Incremental Professional Development in Algebra: Considering Teachers' Opinions on Instructional Nudges

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This study investigates a model of incremental teacher professional development (PD) based on small "instructional nudges"—concise, optional teaching suggestions shared asynchronously. Forty secondary teachers received 18 nudges during an academic year and then participated in heatmap interviews wherein they expressed opinions about each nudge and reported their frequencies of implementation. They tried an average of eleven nudges and regularly continued approximately three. The most and least positively viewed nudges are reported on, and results suggest that optional, small-scale instructional suggestions may support modest but sustainable instructional change.

Teacher professional development (PD) is a common mechanism for promoting improvement in mathematics instruction. Many PD efforts require intensive, transformational instructional changes based on innovative or ambitious visions for mathematics pedagogy, but those transformations have not yet worked at scale, with conventional, teacher-centred forms of instruction still pervasive (Arbaugh, 2025; Clarke et al., 2006; Every et al., 2025; Wilkie, 2019). Thus, scholars have begun investigating alternative models of PD such as incremental PD with support that may be brief and optional (Jansen et al., 2024), or include substantial elements of choice for teachers (Lee et al., 2024; Litke et al., 2025; Partridge, 2025), or possibly involve only slight adjustments to their instruction (Cortina & Višňovská, 2023; Otten et al., 2022; Star, 2016). These incremental efforts, modest in their aims, may be able to sustain and spread to a greater degree than the past attempts at transformational PD (Otten et al., 2025).

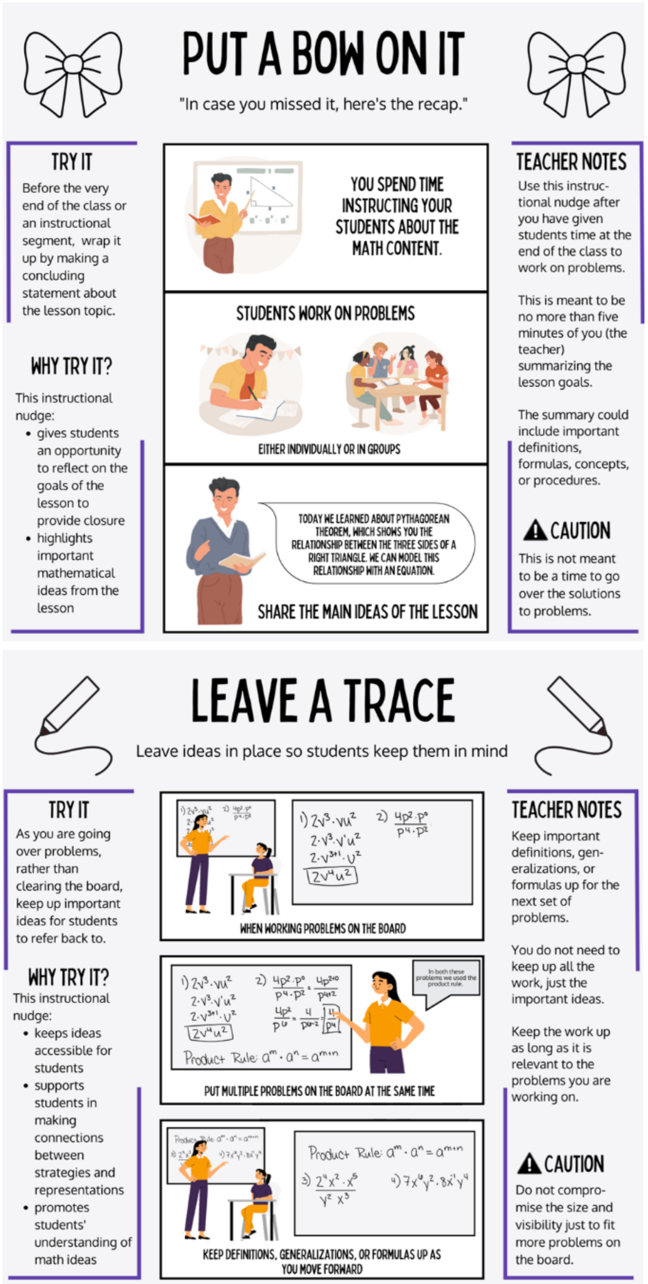
One particular type of incremental PD is nudge-based PD (Otten et al., 2025) in which small teaching suggestions ("instructional nudges") are encapsulated on a single page, with a brief description, instructional notes, and an illustrative example or classroom-based comic strip. These instructional nudges are shared with teachers asynchronously online and the teachers are free to choose any (or none) of the nudges and may implement them as they see fit. Figure 1 contains two examples of instructional nudges and other examples are contained in the following sections. It should be noted that nudges are concise and may seem simple but a great deal of work goes into their design (e.g., drawing from research but making the instructional moves modest and clear, choosing those with high probabilities of immediate success, providing a title/subtitle that "hooks" teachers and increases the likelihood of teachers sharing the nudge with others; see www.PracticeDrivenPD.com, for more detail). We hypothesize that nudge-based PD has the potential to spread instructional change to many teachers, particularly those who may not be reached by transformational PD efforts (Otten et al., 2025). As Star (2016) argued, there is value in making small changes across many teachers, complementing longstanding efforts to make large changes with a small group of teachers.

