes of the online classes that you're making this work in.

Yeah. So I'm really fortunate where we have our class sizes between 25 and 30. But this could easily be done in a much larger class. So most of the LMS systems-- now you can do discussions within groups.

So you can manage it where you've got 20 students in each group.

So that way, it's a lot more manageable for them to go through and see those things. So that is what I would absolutely recommend if you have more than 30 students, is to just use that group feature in your LMS. And that way, the discussion boards don't blow up. And they don't have 8 million posts to read.

Thank you. Do other panelists have something to add to that, maybe an example they're using to support students metacognition or a comment that Jessica's got you thinking about?

I can add and say too that the study skills program, it's been around for a while. I just redid it this past spring. So it's specific to math. And I do talk a little bit about AI in there. But there's an academic integrity video.

But there's been studies that have been done not just by me but by people at other colleges. It's getting used at, I don't know, a lot of colleges now. But it's actually improved pass rates by over 15% just by bringing that in compared to teaching the class without it. So it's been pretty cool.

Thank you. And I did see Emily posted a link to a resource that's also in our example library, where another instructor has created a sort of an AI chatbot tutor. And there are elements of AI literacy in that example as well.

That's mine. I'll talk about it.

Is that one yours too?

It's mine. Yeah, I'll talk about that in the next question that I'm in charge of. So yeah, that one was a little early. We'll get there.

That's OK. I think there is an additional example too. So that'll be fun to compare. So we're going to move to Derek now for our second question about formative practice and how it might reveal our students' thinking. So I'm curious to know about what is one digitally enabled formative strategy that you use. And some examples might be polls or quick writes or draft reviews, discussion tools, like Jessica's already described. So there's a variety of these formative strategies. But I'm curious about one that you use that reliably surfaces how students are thinking, not just what they got right or wrong but how they're thinking about the concept or the content.

So a quick follow-up to Jessica's comment. I had Mary-Ann Winkelmes on my podcast a while back. She heads up the transparency and learning and teaching project. And she said something that's really stuck with me, that even our well-prepared college students may come in with a lot of generic study skills and study strategies. But they may not know how to study well in our disciplines.

And so I love the intentional teaching of that. What does it look like to learn math? What are the habits that you need for that? So I think that's an important thing to think about.

In terms of digitally enhanced tool, long time ago, I wrote a book on teaching with classroom response systems. I was known as the clickers guy for a little bit. So I'm going to have to lean into classroom polling as my example here.

This is my go to in any kind of synchronous class setting, whether it's on site or online, as a way to hear from a lot of my students. One of the challenges is a lot of methods of hearing from students, you only get to hear from a relative handful in a one-hour class.

But with polling, I can invite and encourage all of my students to respond to a question about the course material. My classic example in a math class is a probability question. Your cousin calls. She's having twins.

You know that she's not having identical twins. Is it more likely that she has twin boys, twin girls, or one of each? And I've got a whole kind of 20-minute activity I structure around this.

But it's a simple multiple choice question. And I will have my students respond using whatever polling technology I'm using that semester-- A, B, C, or D. And then I get a bar graph.

And usually, when I'm aiming for is a question where a couple of the answer choices are both popular. In this case, usually there's a right answer and a wrong answer that's equally popular. And then I can show students that bar graph and say, hey, we don't have consensus here.

Then I'll have them turn to their neighbor and talk or some other structure where they get to engage with that question a little bit more, have a second vote. And then at some point, I'll walk them through the right explanation.

But what I love about this structure is it's simple to implement. It handles large classes really well. You get to invite and encourage all students to contribute.

The structure you build around the question is often where you get to hear students reasoning for different answers and how they're thinking. And so some of that happens in a small group. Some of that happens in the full class.

So I think that's an important part of it. You can't just ask the question and move on. But you want to build some interaction around this where you get to hear from students.

A lot of students are hesitant to share their reasoning if you just cold call them. But the structure kind of gives them a little confidence. They've vetted it with a peer. They've had time to think about it.
The one downside of a multiple choice question is that you kind of have to predict where they might go wrong. And so sometimes, you can do that. Sometimes, you can't. But that's where the reasoning comes out.

