# Investigating Teachers' Perceptions of Enabling and Extending Prompts

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Differentiating students' learning needs in primary mathematics classrooms is an issue faced by many teachers. One technique designed to differentiate the level of challenge in mathematics tasks is the use of enabling prompts and extending prompts. We report on survey data pertaining to enabling and extending prompts, and teacher noticing of 37 Year 3 to 6 teachers participating in a project investigating the use of challenging tasks. Data were coded and categorised using grounded theory. The teachers valued enabling and extending prompts when implementing challenging mathematical tasks, and using these prompts stimulated them to notice students' reasoning and mathematical communication.

A challenge for teachers when teaching is to diagnose and notice students' learning and thinking, interpret this information, and decide appropriate opportunities for learning (Hoth et al., 2016). In mathematics education, one model for planning and teaching designed by Sullivan, Mousley, and Zevenbergen (2006) to address the range of mathematical thinking in any classroom is the use of one substantial problem posed to all of the students supplemented by appropriate prompts. These authors emphasised the use of open-ended tasks that create "opportunities for personal constructive activity by students" (p. 498); they also emphasised the use of appropriate sequences of tasks. They coined the terms *enabling prompts* and *extending prompts*. Enabling prompts were designed to support students experiencing difficulty, by allowing students to engage in active experiences related to the initial goal of the task. Extending prompts were for students who completed the initial task readily, and were designed to extend students' mathematical thinking. Sullivan et al. (2006) recommended to teachers that "a decision needs to be made when planning lessons about specific types of barriers that one or more students may experience, and during lessons about difficulties being experienced" (p. 498). This forward thinking and planning was intended as preparation for using an enabling prompt. Similarly, teachers could anticipate which students may benefit from an enabling or extending prompt.

The aim of the study was to investigate teachers' perceived use of enabling and extending prompts when noticing students' mathematical thinking. The following research questions guided the study:

- What were teachers' perceptions about the use of enabling and extending prompts?
- To what extent did teachers notice students' mathematical thinking when reflecting on their lessons?

## Background

The position of the project team in the Encouraging Persistence Maintaining Challenge project (EPMC; Sullivan et al., 2014; Sullivan & Davidson, 2014) was the belief that everyone can learn mathematics. In addition, learning mathematics takes concentration and effort over an extended period of time to build the connections between topics, to understand the coherence of mathematical ideas, and to be able to transfer learning to practical contexts and new topics. The project team recognized that students need to be

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encouraged to persist, to concentrate, apply themselves, believe that they can succeed, and make an effort to learn. The project team developed tasks and lessons that were likely to foster such actions and called them challenging, in that they allowed for the possibility of sustained thinking, decision-making, and some risk-taking by the students. Teachers engaging students in appropriate tasks to develop mathematical reasoning was seen as critical (Anthony & Walshaw, 2009; Brodie, 2010).

In the EPMC project, learning was considered to be stronger if students connected ideas together for themselves, and determined their own strategies for solving problems, rather than following instructions they had been given. Essentially, the idea was for teachers to pose problems that the students did not yet know how to solve and to support them to find a solution. The project centred on problems and their effects in classrooms. The features of the challenging tasks (Sullivan et al., 2013) used in the collaboration reported here were based on those developed in the EPMC and they required students to:

- plan their approach, especially sequencing more than one step;
- process multiple pieces of information, with an expectation that they make connections between those pieces, and see concepts in new ways;
- engage with important mathematical ideas;
- choose their own strategies, goals, and level of accessing the task;
- spend time on the task and record their thinking; and
- explain their strategies and justify their thinking to the teacher and other students.

At least part of the challenge was the expectation that students:

- record the steps in their solutions;
- explain their strategies;
- justify their thinking to the teacher and other students; and
- listen attentively to each other.

Tasks that were seen to be best were those that address important mathematical ideas, are developmentally appropriate, and with which students can engage with minimal instruction. Such tasks create a challenge for students and require considerable persistence. Engaging with important and complex mathematical ideas requires sustained thinking and considerable effort. Students gain a sense of achievement from overcoming a challenge, and this satisfaction leads to improved self-concept (Sullivan et al., 2013). Others suggest anticipation of students misbehaving in their mathematics classrooms can cause teachers to reduce the challenge of the tasks (Stein, Smith, Henningsen, & Silver, 2009).

