Supporting Teachers to Foster Students' Interest in Mathematics Through Flexibly Delivered Teacher Professional Learning

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This study reports on a 10-week professional learning course for teachers of mathematics in an Australian school, designed to address persistent student disengagement in mathematics. Prior research has identified task design and pedagogical strategies that can foster student interest. To support teachers' adopting these strategies, an integrated and flexible hybrid course was piloted, which allowed teachers to choose both the depth of their engagement and the content they wished to emphasise, based on their individual professional learning needs. Data were collected from teachers' interactions with the course and analysed using inductive thematic analysis to examine which course tools teachers found supported or hindered developing interest-promoting teaching practices. The analysis identified teachers' preferences for different learning activities and the reasoning behind their choices. The findings highlight two activities as particularly supportive for teachers' professional learning: reflection-on-the-spot and tasks that deliver. These findings contribute to the literature by specifying concrete features of professional learning that support teachers' agentic knowledge building and meaningful changes in mathematics teaching practice.

Keywords: interest-promoting mathematics tasks • mathematics teaching • reflective professional learning • student engagement • student interest • teacher professional learning

Introduction

Engaged students are more likely to be more motivated, value mathematics and have positive aspirations than their disengaged peers. Problematically, student engagement has consistently presented a challenge to teachers of mathematics, evidenced by students "switching off" mathematics (Collie et al., 2019). To address the challenge, a professional learning (PL) course designed to support teachers in engaging students through the promotion of interest towards mathematics was implemented. As a transfer concept (Middleton et al., 2016; Tuohilampi & Jiang, 2024), interest fostered through regular mathematics learning experiences can lead into deep engagement that lasts long-term.

In a longitudinal study conducted by Attard (2013), further light was shed on the issue of disengagement by examining Australian middle year students. That study identified classroom practices and learning interactions that shape students' attitudes and long-term engagement with the mathematics. The major finding was that to achieve sustained engagement, positive pedagogical relationships (encompassing not only instruction but also relational and affective dimensions) among teachers and students must be developed. This includes not only the selection of tasks, but also attention to pedagogical relationships that involve: 1) the promotion of active participation (behavioural aspect of interest and engagement), 2) the inclusion of academic challenge (cognitive aspect of interest and engagement), 3) the allowance for social interaction (emotional and behavioural aspect of interest

and engagement), and 4) highlighting the relevance of mathematics to everyday life and students' own experiences (emotional and motivational aspect of interest and engagement). In such interactions the teacher listens and directs students' efforts, which are in contrast with interactions where the teacher "tells" and "explains", and/or solves problems for students.

Recognising the two targets for teachers' PL, knowledge growth and instructional change (Brehmer & Ryve, 2024), a PL course based on the principles of *Reflective Reality* (Tuohilampi et al., 2024) was designed. Reflective reality is,

> *… a type of collaborative teacher development that fosters emancipation and agency through meta-reflexive cycles, without aiming for a pre-defined set of perfect solutions but rather the development of a capacity for critical reflection that allows teachers to adapt and improve practice in an ongoing process informed by experience and research.* (Tuohilampi et al., 2024, p. 12)

The PL course was part of the Love Maths project (Tuohilampi & Jiang, 2024) aimed at examining a) students' interest in mathematics, b) how students' interest contributes to their engagement, and c) how to support teachers in utilising interest promotion in their practices. A unique feature of the course was flexibility: the participating teachers were allowed to decide the extent of their involvement with the professional activities provided. The flexibility aspect assisted in identifying the PL activities teachers chose to interact with, to what extent they did so, and reasons for teachers choosing those PL activities. This study focuses on the following research question:

> *What types of professional activities support or hinder teachers in deepening their knowledge of interest promotion and adopting changes in their interaction practices?*

Literature Review

Studies have consistently shown that students develop disengagement with mathematics (Beswick et al., 2021; Martin et al., 2012; Nyman, 2020). This happens both while students are learning (Cevikbas, & Kaiser, 2021, Hill et al., 2021; Marshman & Brown, 2014) and after their school years, when opting out of further engagement with the subject (Burns et al., 2021). Data from the Australian Mathematical Sciences Institute (2019) indicated that the declining rate of mathematics participation largely develops during secondary schooling. Interestingly, more recent and comprehensive data collected via the Longitudinal Youth in STEM Research Survey found that while young Australians believe mathematics is important for future careers, their interest levels in the subject are low (Department of Industry, Science, Energy and Resources, 2020). Engaging students in mathematics may be challenging but becomes more feasible with more knowledge about the mechanisms of engaging students (Tuohilampi & Jiang, 2024).

Student Engagement Fostered Through Interest

Middleton et al. (2016) reported student engagement in mathematics as being reinforced through fostering interest in the subject. The researchers described the interplay between interest and engagement arguing that:

> *When experiences tend to be consistent and coherent over time with regard to motivational affordances, it becomes more probable that the person will develop a (positive or negative) long-term disposition and identity toward mathematics.* (Middleton et al., 2016, p. 19)

Interest as a concept includes at least three components: 1) the cognitive and 2) emotional state of attention and curiosity toward a particular object or topic, and 3) the behavioural engagement (Harackiewicz et al., 2016). To achieve the benefits of interest-promotion, of relevance is Hidi and Renninger's Four-phase Model of Interest Development (2006), which is sequential in nature, representing "cumulative, progressive development in cases where interest is supported and sustained, either through the efforts of others or because of the challenges and opportunities that a person sees in a task" (Hidi & Renninger, 2006, p. 112). The four phases include triggered (first) and maintained

(second) interests that are situational, happening in the moment, and emerging (third) and well-developed (fourth) individual interests that evolve over longer periods.

While the field still lacks conclusive evidence regarding the direct impact of certain teaching practices on student interest or engagement, Rotgans and Schmidt (2017) confirmed empirically that a student's individual interest can be increased by a repeated arousal of "situational interest" (first and second phases of interest development). Hidi and Renninger (2006) also acknowledged that interest is among other affective and cognitive factors that impact learning. They posited the importance of interest in teaching and learning was due to its link to motivation, as well as its contribution to the quality of emotions during learning experiences. The cognitive and affective features of interest for a person ultimately affect their motivation and willingness to engage in learning long-term (Hidi & Renninger, 2006). The value of these connections lies in understanding how to not only capture a students' interest but also maintain it.

Nyman (2017) suggested that the design of teaching and tasks can account for student interest and further engagement. While these findings were limited to a school Years 6–9 case study, they are helpful because this middle school period is often the time when adolescents switch off their engagement in mathematics and learning more broadly (Martin et al., 2012; Nyman, 2020). Tuohilampi and Jiang (2024) added to Nyman's (2017) findings showing how mathematics tasks can better support interest-promotion and avoid inauthenticity of tasks that render them inaccessible or irrelevant. Interest-promoting tasks (Tuohilampi & Jiang, 2024) can make it easy for a teacher to create an interest-promoting mathematics learning situation. Therefore, teachers' PL needs in student interest-promotion likely include clarity about the phases of interest development, as well as being informed about the features of tasks that can truly trigger and maintain student interest.