But nudge-based PD will only work if the instructional nudges offered to teachers are, in their view, worth trying. It is also imperative that the nudges be viewed positively by teachers after they have tried them, so they continue implementing and possibly spreading them. Thus,

(2026). In N. Berger, M. Thompson, J. Ley & C. Wilsmore (Eds.), *Beyond boundaries: Strengthening futures in mathematics education. Proceedings of the 48th annual conference of the Mathematics Education Research Group of Australasia, Sydney* (pp. 297–304). MERGA.

Figure 1

Examples of Two Instructional Nudges (Excerpted from One-Page "Nudge Sheets")



we seek to understand what factors shape teachers' opinions of nudges. Drawing upon teacher interview data from a multi-year PD project, we address the following research questions:

- RQ1: When offered 18 instructional nudges via email over the course of an academic year, how many nudges do secondary mathematics teachers choose to implement and how many do they continue implementing relatively frequently?
- RQ2: Which nudges are regarded by secondary mathematics teachers the most positively and which are regarded negatively?
- RQ3: For those nudges that arise in RQ2, what reasons did the secondary mathematics teachers provide for their opinions?

Our theoretical framing is built upon the nudge-based model of incremental PD (Otten et al., 2025), with key conceptual facets being high levels of teacher choice, low levels of teacher time commitment, close proximity of proposed changes to pre-existing practice, and the considered potential of uptake of instructional suggestions, continuation of instructional changes, and spread to other teachers. These broader ideas connect to practicality theory (Doyle & Ponder, 1977) and PD scale (Coburn, 2003) but for the present analysis the focus here is on teacher choice and uptake of instructional suggestions.

Method

This study comes from a multi-year project investigating nudge-based incremental PD for algebra teachers in the U.S. The project involved one year of baseline data collection in each teacher's classroom (3 observations per year), with teachers coming from diverse school districts across 14 states, and then the creation of 18 instructional nudges. During the subsequent academic year, all 18 nudges were made available to the teachers online and were also sent via email (links to the nudge sheets) in groups of 9 nudges in the first month of the academic year and then the other 9 in the second month (teachers received different groups of nudges but all eventually had access to all 18 nudges by the second month). The present analysis focuses on "heatmap" interviews with 40 teachers, who varied from second-year teachers to those with 20+ years of experience. Within the interview, they were shown the titles of all 18 nudges on a slide and asked to place them spatially (Fig. 2). Their horizontal placement indicated the extent to which they hated or loved the nudge and vertical placement indicated how many times they tried the nudge in practice. There were also regions to place nudges they had not yet tried but intended to and nudges they did not intend to try. During the interview we asked various questions to elicit the teachers' perspectives on the nudges and we video-recorded their movements and transcribed their verbal remarks.