Many tasks in the project required students to make decisions on the solution type and solution strategy. The expectation was that students would try to find a solution by themselves rather than seek the support or direction from the teacher, particularly when the solution was not clear. The underlying expectation of the collaboration was that teachers foster persistence in their students. Teachers were encouraged to talk with students about the benefits of persisting and to affirm persistence when they identified it. Noticing persistence was only one of the noticing behaviours the collaboration expected of participating teachers. The teachers were also encouraged to anticipate their students' responses to the tasks based on what they had noticed about students' earlier approaches to the mathematical content. Teachers were also expected to notice the students' actions as they undertook tasks and to respond at the time, monitoring what the students were doing and noticing the mathematical connections students were making.

Several studies indicated that teachers often fail to see the mathematics content of a task from a student's perspective (Fernandez, Cannon, & Chokshi, 2003; Sullivan, Boreck, Walker, & Rennie, 2016), and focus on superficial features of a task or lesson during planning (Choy, 2013). Current research literature reports there are several facets of teacher noticing (Hoth et al., 2016). Examples include: attending to children's thinking, interpreting children's understandings, deciding how to respond on the basis of children's understanding (Jacob et al., 2010), perceiving particular events in an instructional setting, interpreting the perceived activities in the classroom, and decision-making either as anticipating a response to students' activities or as proposing alternative instructional strategies (Kaiser et al., 2013). Deciding how to respond in the moment and the teachers' decision making are what Miller (2011) referred to as situated awareness, and Mason (2011) described as noticing in the moment that enables teachers "to act freshly rather than habitually" (p. 48). The literature suggests a correlation between teacher noticing and use of enabling and extending prompts.

## Method

The data were collected from 37 Year 3 to 6 primary school teachers who volunteered to be part of the EPMC collaboration in 2016. The collaboration was an offshoot of the original EPMC project. Participating teachers were provided with two days of professional development. The first day included an explanation of the rationale for the collaboration, the expectations of participating teachers, and an introduction of 15 tasks for potential inclusion in lesson sequences addressing the topic of multiplicative thinking. Each task was documented in a booklet, with the key understandings addressing the intended year level range, curriculum outcome, key mathematical language, pedagogical considerations, a possible introduction, enabling and extending prompts, consolidation tasks (designed for students who need further exploration of the mathematical ideas underpinning the initial task), worksheets, and solutions. The specific information dealing with prompts were:

> ENABLING PROMPT:
>
> Most lessons include a suggestion of an enabling prompt that can be posed to students who have not been able to make progress on the main task. The intention is that the students can complete the enabling prompt and then proceed with the learning task. Enabling prompts can involve varying an aspect of the task demand, such as the form of representation, the size of the numbers, or the number of steps. If students have success with the modified task, they can proceed with the original task.
>
> EXTENDING PROMPT:
>
> Some students might finish the learning task quickly. The intention is such students be posed "extending prompts" that extend their thinking on an aspect of the main task.

This information was provided to clarify, for teachers, the intention of the prompts in the task design. On the second day, teachers reported on their experience of implementing the tasks in their classrooms. At the beginning of each professional learning day, participants responded to an online (Qualtrics) survey that included open and closed items. Findings reported in this paper relate to the teachers' responses (Day 2) to the following questions pertaining to enabling and extending prompts, and teacher noticing:

> What were you looking for or thinking about when you chose to use an enabling prompt?
>
> What were you looking for or thinking about when you chose to use an extending prompt?
>
> What is something you noticed about students' mathematical thinking you had not noticed before?

The responses of 37 participating teachers were entered into a spreadsheet, coded, and then categorised through the analysis of data using a grounded theory approach (Strauss & Corbin, 1990).

## Results and Discussion

The teachers' results to the open response enabling and extending prompts survey questions are presented in separate sections below, followed by a discussion of self-reported data related to the teaching noticing question.

### *Enabling Prompts*

If a teacher mentioned multiple ideas, each idea was categorised as a separate response. Therefore, the total number of responses (*n* = 49) was larger than the number of participating teachers (*n* = 37). Table 1 shows the categories that emerged from the data for the survey question: What were you looking for or thinking about when you chose to use an enabling prompt?

