THE MATHEMATICS EDUCATOR

RESEARCH ARTICLE

Vol. 34, No. 1 (2026), pp. 1–24

https://doi.org/10.63301/tme.v34i1.4162

ISSN 1062-9017 (print) 2331-4451 (online)

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Effective School Mathematics Tasks: Perspectives of Student Teachers

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RECEIVED November 13, 2024 · **REVISED** May 22, 2025 · **ACCEPTED** August 04, 2025 · **PUBLISHED** May 21, 2026

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ABSTRACT

This study investigated the features that primary and post-primary student teachers (STs) consider important in mathematics classroom tasks. Quantitative data revealed that STs generally valued tasks that supported higher-order thinking, could be easily differentiated, and were relevant to the curriculum. Aesthetics, use of technology, and ease of preparation were considered less important. Qualitative data explored STs' reasons for these choices and for any changes that occurred over the span of their Initial Teacher Education (ITE). STs expressed growing understanding of the importance of differentiation and pupil engagement. Findings underscored the influence of school placements in shaping STs' pedagogical beliefs. Implications point to the role of ITE courses in developing STs' professional judgement and knowledge base for teaching.

Keywords: Mathematics Tasks · Student Teachers · Initial Teacher Education

HOW TO CITE Hamilton, J., Doherty, B., & Trainor, G. (2026). Effective school mathematics tasks: Perspectives of student teachers. *The Mathematics Educator*, *34*(1), 1–24.

Introduction

Within mathematics teaching, a large body of research (for a sample, see Boston & Smith, 2009; Radmehr, 2023; Sullivan et al., 2009) has highlighted the central importance of good mathematics classroom tasks for pupil learning. What have been less widely examined, however, are the perspectives of student teachers (STs) on this issue, and whether, how, and why these differ over the course of their Initial Teacher Education (ITE).

Given that understanding what makes a good mathematics task is a complex process, with much depending on teachers' professional judgement (Stein & Lane, 1996), equipping STs to design and choose good tasks for their pupils is not straightforward. This is complicated further by the role that subject-specific knowledge plays; although Hiebert (2013) contended that higher mathematics qualifications do not necessarily lead to better mathematics teaching, it is nonetheless evident that subject knowledge, and STs' confidence therein, have a significant influence both on the tasks that they choose, and the efficacy with which those tasks are implemented (Osana et al., 2006; Stein & Smith, 1998).

This study examined STs' perceptions of what makes a good mathematics classroom task and investigated whether and how these perceptions differed between students at different stages of a four-year ITE course. The results have implications not only for mathematics specialist courses, but also for courses with a substantial mathematics component, such as more general education courses.

The value of this research study lies in informing mathematics teacher educators about the perspectives, beliefs, and ideas that STs bring to mathematics ITE, particularly regarding mathematical tasks, to inform future ITE teaching and course design. Goos (2025, p. 446) noted the need for ITE tutors to draw on both rigorous theory and real-life context, arguing that "if teaching mathematics is complex and demanding then teaching about teaching mathematics is even more so." With this in mind, our empirical work seeks to understand what STs' perspectives could add to the ITE context. Additionally, Chapman (2013, p. 2) highlighted that although (student) teachers must develop a knowledge of the nature of worthwhile mathematics tasks, this is an endeavour which is "challenging for a teacher to construct without meaningful intervention." We hope that better appreciating STs' current understanding in this area will enable more effective interventions to this end. A clearer understanding of STs' perspectives on mathematics classroom tasks, and by extension the convictions and ideals that drive their classroom practice, can ensure that the design of ITE courses successfully builds on, develops, and, if necessary, challenges this understanding. This will in turn lead to more effective ITE, and ultimately to the preparation of STs who are better able to serve their pupils' mathematics learning through the design, explanation, and enactment of good mathematics tasks.

Theoretical Framing

A theoretical framework helps organise how task design can be conceptualised. In theoretical terms, mathematics task design can be considered at three frames or levels: grand, intermediate, and domain-specific (Kieran et al., 2015). Grand frames encompass overarching theories of education (e.g., constructivism), intermediate frames offer general principles for teaching and learning (e.g., Assessment for Learning), and domain-specific frames address particular areas of content or pedagogy (e.g., proof using diagrams). This study considers task design at the intermediate level by exploring the features that STs consider important in tasks for school-level mathematics lessons. Radmehr (2023) suggested that this sort of work may sit between intermediate and domain-specific levels, but given Kieran et al.'s (2015) observation that "intermediate-level frames can be characterized by explicit principles… that can be applied to the design of tasks and task sequences," we consider the intermediate level to be most applicable to the present study.