I will say, since I wrote that book a long time ago, the polling technology has improved a lot. And so we're not limited to multiple choice questions anymore. I'm a big fan of clickable image questions, where you show students a graph or an image of some sort.

And you ask them to highlight some part of it. And then you get a little heat map kind of showing where the most students respond. That's still pretty easy to implement.

I had a colleague who showed a diagram of a heart and said, where is the deoxygenated blood? Or I give them a graph of a function and say, where does it change concavity? Those are not fully open-ended. They're clicking on an image. So it's a little bit contained. It's really easy to respond in the moment to a question like that based on how students respond. But it's more open-ended than multiple choice. And so it allows for a little more surprise in terms of what students say.

And then lately, some of the polling tools have added some AI to their free response questions. So you can ask fully open-ended text-based questions. And the AI will look at it and identify themes for you.
Previously, if I had more than 15 students, it would be hard to ask an open-ended question like that because I just can't process it in time. But now, we're getting a little AI help from that. So lots of ways to use polling. I also like it that you can start small and then start to play around with the different formats and tools over time and add to your toolbox as you go.

Yeah, I'm curious to know. I think there's so much value in wrong answers. And you did mention that you need to be able to predict where students might go wrong for a good multiple choice question. And I'm wondering how long it's taken you to build up some of those predictions. Or what's the resource for someone who doesn't have that kind of time?

So I'm a big fan of having some type of pre-class assignment where I ask students some open-ended questions. And so often, that will help me develop the multiple choice questions in class. I will ask an open-ended question on the pre-class, like they've done some reading or watch a video. And I ask them, what's the best example of this or whatever?

They'll try to answer a question in free text. And then I'll take three or four of their answer choices and turn that into a multiple choice question to use in class and say, which is the best answer to this question here? And so that gives me a little preview into their insight before they get to the classroom. And I'm managing them all at once.

And so that's my big recommendation, is to find tools-- that'll speed it up. Some of this comes with time and interactions with students. But that's a systematic way to get some of that insight before you're live in the classroom.

Thank you for that. Beyond polls and clickers, are there other strategies for capturing formative assessment data that we can do from with our classes and with our students? Do other panelists have ideas or success stories there?

I have one more favorite that I'd love to share.

Yeah, yeah, please do.

This started out on Twitter. And it has moved to other technologies now. But there's a biology professor at the University of Connecticut, Margaret Rubega. And she teaches an ornithology course. It's a course about birds.

And she had this assignment. She used to call it hashtag bird class. And the basic idea is that students are asked as they go about their lives to watch for birds and then post about the birds that they see. Where are they? What do they see? And they have to connect it to course material in some fashion. And she does this for a couple of reasons. One is to help students realize that even the birds in suburban Connecticut are interesting. You don't have to go to Africa or Asia to see interesting birds. But it also gives them routine practice at applying course material in a way that's visible to her and to their peers. It's not a completely authentic use of social media. But it's a little more authentic than a discussion board post. And it connects to their daily lives.

And then she can look at these and see what trends and patterns she sees in their thinking. I've heard of other faculty who do similar types of observational postings like that, pre-service teachers who are observing classrooms or civil engineering students who are looking at the built environment. So the tool can vary. But I think that it gives you a quick glimpse into how students are applying the concepts of the class. And you can thread that throughout an entire semester. That works really well for an asynchronous online class too.

I'd like to add that.

I'm sorry, Jessica, go ahead, sorry. You had your hand up.

Go ahead. No, no, no, I've talked already. Go ahead I'll stop.

So I use a online homework platform for my calculus courses and linear algebra. And I'm going to transition it to probability and some other courses as well. But in my courses online, I build in free response questions.

A lot of the time, the questions that the students get are, are you right or are you wrong in your final answer? And the way that I have my homework is I allow them to check their work many times. So when they complete the problem, they can submit it or question my question or at the very end. And it will give them this instantaneous feedback of, did I get the question correct?

And we can have a conversation about, is that teaching them to chase the points on it? Or are they really-- I would argue that they're probably doing a little bit of both. But it's intended to help them really

think about, well, what I thought was correct didn't turn out to be correct. So it gives them that reflection.
But I strategically incorporate free response questions because I want them to talk through their thinking with me. But hopefully, they're collaborating with others. So I'm trying to encourage that discussion that they're having.