Table 1
*Categories of Teachers' Perceptions about Enabling Prompts (n = 49)*

| Category | Frequency |
|---|---|
| Potential to assist thinking – help struggling students | 13 |
| Ensure entry to problem – anticipate students who might struggle | 11 |
| Consider match of student understanding to the task | 11 |
| To support and engage – affective reasons | 6 |
| Experience success | 4 |
| Overcome barrier (students are "stuck" once engaged) | 4 |

Taking the three most frequent categories of responses in Table 1 together paints a picture of the main perceptions teachers had in mind when they were considering enabling prompts. Teachers were aware of the potential of the prompts to help students who were struggling with the main task of the day. Some teachers said that they introduced the main task and watched student behaviours to identify those struggling to "get into the problem." It was at this stage of the lesson that the enabling prompts were used. For example:

> When giving an enabling prompt, I would look for children who were struggling to understand the processes needed to solve the problem.

It was interesting to see that teachers also thought about how to ensure that their students could tackle the main problem. They were not seeing the prompts as an alternative to the problem. They were looking at the way the enabling prompt would create a means of access to the task. For example:

> Something that would help them to do the main problem - usually smaller numbers but the same problem.

The four responses dealing with overcoming a barrier in thinking have connections here. For example:

> When students were "totally stuck", I gave them a simplification "clue" to get them started. Sometimes this was as far as they could go.

Teachers were also considering what they knew about their students' mathematical knowledge in advance of presenting the task and thinking about how the enabling prompt might bridge the two. For example:

> Does this student understand the concepts and do they have the capacity to make the connections they need?

Taken together, these responses show the teachers were thinking about ways to ensure that their students engaged with the main mathematics of the task. A further category of responses added to these findings, as the teachers mentioned affective issues and ways to support and encourage students. For example:

> I was looking for students who showed lack of confidence, students who demonstrated distracted behaviours (in my class they are the kids who don't like maths). How to give those children the confidence to tackle the problem.

These responses show that teachers think about students who cannot tackle the problem due to their attitudes to mathematics. The quoted teacher was aware that a lack of confidence might impact students' persistence with problem solving and that sometimes students who cannot do the problem can become disruptive in the classroom. As Doyle (1986) and Desforges and Cockburn (1987) noted, students sometimes resist tasks that are high in cognitive demand by threatening classroom disorder. The anticipation of students misbehaving in their mathematics classrooms can cause teachers to reduce the challenge of the tasks (Stein, Grover, & Henningsen, 1996; Stein et al., 2009). Allied with teachers' awareness of student negative emotions is their wish to create positive successful mathematical experiences. Another teacher said enabling prompts could help as:

> Making it simpler would empower my students and give them a sense of success – [creating] some light bulb moments.

As can be seen from the responses, teachers were keen to keep their struggling students productively engaged and challenged and, as is reported in the next section, they also considered students who finished the task quickly.

### *Extending Prompts*

The analysis of teachers' responses pertaining to the use of extending prompts fell into five categories (see Table 2). The responses were quite evenly distributed across the categories. The frequency of responses that includes the term *challenge* is not surprising, as it was in the title and purpose of the collaboration. Perhaps teachers were echoing the ideas presented to them when they considered ways in which extending prompts could help them to maintain the level of challenge. Alternatively, they were adopting an orientation to challenge students further.

An interesting category of responses related to teachers attending closely to each student's mathematical thinking, and whether an extending prompt was required. For example:

> [Students] that achieved all the possibilities and could explain their thinking and justify their answers.

The intention of extending thinking was mentioned. For example:

> Extending student understandings - challenge them and put them out of their comfort zone.

The idea that the extending prompt would ask students to apply their knowledge was seen in comments such as:

> To see if students could apply their knowledge to other problems.

Table 2
*Categories of Teachers' Perceptions about Extending Prompts (n = 33)*

| Category | Frequency |
|---|---|
| Taking cues from students and noticing students seeking challenge | 8 |
| Extending students' thinking | 7 |
| Challenging particular students | 7 |
| Matching tasks to student thinking | 6 |
| Asking students to apply their knowledge | 5 |

These data raise questions about whether teachers clearly differentiated between extending prompts, which took the task beyond the initial task at its level of difficulty, and consolidation tasks, which were modifications of the initial task at the same level of difficulty. The purpose of the consolidation task was to reinforce or extend students' learning if they had difficulty with the main task of the day (Sullivan et al., 2016).