Literature Review

This section examines three key areas: the established importance of tasks in mathematics education, features that research identifies as valuable, and specific challenges that STs face in task selection.

The Place of Tasks in Mathematics Education

For this study, we intentionally used a relatively broad definition of a mathematics task: *any structured activity that pupils take part in to accomplish a stated mathematical goal, for example doing questions from a textbook, completing a worksheet, taking part in groupwork, doing investigations, etc.* In this, we follow the example of Arbaugh & Brown (2005) and Stein et al. (1996), both of whom based their work on definitions that encompassed wide ranges of classroom activity. This approach allows us to consider an extensive range of features that may be important, and to draw on STs' varying viewpoints on and experiences of designing and using mathematics tasks and activities.

Stein et al. (1996, p. 462) suggested that the particular choice of tasks in which pupils engage "highly influences" their learning outcomes. However, choosing a good mathematics task is not a straightforward endeavour, neither for practising teachers nor STs, and much depends on the strength of a teacher's knowledge base, comprising both subject and professional knowledge (Anthony & Walshaw, 2009; Lau, 2022; Shulman, 1987). Furthermore, no task is experienced the same way in every classroom, by every pupil. In their seminal Mathematical Tasks Framework, Stein and Smith (1998) highlighted that there can be a significant difference between a task as designed, as explained, and as enacted. There are many factors contributing to this difference, but the role of the teacher is one of the most important (Stein et al., 2000). Sullivan et al. (2009) suggested, however, that turning even the best of tasks into a high-quality mathematics lesson is a process that many teachers cannot do without a great deal of support. This sounds a cautionary note for those involved in the preparation of mathematics ITE programmes or materials – that teaching our teachers about mathematics tasks is itself a task that is both crucial and complex (Goos, 2025).

Features of a Good Mathematics Classroom Task

Existing literature suggests a wide variety of desirable features within mathematics tasks. The National Council of Teachers of Mathematics (NCTM, 1991) stated that tasks should be based on "sound and significant mathematics," suggesting that, at a fundamental level, the inclusion of meaningful mathematics and the mathematical thinking involved is a key criterion for evaluating a task. This encompasses, among other things, developing conceptual understanding (Boaler, 2009), and enabling pupils to make connections between ideas and approaches (Levav-Waynberg & Leikin, 2012). In addition, pupils' mathematical thinking can benefit from opportunities to explore, explain, and communicate their reasoning, verbally and/or in writing (Maher & Martino, 1999).

A good task ought also to be cognitively demanding, i.e., one which makes pupils think (Henningsen & Stein, 1997). The term cognitively demanding should not be taken as being synonymous with complex; the inclusion of too many aspects within a task can lead to pupils becoming bogged down in superfluous details or logistics (Paas et al., 2003). Stein et al. (1996, p. 456) described cognitively demanding tasks as "truly problematic," suggesting that such tasks require pupils to "impose meaning and structure, make decisions about what to do and how to do it, and interpret the reasonableness of their actions and solutions" as well as "having more than one solution strategy." This language of being "problematic" is perhaps more meaningful than the term problem solving, which has lost much of its significance through overuse, and so has been used to cover everything from trivial calculations to complex mathematical investigations (Crespo, 2003; McIntosh & Jarrett, 2000).

Literature also highlights the importance of tasks that are based on real-life contexts or have other aspects of authenticity (Paredes et al., 2020; Radmehr, 2023), which can hence provide motivation and meaning for pupils. Caution is needed, however, as Sullivan et al. (2002) suggested that such contexts can also prove unhelpfully distracting for pupils, diverting their thinking away from the underpinning mathematics. In a classroom setting, this commitment to real-life relevance may additionally be supported by links to other curriculum areas outside of mathematics.

A further important aspect is the extent to which a task can be differentiated (adapted) to match pupils' prior knowledge and current level of understanding (Henningsen & Stein, 1997). This does not exclude tasks that will challenge or stretch pupils, but does demand that tasks are carefully framed, and that pupils have sufficient prior knowledge to be able to meaningfully engage with the main mathematical point (Leatham et al., 2015). Given the diverse range of learners present in any classroom, this criterion may often require a task to be differentiated in multiple ways in order to suit the learning needs of different pupils. Kron et al. (2021) observed that context-specific features of both task and pupils are relevant when choosing or designing a mathematics task; this encompasses both general characteristics of pupils as mathematics learners, as well as relational, specific knowledge of the particular pupils undertaking a particular task in a particular classroom.