But they can get that instantaneous feedback to say, hey, am I on the right track? And then I'm able to get them to dig a little bit further than just the superficial level by asking them some deeper questions to consider. And in my other courses, I'm also incorporating some journal reflection questions because I really think it's important to get them to not just know how to do the math and to get to the final answer correctly but to understand why am I taking the steps that I'm taking to get there.

So yeah, this semester, I started to incorporate the journal type reflective questions in each assignment. And it's been insightful. It helps me get immediate feedback too on how my curriculum is going so I can make some changes in the moment or the next time I teach a course. But to just see how the concepts have been hitting with them. Yeah. So Jessica, I'll turn it over to you.

I was just going to say I have a couple things. Three things kind of hit my mind. So actually, Christina, as you were talking, I'm very similar. So the way we've set up our async online classes is it's kind of like-- I call it like the training wheels at the start.

So for their homework assignments, they get three tries on each question. And then that way, they can just keep on doing it until they finally guess the right answer. But that way, they have to reach out if they still can't.

And then on the quizzes-- so we have quizzes. And then we have exams. So exams, they get one try. And you're done, which I know some people don't like.

But for the quizzes, what I do is they can get two attempts. And it's a different version each time. Thank goodness for algorithmically-generated online homework. But similar questions. And so what they do is they'll take their first quiz. And they have to if they want to take it again in their work page, because they'll upload their work page to the online system. So that I also grade on their steps and notation, not just write answers. But I can give some partial credit.

But they have to reflect and on what they learned from the first attempt, what they're going to do differently on the second attempt, what they're going to study. And then they retake the second attempt.

And as long as they've done that reflection, then I will count that as points if they score higher. And then they'll do a reflection at the end.

The other piece with the study skills stuff-- so I have not only just the videos. But there's worksheets that go along with each study skill. And so within each worksheet, the students-- and so you can put those if you're teaching asynchronously. It's a really easy discussion board. So they learn a topic. They have to reflect on their top three takeaways. And then they have to set a goal-- so a SMART goal. So they'll look at what they learned in that video if it was over time management or whatever.

They'll create a SMART goal for it. And then they'll do three tasks that they're going to do that week to hit that goal. And then they have to come back at the end of the week and reflect on how that went and if they're going to make any changes in the future.

And then there's always a growth mindset reflection question. Like, what is something you struggled with this week, whether it's in math or in life? And then what are some changes that you're going to make to help improve that situation or persevere through that situation? So things like that in there, which, I think-- again, if you start doing those on a regular basis, like Christina's doing all the time in her assignments, it starts to get them to start thinking that way.

And then the last thing I was going to say that Derek brought to my mind with clickers-- so in an async class, it's harder to do polling like that. However, one thing you said that I was like, oh, this is brilliant-- so like talking about the graph concavity and seeing the points.

So I don't know if you guys use-- now, it's Amplify. But Desmos Activity Builders is what I used to use and I still use. And so within it, the students will answer it. There's even the graphing. So in my precalculus class, I'd have them graph the rational functions. And then what's really cool is on the teacher dashboard, you'll see all of their answers. And you can overlay them. So you'll see if-- so most people are here. But oh, there's some people that are doing it here. Let's talk about this as a class.

And so in asynchronous classes-- so it's amazing, obviously, in sync classes. But in async, you can assign those and have a time limit for when they're due. And then you can create a quick video. Or you can even show the students that image and have them reflect on it in a discussion board. So there's some really cool ways that Derek's amazing ideas could also be incorporated in the async. I loved what you shared.

The excitement, I love it. Thank you for these great examples. I'm hearing a lot about building in structures and modeling reflective question asking and answering for our students. I'm going to change gears a little bit now to some of that in the moment planning and thinking. So Christina, we'll turn to you.
And I'm curious to know about more, in the moment, how do you decide what to do with the formative evidence that you're collecting?

So of course, there's lots of options reteaching, regrouping, revising, just hoping next time, it'll go better. But more in the moment, do you have a concrete example of a time when some of this evidence changed your instruction?