Figure 2

Example of the Heatmap Layout Used to Investigate Teachers' Opinions about Instructional Nudges

For RQ1, any nudges teachers placed above the horizontal line (i.e., in the positive "# of Tries" area) were considered to have been tried, and any nudges placed within one-nudge-boxheight of the top of their used graphical space was considered to have been many times (e.g., *Getting Unstuck*, *Pivot*, *Leave a Trace*, and *Put a Bow On It* in Fig. 2). For RQ2, the nudge placed rightmost by an individual teacher was considered "most positive" (e.g., *Put a Bow On It* in Fig. 2) and any other nudges that overlapped horizontally with that nudge were also considered to be in the group of "most positive" (e.g., *Leave a Trace* in Fig. 2). Non-positive opinions were rarer and so we included any nudges placed on the midline (e.g., *Pairing*) and any to the left (e.g., *Here's Where I'm At* and *Rate and Review*) as well as those placed in the "Do Not Plan on Trying It" section as being "least positive". Two coders confirmed these categorisations of the nudges and tallies were made of all the most positive and the non-positive opinions of nudges.

For RQ3, two coders reviewed the interview transcripts for any mention of the most positive and non-positive nudges and conducted open coding of the reasons teachers provided for their opinions. A single nudge could have multiple reasons expressed. After open coding, the two coders met to combine related themes and clarify subtle distinctions, yielding a set of refined codes (Tables 3 and 4 in Results). The co-authors conferred on the results and interpretations.

Results

Number of Instructional Nudges Attempted and Continued (RQ1)

Aggregating across the 40 secondary mathematics teachers, all reported trying at least some of the instructional nudges. In fact, all teachers tried at least three nudges during the course of the academic year and one teacher reported trying all 18. The mean number of nudges tried was 11.0 (median=11.5, mode=13, standard deviation=3.8). As a reminder, within this nudge-based approach to PD, the teachers were free to choose which nudges they implemented and how they enacted them with their own students. Our interest is not in "fidelity" but rather the uptake of the instructional suggestions that were provide without training or required follow-up.

With regard to continuing to implement the nudges, as measured by their placement of the nudge toward the top of the number-of-tries dimension on the heatmap, all teachers had at least one nudge that they reported using regularly. The mean number of such nudges was 2.9 (median=3, mode=3, standard deviation=1.2). In a few cases, these frequently-implemented nudges were teaching practices that were similar to something the teacher had already been doing, but in these cases, the teachers expressed that they still valued the nudges positively as a reinforcement of their own practice or as something that can give them a refined idea of how to implement the teaching strategy.

Positively- or Negatively-Viewed Instructional Nudges (RQ2)

Table 1 displays the five nudges rated most positively by at least 10 teachers. *Put a Bow On It* was rated most positively by 18 teachers (45%); it is the suggestion to teachers to provide a brief summary of the mathematical idea of the lesson before students depart (Shimizu, 2006), inspired by the fact that baseline data showed nearly all lessons ending abruptly without any mathematical conclusion. *Leave a Trace* was rated most positively by 14 teachers (35%); it is the suggestion to place worked examples or problem solutions on the front board in a side-by-side fashion rather than displaying only one worked example or one problem at a time (Rittle-Johnson & Star, 2011). *Leave a Trace* can also involve leaving key information visible while students work. Other relatively popular nudges were *Confidence Meter* (asking students for their confidence level in addition to their answer on a mathematical problem), *Pivot* (shifting the activity structure at least every 10–15 minutes), and *Getting Unstuck* (providing students with options for what to do if they get stuck during work time).