Interest-promoting Teacher-student Interaction

To ensure an interest-promoting learning environment, certain forms of interactions are recommended. Martin et al. (2012) identified four key factors to consider in efforts to reduce disengagement in mathematics. First, mathematics anxiety can be addressed through practices that help students manage fear of failure and develop constructive approaches to academic challenges. Second, self-efficacy can be promoted by individualisation of tasks, creating opportunities for success, addressing negative beliefs and developing goal-setting skills. Third, teachers can highlight the value of mathematics by making its potential applications to students' lives and future pathways explicit, and by serving as positive role models who themselves value mathematics in these ways. Fourth, enjoyment can be fostered through an "optimal balance between task challenge and student skill" (Martin et al., 2012, p. 13), concentrating on the task at hand and having clear feedback when working toward goals.

In mathematics, instrumental practices (i.e., methods focused primarily on procedures and rules rather than sustainable understanding) are largely prevalent, likely resulting in defective but well-meaning approaches in mathematics teaching and hence multiple types of learned helplessness (Beswick, 2012; Beswick et al., 2023; Yates, 2009). Further, change can be unpredictable and intimidating (Tuohilampi et al., 2023). Sutton and Wheatley (2003) discussed teachers' emotions, noticing that negative emotions may arise when teachers feel out of control, or experience situations that are destructive or primitive. Such challenging feelings could lead to a Toolbox Reality (Tuohilampi & Jiang, 2024, p. 12), "a type of teacher development focused on isolated pragmatic solutions and predefined fixes, often combined with feelings of being short of time and resources, potentially leading to neglect of broader pedagogical ideas and dissonance by normalising persistent problems." To avoid this predicament, Sutton and Wheatley (2003) argued that a teacher needs professional goal relevance (congruence with personal and educational goals), as well as safe "ego-involvement" (i.e. no threats to self-esteem).

Adding to the different types of teacher-student interaction, a particular teaching style is described by Sammons et al. (2014). The researchers discussed inspiring teaching, identifying some of its dimensions as 1) positive student outcomes, namely motivation, self-efficacy, aspiration, and achievement, both long- and short-term, 2) teacher behaviours and practices, and 3) teacher

characteristics and relationships, including personality traits, knowledge and motivation. Similar factors were identified in a study of teachers who particularly enjoyed mathematics teaching conducted by Russo et al. (2023). It was noted in that research that teacher enjoyment can be reinforced especially when there was relatedness with students through interactions resulting in light-bulb moments, linking student outcomes (deep understanding and motivation), productive teacher-student interaction, and teacher enjoyment. Through these dimensions, the impact of inspiring teaching may include short-term interest promotion, long-term personal engagement, improved student achievement and self-confidence, and a willingness to pursue mathematics related careers.

Finally, dialogic practice as a particular form of teacher-student interaction includes much of what is essential to interest and engagement. Attard et al. (2018) discussed earlier studies pointing out that dialogic practices imply active participation (behavioural aspect), thought-provoking questioning and justifications (cognitive aspect), and eliciting a sequential flow of teacher-student exchanges (relationship building that could contribute to the emotional aspect). Notably, in their findings, Attard et al. (2018) found that dialogic practices can be scarce: mathematics lessons were dominated by teacher-controlled patterns of talk, limiting the scope for students to develop and produce mathematical reasoning beyond providing a predetermined response. Moreover, Attard et al. (2018) revealed that when dialogic practices are applied, teachers still control the dialogue and often direct the talk towards clarifying queries related to task completion, thus hindering the opportunity to promote students' mathematical reasoning and conceptual understanding.

In their study involving nine primary classrooms in the United States and Scotland, English et al. (2025) developed a framework for *pedagogical listening* that differentiates between five types of teacher listening that occur when students are verbalising struggle and uncertainty during mathematical sense-making discussions. These include 1) empathic listening refers to "listening openly to and for a student's own perspectives, feelings and understandings"; 2) supportive listening refers to "listening to and for ways to support students to listen to one another, so that they learn from each other"; 3) educative listening refers to "listening to and for student struggles with new ideas or interactions, while also seeking ways to support the student to transform the struggle into a pathway for self-reflection and self-activity" 4) self-reflective listening refers to "listening to and for students' unexpected and challenging responses in ways that initiative teacher reflection and shifts towards better supporting student reflective learning opportunities"; and 5) generative listening refers to "listening to and for opportunities for students dialogue to generate new ideas and directions for the discussion, such that new understandings, opportunities, norms and goals can emerge" (pp. 242–245).

Overall, the literature highlights that interest-promoting mathematics teaching relies on relational, dialogic, and emotionally safe teacher–student interactions. In particular, teacher-student interaction must include listening to students in ways that help each student feels heard (Attard et al., 2018; English et al., 2025). Such practices can become difficult to sustain within instrumental teaching cultures and under conditions of uncertainty and time pressure, which demonstrates the need for PL that supports teachers' reflective, agentic engagement with pedagogy, rather than offering isolated strategies or predefined solutions.

Reflective Professional Learning

Interest-promoting teacher-student interaction may be rare but is possible when teachers feel safe (Sutton & Wheatley, 2003), embody inspiration (Sammons et al., 2014), ensure that students feel safe, and make the content relevant and optimally challenging (Martin et al., 2012). PL for interest-promoting teacher-student interactions must then not only promote knowledge growth, i.e., what interest-promoting practices are, but also how to reflect on their own professional practices and personal capacities in order to cultivate instructional change in their own context (Brehmer & Ryve, 2024)

Long-standing theoretical and empirical research highlights that overturning the dominance of teacher talk requires that teachers listen to students in complex ways during discussion (e.g., Davis, 1996; Freire, 1970/2000; Hintz & Tyson, 2015). Studies show that teacher listening that supports students to learn mathematics with understanding and develop mathematical identities goes beyond listening

for students' right and wrong answers, extending to complex modes of being attuned to students' ideas and emotions through pedagogical listening (English et al., 2025). Understanding teachers as reflective practitioners, who learn through continuously encountering and reflectively analysing "messy situations," is largely rooted in the influential work of Schön (1983). Teacher reflection may occur in situations that do not go as expected, urging teachers to think critically about how to proceed. Schön (1983) differentiates between "reflection-on-action" and "reflection-in-action." Reflection-on-action occurs either by means of a stop-and-think or after the unexpected situation has taken place, requiring professional knowledge. Reflection in-action occurs in-the-moment and involves skilful responsiveness to the situation at hand (Schön, 1983/2005; 1987). Reflection in-action can support changes in practices, either by assessing how well the change is going, or making further changes dynamically.

Current recommendations for teachers' PL discuss the important place of situative theory (Horn & Garner, 2022; Nolen, 2024) in relation to approaches to teacher PL. Situative theorists broaden cognitive theories of learning, arguing that learning cannot be separated from the context in which it is to occur (Borko et al., 2010). This means that teachers are placed at the centre of their own PL (Harris & Jones, 2017), rather than being passive recipients of ideas that, while perhaps effective in a few circumstances, could bear little applicability to their personal teaching situations.