Yeah, I think this is a great question. And I've had to think about my response over the last few days. But I would say that in my experience, deciding how to respond to that formative evidence, whether you're going to reteach, as you mentioned, extend, regroup, so forth, for me personally, I think it actually starts before the first day of my class, before the semester begins, because I approach in the moment moments more as a tiered response.

But it's only worked for me successfully because I've intentionally built in the opportunity to pivot into my curriculum. And I will preface this by saying, I'm in my 14th year of teaching. This was not the structure I had on day one.

When I started teaching, I was told the curriculum. You need to cover section 1, section 2, what have you. And I felt what that meant was I needed to cover every possible word, every possible concept that is detailed in this textbook, in this section. And it felt like each class was a sprint each time. And what I've learned is it's taken me years to get there. But I've learned that I need to focus on saying the most important things well so that students can understand. More than just a superficial level, I want them to understand a good number of things rather than trying to cover every possible detail. And so because of that, I, intentionally, I would say, under schedule my curriculum. I used to cover like one section a period. And currently, the way that my class is organized for calculus, for example, we meet four times a week, 50 minutes each time. And in the past, that would be one section per day. So you're covering four different sections in a week. And that's a lot for students to digest.

And so when I under schedule, what I've done is I'm still covering sections that I deem important and that meet the student learning objectives and our curriculum goals for our math program. But now, I'm slowing it down. So I'm covering one section over two periods on average. And so under scheduling my curriculum has actually given me the gift of time. And so if I have evidence that's telling me, hey, we need to pause as a class, as a group, then I'm not feeling this pressure that I need to keep pace because

I have to cover x, y, and z. And so there are three, I would say, signals that I look for. And I would say a lot of us probably do all of these and then some.
But the first thing I look at are what I would consider the micro signals. I'm looking at the vibe check of the room.

These are the immediate, these nonverbal cues. I'm looking at my students' expressions. Are they blank? Are they paying attention? Are they nodding just to nod and to get me to move on to the next topic?
I like to do a lot think-pair-shares, where I give them an opportunity to reflect about the question in their own space. And then they pair themselves up with a neighbor for 30 seconds. And I ask them to convince either their neighbor of their reasoning or be convinced of their neighbor's reasoning. And then we share it as a class.

And as they're in their pair moment, I'm walking around the room. And I'm listening to the things that I'm hearing. And so these kind of micro signals are telling me the energy of the room. Where are my students with regards to the speed and the lecture and the content? I would say the next thing I look at is I turn to the data. So as I mentioned in my previous response, I do use an online homework platform. And I should mention that all their homework isn't just, are you correct or incorrect? You have the free response. And I also require students to upload written work so I can keep track of their notation, their mathematical fluency. And I can give them more concrete, formative feedback for them.

But every night, after the assignment is due, I look at my summary statistics for each question. Conceptually, did the class understand what was going on? Or is there something that we need to come back and rebuild that foundation? So I treat, I would say, the homework as a diagnostic tool to help me know, do I need to go back the next class period and reteach something? preferably in a different language. Because if they didn't catch it the first time, then using the same language isn't going to get them to catch it the next time. Or can I go ahead and go on to the next topic? So that's my second signal.
And then my last one, I would call it my safety net assessment. And I don't always do this because I don't want students to feel like they have that security with each examination. I want them to be responsible for their learning.

But occasionally, I will offer retake problems from an exam. So I'll look at the questions again and see, well, only a number of my students really got to the heart of what I really understood, what I was trying to get at in this question. And so then I'll scaffold the question in a different way than it was presented on the test. And they learned it in a scaffold fashion. But then come the exam, it's just one open-ended prompt. And now, they're responsible for thinking through and presenting their evidence. And so with the scaffold exam retakes, I tell them, you can only improve your score. You're not going to do worse

than your current midterm grade. And so I say that to encourage them to take that risk, to try the retakes, to improve their understanding because I want to remove the threat of failure and shift the focus towards that metacognition.

I want to allow them to be reflective about what they missed rather than be reactive to a letter grade that they got on the exam. And so to give an example, just a few days ago, I had returned linear algebra exams to my class. They got the numerical breakdown. And I had said some comments about some missteps that I saw on the work. And they did receive a scaffold retake set of problems. But I had a student come in to office hours. And they were confused about a particular concept in linear algebra called the standard basis matrix.