Table 1

Five Instructional Nudges (out of 18) Rated Most Positively by the Most Teachers (n=40)

Nudge Title	Nudge Hook	No. of Teachers Rating it Most Positively
Put a Bow On It	In case you missed it, here's the recap.	18
Leave a Trace	Leave ideas in place so students keep them in mind.	14
Confidence Meter	Drive instruction based on your students' confidence.	12
Pivot	Change up your format to keep students engaged.	12
Getting Unstuck	When you're outnumbered, expand students' options.	11

Table 2 displays the three nudges viewed non-positively by pluralities of teachers. *Rate and Review*, viewed negatively by 12 teachers (30%), is an activity wherein students are provided a written mathematical solution and asked to rate it out of five stars and provide a written review, explaining their rating (Stewart et al., 2025). *Here's Where I'm At*, viewed negatively by 11 teachers (28%), is the suggestion to have students pause in the middle of work time, move across the room to discuss their progress with a peer, and then continue working afterward. *Pairing*, viewed negatively by 9 teachers (23%), is the suggestion to supplement a problem set by asking students to identify a pair of problems they see as similar (or different) and explain why. It should be noted that several teachers misremembered the nudge (which they had perhaps viewed briefly several months earlier) as asking the students to pair up with a peer rather than asking them to find pairs of problems to compare/contrast; they often expressed negative opinions of this peer-based alternative version of Pairing. We have subsequently revised the nudge to *Pairing Problems* and are conducting further field tests with it.

Table 2

Three Instructional Nudges (out of 18) Rated Negatively by the Most Teachers (n=40)

Nudge Title	Nudge Hook	No. of Teachers Rating it Negatively
Rate and Review	You rate movies. You rate restaurants. You can also rate math solutions!	12
Here's Where I'm At	Work, move, meet.	11
Pairing	Sometimes two problems are better than one.	9

Rationales Teachers Expressed About Instructional Nudges (RQ3)

With regard to positive opinions of instructional nudges (Table 3), the reasons expressed by teachers often focused on their students (23 instances) but almost as frequently focused on their own work and preference as a teacher (17 instances). The Student-Focused category included teachers' reports of benefits of the nudges on students' learning (12 instances) ("if you don't leave what you've done [on the board]…it doesn't click as quickly, so *Leave a Trace* is really good"). In other cases, teachers viewed the learning as going beyond mathematics ("You need to be able to get unstuck…it's really what you do with regular life when you have problems and you're stuck"). Other reasons (5 instances) focused on classroom management and supporting students' interpersonal dynamics ("I need to pivot and do something else to keep them engaged"). There were also 6 instances where the teacher simply stated that students responded well when they implemented the nudge.

Table 3

Reasons Teachers Provided for Why They Liked the Popular Instructional Nudges

	Student-Focused Benefits			Teacher-Focused Benefits		
Nudge	**Learning**	**Manage-ment**	**Positive Response**	**Improved Instruction**	**Gather Feedback**	**Positive Response**
Put a Bow On It	1	0	1	1	2	5
Leave a Trace	6	1	3	2	0	0
Confidence Meter	1	1	1	0	2	3
Pivot	0	3	1	1	0	0
Getting Unstuck	4	0	0	1	0	0
TOTALS	**12**	**5**	**6**	**4**	**4**	**8**

Table 3 also enumerates the Teacher-Focused reasons for positive opinions of the nudges. In 4 instances, teachers described how the nudge entailed effective instruction or an opportunity for them to improve upon what they had been doing before ("[*Put a Bow On It*] is just a really good way to pull a summary together and, like, remind the students at the end of class, 'Remember, this is what we learned today'"). In another 4 instances, teachers expressed the specific benefit of two nudges (*Put a Bow On It* and *Confidence Meter*), being that they allowed them to gather feedback about how the students were doing in the lesson. The most frequent Teacher-Focused reason for their positive opinions was simply that the teacher liked the nudge or that it had gone well when they tried it ("I do love doing [*Getting Unstuck*]"; "I do [*Pivot*] very often, I like it").