It is important to recognise that PL approaches that are meaningful and suitably targeted are still developing (Harris & Jones, 2017). Ball and Cohen (1999) argued early on that, without involving teachers in the construction of their own understanding, changes to their practice are limited; "what they must learn must be learned in and from practice rather than in preparing to practice" (p. 10). Fortunately, with the move away from more traditional forms, PL opportunities are becoming more sustained and continuous. The Australian Institute for Teaching and School Leadership (2020) endorses such learning principles: "(in) actively engaging the attendees of the [professional] learning you are more likely to elicit an interest in the content than if you were to deliver it passively" (para. 2). This differs from historical representations of PL for teachers, characterised by singular lectures, seminars, or learning that involves an expert presenting an idea or theory, often occurring outside the school environment, and with bounded personal commitments for classroom implementation required of participants (Stein et al., 1999). Moving towards a two-way dialogue between teachers and the experts, wherein teachers' needs are listened to and responded to, builds trust (Beswick, 2014) and adds to the feasibility (referred to as the "reality principle" by Gersten and Dimino [2001]) of PL is desirable.

Context of the Study

This study adopts a qualitative research approach, as the primary focus was on understanding teachers' engagement with, and experiences of, a 10-week PL course. A qualitative approach was chosen because the study aimed to examine teachers' reflective learning processes and meaning-making in relation to interest-promoting strategies, rather than to measure predefined outcomes. This aligns with growing research on professional learning that emphasises depth, reflection, and teachers' agentic engagement with learning experiences (Ng & Tan, 2009). The small scale of the study was a deliberate methodological choice to enable trust building and close collaboration with participants, allowing in-depth exploration of the mechanisms behind teachers' choices and actions in professional learning.

The study was conducted in a single school in Sydney, Australia, where an integrated hybrid professional learning course was implemented over a 10-week period. All junior teachers at the school (classroom teachers K–Year 6) were invited to be involved, as well as three Learning Enrichment teachers. The course combined online learning resources with three face-to-face focus group sessions: detailed descriptions of the course design and learning activities are presented later in this section. This design was informed by research suggesting that integrating online components into face-to-face professional learning can support sustained engagement, relevance to teachers' work, and changes in teaching practice (Fairman et al., 2022; Yurtseven Avci et al., 2020).

Participants and Recruitment

Nine teachers participated in the study on a voluntary basis out of 19 invited teachers. Voluntary participation allowed teachers to engage with the professional learning experience according to their own interests and needs, a feature shown to support meaningful professional learning (Hennessy et al., 2014). The participants taught across primary and secondary levels, with student age ranges from 8 to 18 years. Teachers' ages ranged from 28 to 49 years, and their teaching experience ranged from 1.5 to 25 years. Seven participants were primary school teachers, none of whom held a mathematics specialisation qualification. Two participants were secondary school teachers, both of whom held a mathematics degree or a double degree including mathematics and were responsible for teaching both junior and senior secondary mathematics. All teachers had prior experience working in schools other than the one in which the study took place, with the longest tenure at the current school being 11 years. Additional contextual and demographic details relevant to the study are provided below.

Design of the 10-week Course

Previous research on reflective PL of teachers, as well as the ideas of mathematical tasks and interest promoting teacher-learner interaction, informed our design of a 10-week PL course to present teachers with ideas and theories of students' interest development and interest-promoting teacher-student interaction. The course embedded PL activities into teachers' current practice to facilitate integration with their current knowledge and understanding during a term. The goal was to support teachers to review their current practices and reflect on them in view of relevant research recommendations and utilise their agency in deciding which activities would be helpful for them.

The main goal of the PL course that serves as the context of the study was for teacher participants to learn about students' interest-development. In the course, participants explored supporting teachers in two ways: by providing mathematics activities that would trigger and maintain their students' interest (Tuohilampi & Jiang, 2024), and by providing reflective professional activities to develop teachers' interest-promoting interaction skills with students. This way the course targeted both types of teachers' PL goals as identified by Brehmer and Ryve (2024): changing practices and knowledge growth.

The PL course encouraged teachers to develop their enthusiasm (Keller et al., 2016) in addition to applying interest-developing activities for students. This was in acknowledgement of the rich benefits of placing PL experiences for teachers within the daily work of teachers, rather than separate to or outside of it. Such an approach offers strength when viewed from a situative perspective (Putnam & Borko, 2000), as "the learning of teachers is intertwined with their ongoing practice, making it likely that what they learn will indeed influence and support their teaching practice in meaningful ways" (p. 6).

The teachers were offered a 10-week course comprised of weekly activities (online) and three focus group sessions (in-person). The course allowed flexibility in the depth of engagement from participants, and content was presented in ways that enabled participants to select those elements that best suit their needs. Most of the weekly activities were designed in advance. To provide a tailored PL experience, there were also activities that were finalised after analysis of data from a pre-survey collected from the participating teachers. Therefore, the themes listed in Table 1 were integrated into the activities. Those themes aligned with the overall goal of the intervention and were indicated as important for their personal PL by the teachers in the pre-survey (Likert-type scale, range being from [1] disagree strongly to [7] agree strongly).

Table 1.
Themes Teachers Indicated Important for Their Personal PL in a Pre-survey.

Theme	Mean	Definition	Weekly Modules
Equity	6.2	Fair and respectful differentiation practices	Pedagogical listening, Using feedback
Growth mindset	6.6	Growth mindset for mathematics learning	What for? Pedagogical listening
Intrigue	6.4	Viewing mathematics as intriguing	Reverse psychology, Brain train
Enjoyment	6.5	Enjoying teaching mathematics	With the parents, Hands-on

A digital platform, *Qridi,* was used as an online learning environment for participating teachers to access course materials. At the start of the project, participating teachers were given individual logins and access to *Qridi*. The platform was updated weekly with tools for teachers. The tasks were designed by the team and focused on characteristics of interest triggering and maintaining activities as demonstrated in prior research (Attard, 2013; Nyman, 2017; Tuohilampi & Jiang, 2024). The tasks within the *Qridi* platform included readings, reflections and classroom tasks to be trialled in mathematics classes at the discretion of the teacher participant (Figure 1). The aim was to encourage the teachers to commit to at least one lesson per week that included a focus on interest-developing mathematics practices, something that has proven to change the way students engage in mathematics so that learning mathematics is a positive experience for them (Tuohilampi et al., 2016).

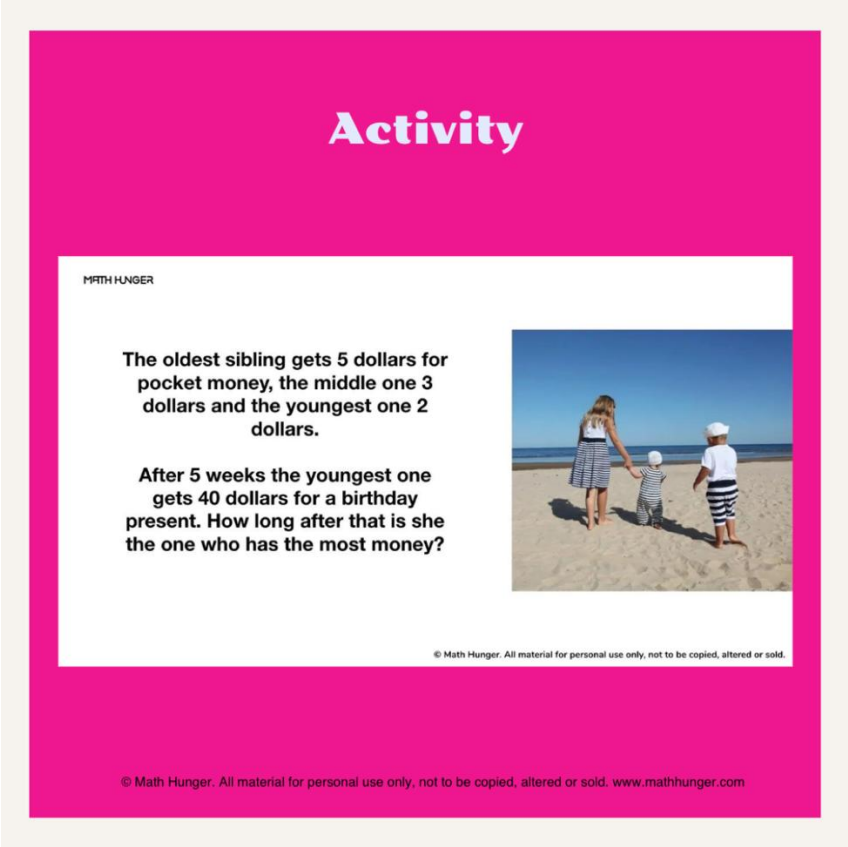

Figure 1. Example of a task offered to be trialled with students.