And what I had seen on the exam, many students made this fundamental error that they assumed that the standard basis matrix in its construction was that the columns of this matrix were just these arbitrary input vectors for the linear transformations. I'm getting more into the theory. But the takeaway was there was this misstep across the board of my class.

So he was inquiring about, well, how can I derive this matrix if I just had this information? And that wasn't really what I wanted them to take away on the problem. But I felt it was a great conversation to have.
So since I had built in this buffer time into my curriculum, I spent the first 20 minutes of my class, I think, on Tuesday just explaining, well, here is the prompt. I know we were all really excited to try to get this matrix. So let's see how we can get it from here.

And they soon learned that you could do it. But it was more work than one needed to take to get to the problem. But it was another way to think through the problem. And I do want to encourage them to think of other solutions. So I didn't have that planned into my lesson plan for the day. But I thought it was a very valuable conversation to have. And I didn't quite get to where I wanted. But that's fine. We'll adapt and adjust. And I think if there's one primary advice that I would give, it's to give yourself the permission to do less so that you actually have the space to do more when the evidence is saying, yeah, we got to do that now.

Thank you for that. Thank you. There is a question in the chat about, how do you strategically do less? So when you're having that upfront planning moment, maybe you're not completely cutting content in half. But how do you decide what to prioritize? Or do you have clear learning outcomes in your department? Or what guided you to do that do less structure from the start?

First of all, a very good question. I don't want to say there's one answer to it. I think for me, it was a lot of, let's try this, and a lot of revision. So my calculus notes, for example, I think I'm on the fifth version of these notes, where every time I teach a section, I make a note of, I was able to stop here in this time, and, oh, students didn't really understand this.

And over time, I like to teach a course three times with the set of notes so that I can really get a feel of the content and what students are receptive to and what they're really hitting. And it's usually in a year and a half I'll have taught the course three times. And so from my notes, I can see, well, I never had time to cover this. And was this actually really an integral part of their understanding? If I were to remove it, that gives me more time. But is it critical to be in there?

And if I feel like it does need to be in there, then I have to go back and think, well, can I restructure the examples? Can I get to the heart? And what I had found early on was that my examples were way too complicated right off the jump. I don't like to lecture. I like to say we're having a conversation together with my class. So we'll do the example problems collectively. But I like to start with an easy one, where we can all do it together. And then we build up to a medium. And I just found you got to really focus on what the examples are and make sure that they're touching the heart of the concept.

As a mathematician, we love fun, like learning how e is defined. But is that really important for them to know in this lesson on limits necessarily? So I would say it just took a couple years of seeing how the content was falling and then being open to revising the notes because it does take a lot of work to do that.
And I think if we want students to really understand what's going on, we have to be willing to put in the time and the effort to say, nope, I fell short here. So what can I do to help my students be more successful? And that oftentimes will take a lot of time to revise.

So I would say it's reflection. And I looked at the exams that I was giving. What I was testing didn't always match up with-- why am I including some of the things if I'm not going to have them be tested on it? So I would pull things here, as in conversations with my colleagues who had taught the class before to see, what were you guys focusing on?

So just being willing and open to making revisions. But it takes time. But I also say give yourself grace because we can't do it all in one day. And so just being open to-- being willing to modify, I think, is a great first step.

Yeah, thank you very much. That self-reflection coupled with some of the chat was saying, also talking with colleagues before and after, making it be a little bit holistic so that then we can have that flexibility in the moment. Thank you.

I'm going to shift to Jennifer now thinking about-- I think Derek already mentioned something about the skills that our students bring that might not align with college skills. Perhaps they might have different strategies from the past. And so this next question has to do with adaptations that you've made to routines-- metacognitive, formative routines-- that can support students who are new to college level expectations, perhaps navigating belonging and confidence barriers, maybe juggling more outside responsibilities than we recognize, doing these things without lowering the rigor of your courses. So I'm curious about examples you might have there.