Teachers' negative opinions (Table 4) were largely driven by their views on how students reacted to the nudge; they expressed 23 reasons in the Student-Focused Concern category and only 12 reasons in the Teacher-Focused Concern category (4 reasons were too vague to be categorised). *Pairing* garnered negative opinions primarily because of concerns about how students would respond to the nudge, be it learning concerns ("Other [students] are like, 'Yeah, whatever, it's just two problems,' so they're indifferent") and management/engagement concerns ("They're really lazy, and so I found [Pairing] to be more work than our kids were willing to try"). *Here's Where I'm At* and *Rate and Review* were quite different from one another in the reasons for being disliked. *Here's Where I'm At* was disliked primarily (5 instances) due to concerns about classroom management ("It turns out sometimes to be more of a managing thing than I want"; "[Students] moving around the room can be a lot for us"), but 3 teachers also expressed that they did not like *Here's Where I'm At* because they already had a particular way they organized their student interactions during work time (e.g., teacher-selected groups without the standing and mixing that the nudge suggests). In contrast, it was student learning concerns (7 instances) that prevailed for *Rate and Review* ("I've really seen kids struggle and get discouraged with the writing"). Additionally, 3 teachers expressed they were unsure of the purpose or how to implement the nudge ("I don't know if I did it incorrectly…they couldn't explain to me why they gave [their rating]").

Table 4

Reasons Teachers Provided for Disliking (or Not Trying) Unpopular Instructional Nudges

	Student-Focused Concerns		Teacher-Focused Concerns			
Nudge	**Learning**	**Management**	**Already Do Similar**	**Not My Style**	**Unclear Purpose**	**Not Enough Time**
Pairing	4	3	0	1	2	0
Here's Where I'm At	2	5	3	1	0	0
Rate and Review	7	2	1	0	3	1
TOTALS	**13**	**10**	**4**	**2**	**5**	**1**

Discussion

This nudge-based approach to instructional change is based on the observation that intensive, transformational PD has not succeeded in a widescale sense because it is difficult to make large, ambitious changes away from conventional instruction and it is unlikely for such changes to easily spread (Otten et al., 2025). But nudge-based PD is also unlikely to succeed if teachers are not able or are unwilling to try instructional suggestions based only on brief one-page descriptions. It was not obvious to us beforehand that teachers would actually implement small instructional nudges without being required to do so and without receiving any training or direct support from professional developers. Although there may have been implicit pressure because they were enrolled in the ongoing project, we explicitly informed teachers many times that the nudges were voluntary and that we knew they were busy and did not mind if they chose to forego the nudges. Yet, results for RQ1 show that all teachers were willing to try some of the nudges and were able to do so based on the brief instructional nudge content. Moreover, all teachers had at least one nudge, and typically three nudges, that they were happy to continue implementing fairly regularly. This result does not generalise to all teachers, because these were individuals who were willing to sign up for a university-based research project, but it is at least an encouraging result for initial uptake of instructional nudges, and perhaps such teachers can be the initiators of further spread since the nudges are packaged in easily-shareable forms. (Analysis of the data about their spreading/sharing behaviours is beyond the scope of this brief report, but we have indications of some spontaneous sharing of the teachers' favourite nudges.)

As teachers are considering whether to try or continue instructional nudges, results show that they may focus primarily on how the nudges affect or will be received by students, which corroborates findings by Partridge (2025) at the elementary level. Yet, there were also some reasons for nudge preferences that were teacher focused, with teachers opting against instructional suggestions in areas where they already have a preferred practice or against suggestions that do not resonate with their personal style, but opting for modest suggestions they felt were slight improvements to practice. In designing nudges, it can be challenging to find the distinction between nudges that are similar to what they are already doing and viewed as an enhancement versus nudges viewed as unnecessary because teachers already have a similar means for achieving the same ends. Our data suggests these distinctions are not to be found for nudges in general but, rather, the distinction depends on individual teachers. Thus, it may be essential in the nudge-based incremental PD approach to provide a variety of options to teachers and allow them to choose which nudges they want to implement and how. After all, in this study, even the most popular nudge was only rated most highly by less than half of the participants, but all teachers had some nudges they rated very highly. This suggests potential in this PD approach, and we are interested in how the possible criteria for success in this nudge-based approach may compare, or more likely *contrast*, with the known criteria for transformational PD (e.g., Desimone, 2011; Feiman-Nemser, 2001).

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References

Arbaugh, F. (2025). Commentary: Personal transformations and the possibilities of incremental progress in mathematics teacher professional development. *Education Sciences*, *15*(1), 30.