## *Teacher Noticing*

As reported in Table 2, the teachers took cues from the students and noticed those students who needed an extending prompt. In other words, the teachers noticed the behaviours of their students in the moment in their classroom and decided how to maintain the mathematical challenge. This behaviour, termed by Sherin, Jacobs, and Philipp (2011) as adaptive and responsive teaching, is considered a critical teaching skill.

Another survey question asked: What is something you noticed about students' mathematical thinking that you had not noticed before? Three teachers responded:

> The multiple ways of thinking. Some particular students surprised me with their strategies. This was interesting as it led our discussion.

> [Students] tended to get better at it as they completed more tasks. At first they would only solve problems one way but then they realised that there was more than one way. This led to the students looking at different ways without being prompted.

> They can think quite differently and have the ability to present various ways of solving a problem.

The teachers, as illustrated by these quotations, noticed a range of strategic thinking, problem solving, resilience, flexibility, and variation in students' mathematical thinking. They also came to recognise that all students can solve challenging problems. Teachers also considered what they noticed in the classroom and reflected on its importance in building their knowledge of the learners and the learning.

Teachers' awareness of the necessity to match the task to the mathematical needs of their students was clear. Self-questioning was reported by one teacher who said, "Was this too easy? Does this extend their mathematical understandings? Does this build their capacity to persist?" There was a shift in the teacher's thinking from considering whether the student could complete the task to whether the task challenged the student's thinking and required persistence. It seems that the prompts served the purpose of stimulating the teachers to consider individual students' thinking and knowledge in relation to the proposed challenging task, to think in advance, and to predict whether the task was a good "fit" for students. This action was seen by Mason (2011) as preparing to notice.

One outcome of this collaboration suggesting teacher change was summarised by the following reflection:

> I have started to give the students the task (on paper) and give them time to figure out what to do without me telling them what to do or how to do it. Giving students enabling/extending prompts has helped their understanding as they are still completing the same tasks - it means I don't have to plan three or four different tasks in one lesson. Getting the students to explain their answers and reasoning has been great. It allows the other kids to hear from one of their peers what I would usually tell them.

This teacher realised the importance of holding back, allowing the students to lead the discussion, which is an example of deciding how to respond in the moment, or situational awareness (Miller, 2011). In addition, teachers were aware that if they noticed students who were "stuck" or who "breezed through" the problem, they had prepared prompts that were designed to help those students.

## Conclusion

In relation to the research questions, the findings suggest that the teachers saw value in using enabling and extending prompts to support student learning when one substantial problem is posed to all students. These findings support earlier studies (e.g., Hoth et al., 2016; Sullivan et al., 2006). In our study, the prompts had at least two positive effects on teachers' pedagogies: They allowed teachers to differentiate their teaching and they stimulated teachers' noticing of students' reasoning, strategic thinking, and mathematical communication. However, there appeared to be limited teacher perceptions and understanding of the purpose of the consolidation tasks and extending prompts.

Teachers were also aware of noticing when responding to the interview questions, and some teachers reported that noticing was a difficult component of the lessons. However, the reality of their classrooms required participating teachers to notice the meaningful features of the classroom situation and figure out what to do in the moment. Further studies including lesson observation would provide richer insights into teacher noticing and how this expertise can be fostered. Deciding how to respond in the moment and being aware of student learning is a component of teacher noticing (Stein et al., 2009) but, as the findings of our study suggest, it remains complex and is challenging for teachers to master.

The two days of the research project and professional development suggest that the teachers were able to gain knowledge for implementing the lesson sequence of challenging tasks. There is further research to be done in terms of teachers' ongoing adoption and adaptation of the use of enabling and extending prompts. The extent to which teachers of mathematics can use the idea of prompts as a differentiation technique and devise enabling and extending prompts when teaching with challenging tasks is yet to be fully investigated.

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## References

Anthony, G., & Walshaw, M. (2009). *Effective pedagogy in mathematics*. Geneva, Switzerland: International Bureau of Education.

Brodie, K. (2010). Mathematical reasoning through tasks: Learners' responses. In K. Brodie (Ed.), *Teaching mathematical reasoning in secondary school classrooms* (pp. 43–56). New York, NY: Springer.