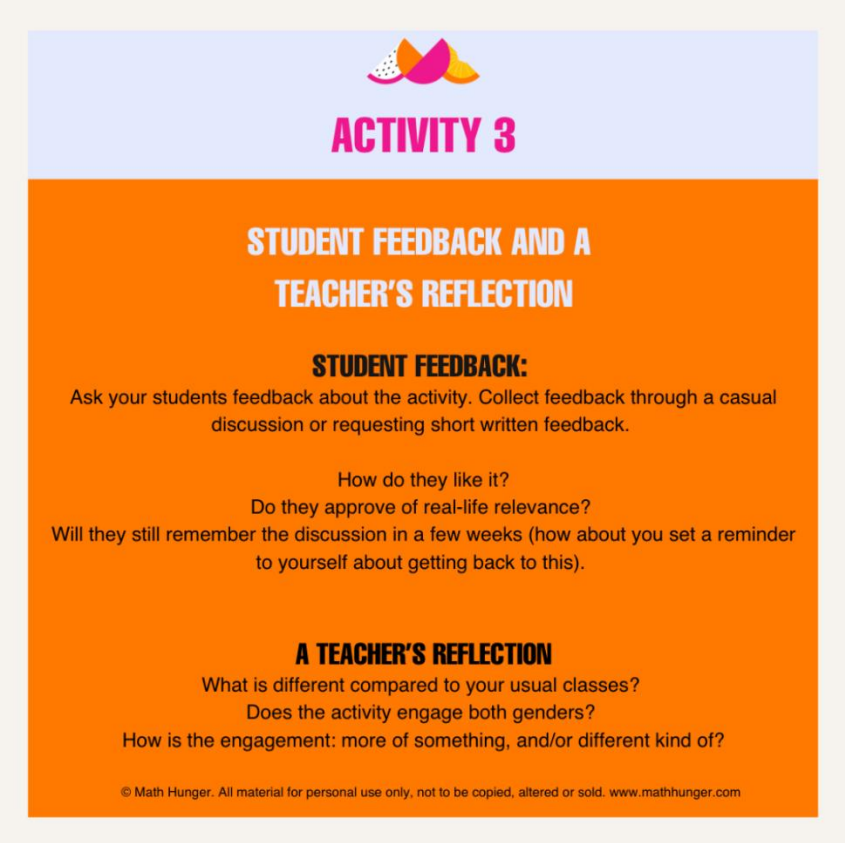

Figure 2. Example of weekly activity for teachers.

Korthagen (2017) presented empirical evidence that highlights the need to recognise the link between the person of the teacher and teacher PL. This requires considering teachers' thinking, feeling and wanting and in doing so, ultimately merging the professional and personal aspects of teacher learning. This study utilised a pre-intervention survey addressing teachers' views, beliefs and emotions on their teaching compiled from validated quantitative instruments used in other studies[1] (e.g., Beswick, 2012). Teachers' responses were reviewed and used to inform the design of the weekly activities, as well as to inform the design of the focus group discussions. The questions addressed the participating teachers' background information, personal qualities, goal orientation, self-efficacy, approaches and practices, beliefs and attitudes about mathematics teaching and about students.

Aiming for reflective PL experience, three ways of supporting reflection were woven into the course design. Firstly, the teachers were able to choose the degree they engaged with the weekly activities, including: 1) "I engaged with the activity", 2) "I engaged my students with the activity", and 3) "I reflected my experience with the activity" and 4) "Not completed". Secondly, the teachers were asked to proactively reflect whilst completing activities (reflection-on-action; Schön, 1983). An example of this is when the teachers were introduced to a pedagogical strategy named "quasi-empirical classroom", asking the teachers to think whether there were topics they had ever taught applying the principles of quasi-experimental interaction, and finally encouraging trialling the approach. Thirdly, scenarios called "Reflections" describing what might happen should the teacher vary interactions in the classroom were included. Reflections were included twice, asking the teachers to identify whether they related with the scenarios presented.

[1] Contact the corresponding author for details about the development of the pre-intervention survey.

The multiple approaches recommended in previous literature of teachers' PL that were adopted in the design of the course are summarised in Table 2. These approaches were identified as having the potential to provide an individualised, inspirational and effective PL experience.

Table 2
Aspects of Focus in Teachers' PL

Literature	Recommended Approaches	Implementation
Borko et al. (2010)	Participation	Teachers received activities that consisted of research summaries and tasks for their students plus instructions for implementation (Figure 1).
	Duration	The project was spread out for 10 weeks with new activities for each week.
	Form	The online platform used was *Qridi*.
	Degree of content focus	The activities focused on one key idea per week.
	Active learning opportunities	Trialling and reflection were prompted in weekly activities. The activities consisted of tasks to apply, but also principles to extend or replicate the ideas.
Korthagen (2017)	Individualisation	There was flexibility in when and how deeply to engage with the weekly activities. The activities could be integrated in teachers' pre-planned lessons.
	"Bottom up"	The participating teachers' pre-survey responses were used to inform some of the weekly activities.
Hennessy et al. (2014)	Practical	There were syllabus links in the teacher activities, and relevant tasks to give their students to test the approaches.
	Spark interest	The activities were visually designed, embedded in the online environment as "posts", and they sometimes included motivational and inspiring quotes (Figure 1).
	Conversation, sharing and discussion.	There were three focus groups where the key concepts were discussed.

Data Collection

Data were collected through teachers' engagement with the hybrid course, including interaction with online resources, and contributions during face-to-face focus group sessions. The first two in-person focus groups (held in weeks 6 and 9 of the ten weeks course) were hosted with teacher participants and the principal investigator (first author). In both sessions, the teachers were asked to share their thoughts and experiences related to interest-promoting mathematics teaching. During the focus groups, the principal investigator imparted knowledge and research in relation to the importance of using interest-developing mathematics practices in the classroom. The third focus group occurred after the ten-week course without the participation of the principal investigator. The topic of the third and final focus groups centred on the potential and impact of the PL course in terms of the extent to which it promoted teachers' inclusion of interest-promoting practices within their mathematics classrooms. All focus groups were facilitated by two research assistants (the second and the third author). Focus group sessions excluded, the course was designed to be flexible so that the participating teachers were able to engage at their own pace and depth.