Clarke, D., Emanuelsson, J., Jablonka, E., & Mok, I. A. C. (Eds.) (2006). *Making connections: Comparing mathematics classrooms around the world.* Sense Publishers.

Coburn, C. E. (2003). Rethinking scale: Moving beyond numbers to deep and lasting change. *Educational Researcher*, *32*(6), 3–12.

Cortina, J. L., & Višňovská, J. (2023). Designing instructional resources to support teaching. In T. Lamberg & D. Moss (Eds.), *Proceedings of the 45th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (Vol. 1, pp. 15–26). Univ. Nevada.

Desimone, L. M. (2011). A primer on effective professional development. *Phi Delta Kappan*, *92*(6), 68–71.

Doyle, W., & Ponder, G. A. (1977). The practicality ethic in teacher decision-making. *Interchange*, *8*(3), 1–12.

Every, E., Ball, L., & van Driel, J. (2026). Mathematics teachers' perceptions of teaching strategies when adopting a STEM approach. *Mathematics Education Research Journal*, *38*, 1–33.

Feiman-Nemser, S. (2001). From preparation to practice: Designing a continuum to strengthen and sustain teaching. *Teachers College Record*, *103*(6), 1013–1055.

Jansen, A., Botello, M., & Silla, E. M. (2024). Rough Draft Math as an evolving practice: Incremental changes in mathematics teachers' thinking and instruction. *Education Sciences*, *14*(11), 1266.

Lee, H. S., Thrasher, E., Mojica, G. F., Graham, B. M., Lee, J. T., & Kuhlman, A. (2024). Examining teachers' professional learning in an online asynchronous system: Personalized supports for growth and engagement in learning to teach statistics and data science. *Education Sciences*, *14*(11), 1236.

Litke, E., Wilson, J., & Hill, H. C. (2025). Equity-focused, rubric-based coaching: An incremental improvement approach to supporting teachers to shift toward more equitable mathematics instruction. *Education Sciences*, *15*(4), 444. https://doi.org/10.3390/educsci15040444

Munter, C., Stein, M. K., & Smith, M. S. (2015). Is there a common pedagogical core? Examining instructional practices of competing models of mathematics teaching. *NCSM Journal of Mathematics Education Leadership*, *16*(2), 3–13.

Otten, S., de Araujo, Z., & Candela, A. G. (2025). The benefits of modesty: Considering incremental professional development for mathematics teachers. *Education Sciences*, *15*(4), 473.

Otten, S., de Araujo, Z., Candela, A. G., Vahle, C., Stewart, M. E. N., Wonsavage, F. P., & Baah, F. (2022). Incremental change as an alternative to ambitious professional development. In A. Lischka & J. F. Strayer (Eds.), *Proceedings of the 44th annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1463–1468). PME-NA.

Partridge, E. (2025). *Investigating instructional nudges as a model for elementary mathematics professional development* [dissertation]. University of Missouri, Columbia, MO, USA.

Rittle-Johnson, B., & Star, J. R. (2011). The power of comparisons in learning and instruction: Learning outcomes supported by different types of comparisons. *Psychology of Learning and Motivation: Cognition in Education*, *55*, 199–226.

Shimizu, Y. (2006). How do you conclude today's lesson? The form and functions of 'matome' in mathematics lessons. In D. Clarke, J. Emanuelsson, E. Jablonka, & I. A. C. Mok (Eds.), *Making connections: Comparing mathematics classrooms around the world* (pp. 127–145). Sense Publishers.

Star, J. R. (2016). Improve math teaching with incremental improvements. *Phi Delta Kappan*, *97*(7), 58–62.

Stewart, M. N., Brown, N., Candela, A., Otten, S., & de Araujo, Z. (2025). Rate and review. *Mathematics Teacher: Learning and Teaching PK-12*, *118*(1), 45–57.

Wilkie, K. J. (2019). The challenge of changing teaching: Investigating the interplay of external and internal influences during professional learning with secondary mathematics teachers. *Journal of Mathematics Teacher Education*, *22*(1), 95–124.