Thanks. Specifically, there's one example that I have that I'm going to talk about. And this is in the library. There's lots of good stuff in the library too, by the way. So lots of good things in there. And I teach-- it's a transferable level math class. A lot of our nursing students take it. We have a lot of dual credit, actually, taking it also. And I found that when I took over the class, a lot of them were coming in not quite-- just, again, kind of not quite ready to go. And so I started doing this exercise that I call the first five.

And so basically, we start our conversation a week or two before the semester starts. And these are usually pretty highly motivated students even if they don't have everything kind of figured out yet. So they want to get things going. And so the five things are just five things that I found was lacking that would help them be more successful in my class. And so specifically, the five things that I have them do-- I have them read the syllabus. And then I have a short little video just orienting them to the class.

So here's our online class. Here's where things are how to find things, where to click so they can see how to get to where they need to get in the class. Here's your assignments. I think a lot of times, we assume students know. But they don't always. And so it just kind of helps get them up to that level, the same level that everyone's-- we're all starting at the same point.

I have them sign up for the online courseware. So I think like a lot of us, we use an online system for most of our assignments and exams. And so I get them signed up for that so they're ready to go with assignments the first day. We're not a week into class. And they're still trying to figure out how to sign up for stuff. And now, they're behind on assignments. So getting that so that's all set and ready to go. I have them do a video introduction. So our discussion in our LMS, they can post like a two-minute video. So just a quick little video, hi, who I am. And that allows me to see them also.

Also, what they want to be called-- so do you want to be called Tom? Or do you want to be called Thomas? And then I can make a quick note so that in all of my correspondence with them, when I'm sending an email out, it's, hey, Tom. It just gives us that a little bit more familiarity.

They do a screenshot practice, which is just something specific to me. It's easier for me to help them. For LMS or the assignments they do, I can't see it while they're working on it. So if they can screenshot the problem they're working on, I can help them with it. So screenshot email.

So that's just something that's helpful for me to help them more quickly. And so that just, I found, valuable for me personally. So it may or may not be helpful to other people. But it helps a lot with me. So I have them do that.

And then the fifth thing is they have to email me that they've done the other four things. And then they have to schedule a meeting with me. And it's a five-minute online, like we are here-- so kind of just face to face. We use Teams in our school. But whatever system you have. And it's just a real quick, hi, how you doing? So we see someone face to face.

And in that meeting, I've watched their introduction. I kind of already have a sense a little bit about them. And so if in their introduction they've talked about how they have kids and are working-- and we can talk. I can use that as a bridge to start talking about, so how are you going to manage your time this semester? We can bring other things into that.

But then they also know me and have talked to me. They've seen me. And I just find that that has really helped. And I've had a lot of students reach out to me even after the fact of just first week of school, this is going on in my other class. Or I haven't heard from financial aid.

And so I also present myself, as, you can always communicate with me. And I know people. And so I can find you help if you need help. And we can make sure that you're going to be successful with this.
So again, the five things are they don't have to be the five things I do. It can be whatever you find helpful for your situation. But I just have found that has made the introduction smoother. And it's made just the progression-- I have a lot of students starting a lot more stronger than they were in the past, where, again, it's not a week into the class. And they're still trying to figure out their footing. We get off and running right away.

Thank you very much. Yeah, again, modeling the behaviors we want our students to be practicing, providing them those tools to get them a good start there. I know we've heard the term points chasing already today. And I'm wondering if one of our panelists might have an example about helping our students shift from that points chasing reflection.

So often, we incentivize. And I've heard examples of that, 5 points for something. But if anyone's had a quick success story about making that reflection become learning focused, making participation in those five steps be, I know this is good for me in my learning-- Jessica, do you want to say something real quickly about that one?

Yeah, I was going to say-- so the AI chatbot, Emily, now's the time to put that one in the link. So you guys have the directions now for it on Every Learner Everywhere. But we all know they're using it.
And so I wanted to try to find a way to help students learn how to use it to help their learning and enhance it versus doing the learning for them and the thinking for them because we know that's not good. So what I did is I created-- and it sounds really scary when I'm like, ooh, I have them create an AI chatbot.
It sounds overwhelming when you hear that. But it's really just a prompt you put into AI. And it creates the AI. The AI ends up becoming a tutor at that point to them. And so you're giving it the guardrails.
So basically, it has students go into-- so at my school, we have access to Gemini through their email address. So it's like the safe version of it, where it doesn't collect their data. But whatever your college has-- or you can do it for any of them.