The focus groups were a platform for teachers to discuss their reflections, share ideas and co-plan future activities with an expert of the topic, affording a way to increase the enactment of promoted practices (Polly & Hannafin, 2011). For the focus group data collection, the study adopted a researcher-led interview guide approach, characterised by question topics set in advance (Cohen et al., 2018). This was used as a means of applying a systematic and structured approach to collecting information from

participants. Questions of the teachers' experiences during the course were posed to the group, and a timer was used to allow all participants' sufficient time to voice their responses. The timer ensured no voice was neglected as it gave time for all participants to contribute, including thinking time.

The interview guide featured questions of an open-ended nature. The advantages of using open-ended questions are their ability to allow the interviewer to probe deeper, if necessary, and give participants a chance to bring forward unanticipated thoughts and additions (Cohen et al., 2018). A funnelling questioning technique allowed the interviewers to probe deeper and convey more information when it was required. During the focus groups, teachers were encouraged to describe dynamical processes, for example, "Because of X, I was able to apply ..." or "Since I'm also requested to pay attention to Y, it was difficult for me to ..." The dynamical elaborations helped to validate and explain the possible changes identified by the teachers.

Analysis Method

In this study, the concluding discussions from the third (and final) in-person focus group that occurred after the completion of the 10-week course were analysed. Each focus group examined a distinct theme, of which the first two have been reported elsewhere. The first focus group addressed task design for triggering and maintaining interest, reported in Tuohilampi and Jiang (2024). The second focus group addressed different professional realities of teachers, reported in Tuohilampi et al. (2024). In the final focus group, the discussion was based on the teachers' experience during the course, informing the research question of the study. From the transcript, teachers' thoughts about their willingness to apply the tools introduced, as well as what they had found challenging were identified. The duration of the focus groups was 60 minutes.

The first author read and analysed the transcript of the third focus group, which she did not attend. Relying on the phenomenological approach (Østergaard et al., 2008), the analysis focused on how the teachers described their lived experiences and the meanings attributed to the experiences. The data were then analysed inductively to identify the three themes that stood out, initially named as: 1) mirroring own practices (reflection); 2) usefulness of activities (utility value); and 3) individualised PL (needs, means and goals)—these themes were later renamed as discussed in the findings section. The categories were partly overlapping, especially the first and the third one. In the first the emphasis was on reflective pondering on theoretical and practical insights, while in the third, the emphasis was on what generally concerned the teachers and what they are looking to learn more about. The categories are hierarchical in nature.

The second step was to collect and categorise transcript excerpts under the three themes in a spreadsheet (data available on request). The first author annotated some of the excerpts to identify initial topics for analysis. The second author reviewed the spreadsheet and the data to identify any themes omitted, or challenge the categorisation assigned and the annotations added. Once a shared understanding was achieved, the first author focused on the categorised excerpts to discuss what they communicated. The categories are mainly based on the participants' expressed opinions, however, interconnections among the various research participants were also acknowledged. The original transcript was frequently visited when analysing the content of the categories and identifying the dynamical processes (e.g., "because of X, I was able to apply ...").

Results

Conceptual Knowledge, Utility and Individualisation During the Course

Three themes were identified in the teachers' final focus group conversation about their PL experience. The first theme was conceptual knowledge: the teachers identified situations where there was a need to consult with or add to their professional knowledge. The second theme was the utility value of the weekly student activities they trialled during the course: the functionality in terms of the tasks' ability to trigger and maintain student interest was established as the key reason for the teachers to include them

in their weekly practice. The third theme was individual PL. This theme included insights about hurdles when trying to adopt new teaching practices, as well as elaborations on their personal teaching circumstances.

Conceptual knowledge

The PL course guided the teachers to make weekly trials in their classroom aiming to increase student interest and also encouraged teachers to reflect on the trials. The weekly trials urged the teachers to focus not only on the technicalities of the trials, but also their understanding and experiences of the topic. It was noted that more learning might be needed to understand the concept of interest and how to support interest given the diversity of students in the classroom:

> *There's a difference between engagement and compliance, isn't there?*
>
> *I got the extension last week and they were so excited and engaged in it and I wonder, is there a difference with students who are in the core group or students needing learning support, what the difference is of engagement.*

The teachers also discussed the need to stay informed. There was a consensus among the teachers acknowledging that any person only knows so much. Therefore, ideas, strategies and resources must be imported and brought to teachers' attention.

> *That's why we need to – that's why I think we need to get a list rather than just come up with, what do you need help with? Well, I don't know.*

The teachers anticipated that new ideas and practices must be integrated into current practices, and teachers must be given opportunities to reflect on their application:

> *Let's make it problem solving Friday, for example, so that if you dedicate that time to a lesson, you're more likely to get it all happening. So that if – teachers have got the whole week, for example, to read the information, prepare, that they know that on Fridays we're going to do maths, that I think that that's going to be a way to help it to actually happen.*
>
> *See what other children are thinking, what other comments teachers are saying. It kind of then spurs you on as well even more.*

There was a specific type of professional activity that managed to assist teachers reflecting upon their practices effectively: prompting the teachers to engage in scaffolded reflection-on-the-spot in view of the new knowledge. For instance, the benefits of the different types of listening from the pedagogical listening framework were introduced to the teachers, and then the teachers were asked to self-observe their use of the different listening types in class without the pressure of changing their practices. Both knowing about the listening types and using them for on-the-spot "no pressure" reflection was raised as one of the particularly effective activity types:

> *One that stuck—sticks out in my mind is the one where they were talking about how you're responding to the answers. It was something about are you – what words are you giving them back?*
>
> *This made teachers reflect on whether they are entirely truthful to themselves, which again felt useful to the teachers:*
>
> *I remember thinking that was really helpful … "What am I saying back to the girls?" If you had asked me if I had behaved like that in my class I would have said, "No."*

In sum, there were aspects in the design of the course and the weekly activities that were deemed effective for reflection. The aspect that was stated as specifically effective was the type of weekly activity that prompted scaffolded in-the-moment reflection. The effectiveness of the activity was attributed to its potential to observe oneself truthfully.

Utility of learning activities

The second theme was utility: if the PL resources provided actually work, teachers approve of what is asked of them. In the statements, the teachers expressed that they applied the resources largely because the response from the students indicated interest. This was evident in a short discussion where the teachers expressed their opinions about the tasks, justifying why they appreciated them:

> *I really liked the tasks.*
>
> *But the tasks themselves were fantastic.*

I love the way that it's designed to help students be engaged in maths.

The activities helped interact with students. The teachers elaborated on what made the tasks effective: they succeeded in exciting students, prompted mathematical conversations on conceptual understanding, and they addressed the diversity of students:

I thought they were really effective with engaging the students, generating discussions and they really enjoyed kind of sharing their ideas about them and it just generated that sense of maths is interesting and we can have a really fun discussion about what we think and our different approaches.

Because they really encouraged discussion.

If they can see so many different ways of approaching, I think that can help them to build that conceptual understanding as well.

It also allowed the—they weren't pitched at a high level to enter the task so that all the class could become involved.

The teachers also reflected on the appropriate proportion of interest-promoting practices, and noted that student interest-development (resulting in quality engagement) is rarely the focus of PL projects:

I felt that they were – well, maybe for the period of time that they were supposed to, yes, but – but you wouldn't want to do it much longer than that. Just for the period of time.