Choy, B. H. (2013). Productive mathematical noticing: What it is and why it matters. In V. Steinle, L. Ball, & C. Bardini (Eds.), *Mathematics education: Yesterday, today and tomorrow: Proceedings of 36th Annual Conference of Mathematics Education Research Group of Australasia* (pp. 186-193). Melbourne: MERGA.

Desforges, C., & Cockburn, A. (1987). *Understanding the mathematics teacher: A study of practice in first schools*. London, England: The Palmer Press.

Doyle, W. (1986). Classroom organisation and management. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (pp. 392-431). New York, NY: Macmillan.

Fernandez, C., Cannon, J., & Chokshi, S. (2003). A U.S.-Japan lesson study collaboration reveals critical lenses for examining practice. *Teaching and Teacher Education, 19*(2), 171–185.

Hoth, J., Dohrmann, M., Kaiser, G., Busse, A., Konig, J., & Blomeke, S. (2016). Diagnostic competence of primary school mathematics teachers during classroom situations. *ZDM, 48*, 41-53.

Jacobs, V., Lamb, L., & Phillipp, R. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathematics Education, 41*(2), 169-202.

Kaiser, G, Busse, A., Hoth, J., Konig, J., & Blomeke, S. (2015). About the complexities of video-based assessments: Theoretical and methodological approaches to overcoming shortcomings of research on teachers' competence. *International Journal of Science and Mathematics Education, 13*, 369-387.

Mason, J. (2011). Noticing: Roots and branches. In M. Sherin, V. Jacobs, & J. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 35-50). New York, NY: Routledge.

Miller, K. (2011). Situation awareness in teaching: What educators can learn from video-based research in other fields. In M. Sherin, V. Jacobs, & R. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 51-65). New York, NY: Routledge.

Sherin, M., Jacobs, V., & Philipp, R. (2011). Situating the study of teacher noticing. In M. Sherin, V. Jacobs, & R. Philipp (Eds.), *Mathematics teacher noticing: Seeing through teachers' eyes* (pp. 17-34). New York, NY: Routledge.

Stein, M., Grover, B., & Henningsen, M. (1996). Building student capacity for mathematical thinking and reasoning: An analysis of mathematical tasks used in reform classrooms. *American Educational Research Journal, 33*(2), 455-488.

Stein, M., Smith, M., Henningsen, M., & Silver, E. (2009). *Implementing standards-based mathematics instruction* (2nd ed.). New York, NY: Teachers College Press and NCTM.

Strauss, A., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: SAGE.

Sullivan, P., Boreck, C., Walker, N., & Rennie, M. (2016). Exploring a structure for mathematics lessons that initiate learning by activating cognition on challenging tasks. *Journal of Mathematical Behaviour, 41*, 159-170.

Sullivan, P., Askew, M., Cheeseman, J., Clarke, D., Mornane, A., Roche, A., & Walker, N. (2013). Supporting teachers in structuring mathematics lessons involving challenging tasks. *Journal of Mathematics Teacher Education*, *18*(2), 123-140.

Sullivan, P., Clarke, D., Cheeseman, J., Mornane, A., Roche, A., Sawatzki, C., & Walker, N. (2014). Students' willingness to engage with mathematical challenges: Implications for classroom pedagogies. In J. Anderson, M. Cavanagh, & A. Prescott (Eds.), *Curriculum in focus: Research guided practice: Proceedings of the 37th Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 597-604). Sydney: MERGA.

Sullivan, P., & Davidson, A. (2014). The role of challenging mathematical tasks in creating opportunities for student reasoning. In J. Anderson, M. Cavanagh, & A. Prescott (Eds.), *Curriculum in focus: Research guided practice: Proceedings of the 37th Annual Conference of the Mathematics Education Research Group of Australasia* (pp. 605-612). Sydney: MERGA.

Sullivan, P., Mousley, J., & Zevenbergen, R. (2006). Developing guidelines for helping students experiencing difficulty in learning mathematics. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Identities, cultures and learning spaces: Proceedings of the 29th Annual Conference of the Mathematics Education Research Group of Australasia* (Vol. 2, pp. 496-504). Canberra: MERGA.