All of the AI's have this really cool tool in them. Like in Gemini, it's called Guided Learning tool. And in ChatGPT, it's Copilot. Claude, it's called study and learn. But with this one prompt, it'll put you in all those tools for whichever AI you're using. And so what it does is I ask them to-- the prompt basically has a couple parts. So first, they go in-- they tell the AI, I need you to-- so I'm just going to use my calculus class.

So u-substitution, sometimes they screw it up, especially when they have bounds. And so the first part is, explain to me how u-substitution works for definite integrals like I'm in fifth grade. And provide images as well.
So "like I'm in fifth grade" is the key because it breaks things down so well. For one student, when they were learning about the fundamental theorem of calculus, they ended up using LEGOs as an example. And I was like, oh my gosh, I need to change my video to actually using this analogy now because it made sense for the first time.

So the first thing is they have it explained to them, like AI explain it. And then the AI asks them to explain it back in their own words what u-sub is. And then the AI tells them, actually says, did you do a good job? Or did you not? Were you missing anything? So it goes through and critiques their response to ensure that students have the full understanding. We know when a student has to put something in their own words, it gets into the longer term memory.

Then the next part of it is that students go through and will ask-- it has the AI give them four practice questions. And it tells the AI do not give me the answers to them. Varied in difficulty, have me give you the answer. If I get it wrong, prompt me to figure out where I made my mistake. And so it's really great. And then give me a similar question. So they'll go through. And the AI will give them a question. If they get it right, great, they get the next question. If they get it wrong, then it'll probe. Like, what did you use for your u? What did you change the bounds to? And then it gives them that specific feedback for where they made that specific mistake. So it's really personalizes learning for them.

I know that with AI, it's a definite situation where some people are pro, some people are against, so don't feel like you have to use it. But I will say, if you use my prompt, it will turn this AI into a tutor. And it will not give them the answers or the steps. And then I have my students reflect on their practice. And then they have to turn in all of the work that they did for those practice questions. If you're going to use one, if your school has access to Gemini, make sure you're in that thinking model, not the fast model, because the thinking model is having-- the newest one has-- I think that research was showing 94% accuracy in math.
So they're getting better and better at math, which is crazy. And then I also have a bonus if the AI did something wrong, say it. Say it. Explain how they did it wrong and why. But none of them have had an error with AI yet, luckily. Knock on wood.

Thank you very much for that. And from the points chasing standpoint, by not just asking for the right answer but really having students reflect on the process and word the question correctly, they're practicing communicating mathematically.

Conclusion

We are going to start wrapping things up today. Thank you so much to our panelists. I could talk for a lot longer. I'm sure you can tell. This is so interesting.

We have mentioned our example library a number of times today. If you are a math faculty who's using technology in a way that facilitates your teaching strategies or enhances student learning outcomes, we will pay you to share your story.

And we encourage you to visit the Transform Learning website and consider submitting an example of your own teaching practices that illustrate one or more of the eight evidence-based teaching practices. And thank you again to our panelists. I'll hand things back over to Norma.

Thank you all for your time, your energy, your excitement, all your wonderful ideas. I wish we had more time. Do appreciate it. Thank you. Christine.

We do want to invite our audience to join us next month, March 19th, for a webinar on the report, Transforming Undergraduate STEM Education-- Supporting Equitable and Effective Teaching, published by the National Academies of Sciences, Engineering, and Medicine. So we're hoping to see you all there. Everybody that was here, then invite your friends too to come next month for that one.
As far as our audience is concerned, we do ask that you take just a few minutes out to complete our survey for today's webinar using the link that we are posting in the chat for you. If you have something else going on right away, that's OK. We will be sending the link to you in an email in a couple of days after the webinar as a follow-through as well as the link to the recording to this.

So I want to thank our panelists. I want to thank Christine for moderating. I want to thank my background crew that you don't see, but you do see their names, Emily and Patty, for posting all the links and keeping up with everything. I want to thank our audience for taking time out. And we hope to see you again next month. Thanks to everybody. And we hope everyone has a wonderful day.