I think that's so important because a lot of PD you go to is more focused on the content whereas this is focused so much on engagement and the importance of that. I think that's one of the things I really enjoyed about it.

The utility value of the tasks, that is, the recommended student tasks received well by students was one of the key reasons the teachers approved of the application of the tasks. There were multiple positive outcomes as a result of applying the tasks: enjoyment, more communication, learning about multiple approaches and being accessible to many. This means that in the teachers' view, the interest-promoting tasks succeeded in promoting all three aspects of engagement (emotional, cognitive and behavioural; Fredricks et al., 2004). The teachers were able to consider the integration of interest-promoting practices in their current practices, and they deemed the topic as relevant.

Individual professional learning

In the focus group conversation, the teachers brought up multiple personal and contextual factors that either act as a hurdle or a springboard for their PL. The hurdles included lack of time and the diversity of their students:

I felt that the amount of the readings was quite a lot … when you consider the busyness of teachers.

As you go through the years it becomes more textbook [unclear 4:45] *… The Year 11 and 12s all they care about is results … and they're the ones that–they're hating maths.*

Like 95 per cent of them are good but then …

I'm like, oh my god. Put it away. Engage. She won't. She won't engage. She has her own mind. It's very hard to engage though.

Aspects that the teachers deemed helpful for their PL were pacing (spaced out), being held accountable, individualisation and seeing how the recommended practices are applied by others:

When you pace it out in smaller chunks, you're much more likely to engage.

Have us come together and talk about the activities and why they worked well and [unclear 15:25] *more accountable. It's like having a personal trainer and [unclear 15:25] how did you go.*

Then you're going to need to tailor different PDs for whoever needs. So, if someone wants to learn more about [growth mindset 17:11] *then they might have a different learning journey to somebody else. If someone wants to learn more about number [*sets 17:18] *that's going to be a different journey for them. But you definitely need to give them the options first rather than making it open and what everyone dealt with.*

So, they do model teaching and then they watch you teach.

In summation, there were aspects in the PL course that supported the teachers' reflective knowledge building and making changes in their practices, yet challenges were also present. There were multiple barriers expressed by the teachers to be acknowledged in order to fully support their PL during the

course. Solutions were introduced: the main concerns the teachers expressed were the lack of time, as well as the individual context and student diversity, and the solutions included spacing out the PL activities, providing optional contents, having clear models to follow and being held accountable.

Discussion

This report elaborates on a 10-week PL course for Australia-based teachers that supports teachers to promote students' interest in mathematics to foster long-term engagement. The design followed recent recommendations for teachers' PL (Borko et al, 2010; Hennessy et al., 2014; Korthagen, 2017), and addressed quality student engagement that has multiple benefits but is traditionally seen as a challenging task for educators (e.g., Attard, 2013; Beswick et al., 2021; Burns et al., 2021; Cevikbas & Kaiser, 2021; Hill et al., 2021; Marshman & Brown, 2014). The PL course, delivered in a hybrid format of face-to-face focus groups and online content, assisted teachers in this challenging quest by equipping them with understanding and practical aspects of the topic. The participating teachers were asked to trial activities in their classroom and observe their own behaviour. There was no pressure for the teachers to start making immediate changes, and this way the course was a unique blend of hybrid delivery, allowing for flexible reflection on each teacher's current practices in view of new knowledge about the issue, based on honest observations.

There are three key findings that helped us understand the type of activities teachers' find useful when learning about interest-promotion. First, the design was successful, as the activities, "reflection-on-the-spot" in particular, were found especially effective for teachers to reflectively observe their practices without the pressure to make immediate changes. Second, teachers welcomed student tasks in their classrooms for their functionality ("tasks-that-deliver"), that is, the tasks' ability to trigger and maintain student interest. Third, lack of time was presented as a considerable hurdle to adopting new practices in general. Thus, the course activities proved effective because of their functionality and because teachers could use them without needing additional preparation time. Moreover, teachers were not required to make immediate changes to their practices, which supported their agency and ensured a safe, trusting, non-pressure PL environment. Any changes that did occur happened gradually during the weekly trials and were driven by teachers' honest observations of their current practices. Overall, the goals of the research team and the teachers aligned largely due to the ready-made tasks that teachers found satisfactory for improving their students' interest. The online delivery platform with weekly content modules allowed for flexibility, particularly when lack of time was an immediate concern.

Practical Implications

The findings suggest the following aspects to be included in PL course design aimed at reflective PL: providing flexibility in the extent of how teachers engage with the material; offering evidence-based practical resources proven effective in achieving their goals; and including professional activities that prompt reflections-on-the-spot without urgency to change practices. This allows honest observation and incremental changing of practices, aligning with reflective reality (Tuohilampi et al., 2024). The findings of this study show that it is possible to design a PL course that assists teachers in adopting practices that contribute to student interest.

Using a hybrid delivery combining online content and focus groups encouraged reflective practice in a collaborative setting with colleagues also participating in the course, consistent with findings from other small-scale studies on PL of teachers (Mulhayatiah et al., 2021; Webb et al., 2017). Online learning engagement and participation was found to be diverse in this study and dependent on the week, with a mixture of short participation to more reflective engagement, as observed in other online learning practices (Thorpe et al., 2012). The pilot study can be developed further into a more comprehensive innovative hybrid PL course, with the rise of hybrid PL for teacher education and evaluation (Rodrigues, 2023). This aligns with the emerging emphasis on collaborative learning within each school, instead of mass delivery online courses that may risk a lower completion rate as seen in Webb et al. (2017).

Theoretical Implications

The findings inform the three different foci on the impact of inspiring teaching: the actions and the individual and interindividual features of inspiring teaching (Sammons et al., 2014). The actions include evidence-based recommendations, such as applying the range of listening types (Hintz et al., 2018) and offering tasks that trigger and maintain students' interest (Hidi & Renninger, 2006; Tuohilampi & Jiang, 2024), positively contributing to interest-promoting teacher-student interaction. PL interventions could support the adoption of incremental changes with the help of a range of reflection-on-the-spot activities and ensuring tasks-that-deliver. In fact, it appears to us that reflection-on-the-spot as a phenomenon aligning with Schön's (1983) concept of reflection-in-action, related to mindfulness and metacognition, is emerging in other behavioural domains, as there are currently digital apps available that can be used to stop and reflect before (digitally) doing something potentially harmful, or engaging with unproductive (digital) content. Reflection-on-the-spot as a PL concept has potential and could be expanded theoretically in future studies.

Limitations and Concluding Remarks

The limitation of this study lies in its short-term duration and focus on a single school. It is beyond the scope of this study to determine the degree to which participating teachers sustained changes after the 10-week course. However, the benefits of reflective PL are well established in earlier literature, therefore the findings of this study should be used to inform understanding of the mechanisms that make hybrid PL reflective and effective for teachers in mathematics education. Expanding teachers' knowledge of student interest as a pathway to quality engagement contributes to the global conversation about student disengagement in mathematics, which has recently reached political arenas and heated media debates in Australia (Sawatzki et al., 2025) This attention is not unwarranted, given the concerning fall in mathematics achievement and declining national participation rates at the secondary school level (De Bortoli et al., 2023; Thomson et al., 2019).

This study builds on the call made two decades ago by Hidi and Renninger (2006) for empirical investigation into the conditions and situations that enable students to develop and sustain interest. Advances in the field have made it possible to design a hybrid course using modern digital technologies on an e-learning platform. Such a design allows flexibility in the depth of engagement expected from participants, and content can be presented in ways that enable participants to select those elements that best suit their needs. These digital learning affordances can also record data on participants' engagement, which can then be used to inform and enrich integrated face-to-face sessions for teachers. In the study, insights were gained into how teachers can be supported to take steps toward interest-promoting practices through flexibility and relevant content while utilising an e-learning platform, at a time when digital technologies continue to grow in relevance and impact in education and professional learning.

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Ethical approval

The Love Maths study was classified as low-risk research under UNSW criteria for research. The research ethics for the entirety of the Love Maths Research Project was approved by the UNSW Australia Human Research Ethics Advisory Panel prior to contacting schools for involvement. Written consent was obtained from all participating teachers, their students, the students' parents and the school principals before commencing the project.

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Competing interests

The authors declare there are no competing interests.

References

Attard, C. (2013). "If I had to pick any subject, it wouldn't be maths": Foundations for engagement with mathematics during the middle years. *Mathematics Education Research Journal, 25*(4), 569–587. https://doi.org/10.1007/s13394-013-0081-8

Attard, C., Edwards-Groves, C., & Grootenboer, P. (2018). Dialogic practices in the mathematics classroom. In J. Hunter, P. Perger, & L. Darragh (Eds.). *Making waves, opening spaces.* Proceedings of the 41st annual conference of the Mathematics Education Research Group of Australasia, Aukland (pp. 122–129). MERGA.

Ball. D. L., & Cohen, D. K. (1999). Developing practice, developing practitioners: Towards a practice-based theory of professional education. In G. Sykes & L. Darling-Hammond (Eds.), *Teaching as the learning profession: Handbook of policy and practice* (pp. 3–32). Jossey-Bass Publishers.

Beswick, K. (2012). Teachers' beliefs about school mathematics and mathematicians' mathematics and their relationship to practice. *Educational Studies in Mathematics, 79*(1), 127–147. https://doi.org/10.1007/s10649-011-9333-2

Beswick, K. (2014). What teachers' want: Identifying mathematics teachers' professional learning needs. *The Mathematics Enthusiast, 11*(1), 83–108. https://doi.org/10.54870/1551-3440.1293

Beswick, K., Faragher, R., & Sullivan, P. (2021). *The knowledge and skills gap in Australian secondary mathematics classrooms: Knowledge and skills gap report 2021.* Oxford University Press.

Borko, H., Jacobs, J., & Koellner, K. (2010). Contemporary approaches to teacher professional development. *International Encyclopedia of Education, 7*(2), 548–556. https://doi.org/10.1016/B978-0-08-044894-7.00654-0

Brehmer, D., & Ryve, A. (2024). Facilities for mathematics teachers' learning from professional development programmes: A qualitative systematic review. *Mathematics Teacher Education and Development, 26*(2), Article 1. https://mted.merga.net.au/index.php/mted/article/view/870

Burns, E. C., Martin, A. J., & Collie, R. J. (2021). A future time perspective of secondary school students' academic engagement and disengagement: A longitudinal investigation. *Journal of School Psychology, 84,* 109–123. https://doi.org/10.1016/j.jsp.2020.12.003

Cevikbas, M., & Kaiser, G. (2021). Student engagement in a flipped secondary mathematics classroom. *International Journal of Science and Mathematics Education*, *20*(7), 1455–1480. https://doi.org/10.1007/s10763-021-10213-x

Cohen, L., Manion, L., & Morrison, K. (2018). *Research methods in education* (8th ed). Routledge.

Collie, R. J., Martin, A. J., Bobis, J., Way, J., & Anderson, J. (2019). How students switch on and switch off in mathematics: Exploring patterns and predictors of (dis) engagement across middle school and high school. *Educational Psychology, 39*(4), 489–509. https://doi.org/10.1080/01443410.2018.1537480

Davis, B. (1996). *Teaching mathematics: Toward a sound alternative.* Taylor & Franics.

De Bortoli, L., Underwood, C., & Thomson, S. (2023). *PISA 2022: Reporting Australia's results. Volume I: Student performance and equity in education.* Australian Council for Educational Research. doi.org/10.37517/978-1-74286-725-0

Department of Industry, Science, Energy and Resources. (2020). *Youth in STEM research: Summary of results 2019/20.* https://www.industry.gov.au/sites/default/files/2020-03/youth-in-stem-research-2020-summary-results.pdf

English, A. R., Tyson, K., Hintz, A., Murdoch, D., Anderson, J. (2025). Pedagogical listening: Understanding how teachers listen to student struggle during mathematical sense-making discussions. *Teachers and Teaching*, *35*(2), 238–262. https://doi.org/10.1080/13540602.2023.2263738

Fairman, J. C., Smith, D. J., Pullen, P. C., & Lebel, S. J. (2022). The challenge of keeping teacher professional development relevant. In S. Saffield & P. E. Poekert (Eds.), *Leadership for professional learning perspectives, constructs and connections.* (pp. 251–263). Routledge. https://doi.org/10.1080/19415257.2020.1827010

Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109. https://doi.org/10.3102/00346543074001059

Freire, P. (1970/2000). *Pedagogy of the oppressed.* Bloomsbury.

Gersten, R., & Dimino, J. (2001). The realities of translating research into classroom practice. *Learning Disabilities Research & Practice, 16*(2), 120–130. https://doi.org/10.1111/0938-8982.00013

Harackiewicz, J. M., Smith, J. L., & Priniski, S. J. (2016). Interest matters: The importance of promoting interest in education. *Policy Insights from the Behavioral and Brain Sciences, 3*(2), 220–227. https://doi.org/10.1177/2372732216655542

Harris, A., & Jones, M. (2017). Leading professional learning: Putting teachers at the centre. *School Leadership & Management, 37*(4), 331–333. https://doi.org/10.1080/13632434.2017.1343705

Hennessy, C., Adams, G., Mahon, E., Nixon, S., Pratt, A., & Williams, L. (2014). Discovering inspiring teaching: Immersive models of staff development. *Quality Assurance in Education. 22*(3), 240–254. https://doi.org/10.1108/QAE-01-2013-0006

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hill, J. L., Kern, M. L., Seah, W. T., & van Driel, J. (2021). Feeling good and functioning well in mathematics education: Exploring students' conceptions of mathematical well-being and values. *ECNU Review of Education, 4*(2), 349–375. https://doi.org/10.1177/2096531120928084

Hintz, A., & Tyson, K. (2015). Complex listening: Supporting students to listen as mathematical sense-makers. *Mathematical Thinking and Learning, 17*(4), 296–326. https://doi.org/10.1080/10986065.2015.1084850

Hintz, A., Tyson, K., & English, A. R. (2018). Actualizing the rights of the learner: The role of pedagogical listening. A response to "The rights of the learner." *Democracy and Education, 26*(2), Article 8. https://democracyeducationjournal.org/home/vol26/iss2/

Horn, I., & Garner, B. (2022). *Teacher learning of ambitious and equitable mathematics instruction: A sociocultural approach.* Routledge. https://doi.org/10.4324/9781003182214

Keller, M. M., Hoy, A. W., Goetz, T., & Frenzel, A. C. (2016). Teacher enthusiasm: Reviewing and redefining a complex construct. *Educational Psychology Review, 28*(4), 743–769. https://doi.org/10.1007/s10648-016-9358-4

Korthagen, F. (2017). Inconvenient truths about teacher learning: Towards professional development 3.0. *Teachers and Teaching, 23*(4), 387–405. https://doi.org/10.1080/13540602.2016.1211523

Marshman, M., & Brown, R. (2014). Coming to know and do mathematics with disengaged students. *Mathematics Teacher Education and Development, 16*(2), 71–88. https://doi.org/10.1007/s10648-016-9358-4

Martin, A. J., Anderson, J., Bobis, J., Way, J., & Vellar, R. (2012). Switching on and switching off in mathematics: An ecological study of future intent and disengagement among middle school students. *Journal of Educational Psychology, 104*(1), 1–18. https://doi.org/10.1037/a0025988

Middleton, J. A., Jansen, A., & Goldin, G. A. (2016). Motivation. In G. A. Goldin, M. S. Hannula, E. Heyd-Metzuyanim, A. Jansen, R. Kaasila, S. Lutovac, P. Di Martino, F. Morselli, J. A. Middleton, M. Pantziara & Q. Zhang (Eds.), *Attitudes, beliefs, motivation and identity in mathematics education: An overview of the field and future directions* (pp. 17–23). Springer Nature. https://library.oapen.org/bitstream/handle/20.500.12657/27855/1002149.pdf?sequence=1

Mulhayatiah, D., Sinaga, P., Rusdiana, D., Kaniawati, I. & Suhendi, H. Y. (2021). Pedagogical and professional physics teacher training: Why hybrid learning is important? *Journal of Physics: Conference Series, 1806*, Article 012036. https://doi.org/10.1088/1742-6596/1806/1/012036

Ng, P. T., & Tan, C. (2009). Community of practice for teachers: Sensemaking or critical reflective learning? *Reflective Practice, 10*(1), 37–44. https://doi.org/10.1080/14623940802652730

Nolen, S. B. (2024). Taking a situative approach to research in educational psychology. In P.A. Schutz & K. R. Muis (Eds.), *Handbook of educational psychology* (pp. 119–138). Routledge.

Nyman, R. (2017). *Interest and engagement: Perspectives on mathematics in the classroom.* [Doctoral dissertation, University of Gothenburg].

Nyman, M. (2020). *What do students' feel about mathematics? Compulsory school students' emotions and motivation towards mathematics.* [Licentiate thesis, Stockholm University]. Stockholm University Press.

Østergaard, E., Dahlin, B., & Hugo, A. (2008). Doing phenomenology in science education: A research review. *Studies in Science Education, 44*(2), 93–121. https://doi.org/10.1080/03057260802264081

Polly, D., & Hannafin, M. J. (2011). Examining how learner-centered professional development influences teachers' espoused and enacted practices. *The Journal of Educational Research, 104*(2), 120–130. https://doi.org/10.1080/00220671003728062

Putnam, R., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? *Educational Researcher, 29*(1), 4–15. https://doi.org/10.3102/0013189X029001004

Reeve, J., & Tseng, C.-M. (2011). Agency as a fourth aspect of students' engagement during learning activities. *Contemporary Educational Psychology, 36*(4), 257–267. https://doi.org/10.1016/j.cedpsych.2011.05.002

Rodrigues, A. L. (2023). Innovative hybrid learning: A new paradigm in teacher education for transformative learning. In M. D. Lytras (Ed.), *Active and transformative learning in STEAM disciplines: From curriculum design to social impact* (pp. 153–175). Emerald Publishing Limited.

Rotgans, J. I., & Schmidt, H. G. (2017). Interest development: Arousing situational interest affects the growth trajectory of individual interest. *Contemporary Educational Psychology, 49,* 175–184. https://doi.org/10.1016/j.cedpsych.2017.02.003

Russo, J., Bobis, J., Downton, A., Feng, M., Hughes, S., Livy, S., McCormick, M., & Sullivan, P. (2023). Characteristics of high enjoyment teachers of mathematics in primary schools. *Mathematics Education Research Journal, 35*(1), 1–21. https://doi.org/10.1007/s13394-021-00372-z

Sammons, P., Kington, A., Lindorff-Vijayendran, A., & Ortega, L. (2014). *Inspiring teachers: Perspectives and practices.* CfBT Education Trust.

Sawatzki, C., Brown, J., & Tuohilampi, L. (2025, June 5). Is successful maths teaching more than method? *EduResearch Matters.* https://blog.aare.edu.au/is-successful-maths-teaching-more-than-method/

Schön, D. (1983/2005). *The reflective practitioner: How professionals thinking in action.* Ashgate.

Schön, D. A. (1987). *Educating the reflective practitioner: Toward a new design for teaching and learning in the professions.* Jossey-Bass.

Sutton, R. E., & Wheatley, K. F. (2003). Teachers' emotions and teaching: A review of the literature and directions for future research. *Educational Psychology Review, 15*(4), 327–358. https://doi.org/10.1023/A:1026131715856

Stein, M. K., Smith, M. S., & Silver, E. A. (1999). The development of professional developers: Learning to assist teachers in new settings in new ways. *Harvard Educational Review, 69*(3), 237–269. https://doi.org/10.17763/haer.69.3.h2267130727v6878

Thomson, S., De Bortoli, L., Underwood, C., & Schmid, M. (2019). *PISA 2018: Reporting Australia's results. Volume I student performance.* Australian Council for Educational Research. https://research.acer.edu.au/ozpisa/35/

Thorpe, M., & Gordon, J. (2012). Online learning in the workplace: A hybrid model of participation in networked, professional learning. *Australasian Journal of Educational Technology, 28*(8), Article 1. https://doi.org/10.14742/ajet.763

Tuohilampi, L., & Jiang, H. (2024). Introducing the ProInterest model: Designing tasks for sustainable positive mathematics experiences. *LUMAT: International Journal on Math, Science and Technology Education, 12*(3), Article 9. https://doi.org/10.31129/LUMAT.12.3.2373

Tuohilampi, L., Laine, A., Hannula, M. S., & Varas, L. (2016). A comparative study of Finland and Chile: The culture-dependent significance of the individual and interindividual levels of the mathematics-related affect. *International Journal of Science and Mathematics Education, 14*(6), 1093–1111. https://doi.org/10.1007/s10763-015-9639-0

Tuohilampi, L., Li-Williams, S., & Gooch, S. (2024). No time to "put that in": Can we silence the ticking clock that controls teachers' professional learning? *Professional Development in Education*, 1–16. https://doi.org/10.1080/19415257.2024.2390880

Webb, D., Nickerson, H., & Bush. J. (2017). A comparative analysis of online and face-to-face professional development models for CS education. In *Proceedings of the 2017 ACM SIGCSE Technical Symposium on Computer Science Education*, Seattle (pp. 621–626).

Yates, S. (2009). Teacher identification of student learned helplessness in mathematics. *Mathematics Education Research Journal, 21*(3), 86–106. https://doi.org/10.1007/BF03217554

Yurtseven Avci, Z., O'Dwyer, L. M., & Lawson, J. (2020). Designing effective professional development for technology integration in schools. *Journal of Computer Assisted Learning, 36*(2), 160–177. https://doi.org/10.1111/jcal.12394