Additionally, good tasks provide opportunities for meaningful Assessment for Learning (AfL), sometimes also known as formative assessment or diagnostic potential (Kron et al., 2021). Since effective use of AfL is a central part of good teaching, and one of the most significant factors leading to gains in pupil outcomes (Black & Wiliam, 2009), this aspect of task design, while flexible and multifaceted, needs to be given real prominence; Kieran et al. (2015) argued that assessment should be part of task design from the very beginning rather than a later add-on. Furthermore, Nicol and MacFarlane-Dick (2006) have suggested that well-designed AfL can increase pupil motivation and enjoyment of mathematics.

Consideration should also be given to the increasingly important role of technology within mathematics education. Thurm & Barzel (2022) suggested that technology can be used within mathematics teaching for a variety of purposes, including working with multiple representations (e.g., using virtual manipulatives), allowing mathematical exploration (e.g., testing geometric conjectures with dynamic geometry software), and supporting the routine practice of skills (e.g., times table practice). In a similar vein, the NCTM (2023, p. 1) stated that “technology should be used to develop and deepen learner understanding, stimulate interest in the mathematics being learned, and increase mathematical proficiency.” In a more local context, the Northern Ireland (NI) curriculum highlights the statutory requirement for pupils to use technology within the curriculum strand of Mathematics and Numeracy (CCEA, 2007).

Table 1. Desirable features from literature.

Mathematically meaningful
Cognitively demanding
Incorporates real life links
Differentiability
Incorporates Assessment for Learning (AfL)
Uses technology

In summary, the desirable features of a mathematics task are shown in Table 1. These are presented not as a hierarchy, nor a comprehensive list of features that must always be present in a quality mathematics task, but as a summary of features that are consistently recognised as good practice within the literature. While a good mathematics task may not exhibit all these features, we suggest that if none or very few of them are present, the task may not serve mathematics learning well.

Challenges for Student Teachers in Selecting Mathematics Tasks

Having examined the importance of mathematics tasks and some of the desirable features thereof, we now consider the particular challenges faced by STs in designing/choosing, explaining, and enacting good mathematics tasks. Several areas seem to be particularly problematic for STs. The first relates to the level of cognitive demand. Here, novice teachers often exhibit a two-pronged form of error in relation to the cognitive complexity of tasks. On one hand, Ostermann et al. (2018) suggested that STs routinely underestimate the difficulty of the problems posed by a textbook or other external source. On the other hand, STs also exhibit a strong tendency to offer their pupils tasks that fail to impose appropriate cognitive demand (Lee et al., 2024). In addition, they are often too quick to simplify problems and to ask questions that funnel pupils towards the correct method or answer (Crespo, 2003).

Second, Crespo and Sinclair (2008) suggested that STs often pay much more attention to the pedagogical aspects of a task (such as accessibility and assessment) than to the mathematical aspects (such as solution strategies and connections to other topics). While the pedagogical aspects are certainly important, and are, in fact, central to the enactment of the task (Stein & Smith, 1998), we suggest that if a good mathematics task has quality mathematics at its heart (NCTM, 1991), then the mathematics must also be at the heart of a teacher's decision-making. However, STs can easily underestimate the intentionality this requires on their part. Zwahlen (2014) observed that STs frequently agreed that meaningful mathematics was the central criterion for a worthwhile task, but when asked to evaluate existing tasks, they often assumed that the tasks would contain meaningful mathematics by default. The skill of designing non-routine, interesting, creative tasks that allow pupils to function as "real mathematicians" needs to be actively developed in STs (Shriki, 2010).

Third, appreciating diagnostic potential has been shown to be particularly challenging for STs (Kron et al., 2021; Ostermann et al., 2018). This is not only the case within mathematics teaching, but reflects the challenge of assessment for learning more generally: the need for insight based on experience is a "formidable problem" facing classroom teachers of all levels of experience (Black & Wiliam, 2009, p. 13). At least part of this may result from the difficulty of learning to notice and attend to important and pertinent aspects of pupils' mathematical thinking; an activity that Stockero et al. (2017) have argued is even more difficult for STs who lack wide experience of pupils.

Given the challenges of good task design, especially for inexperienced teachers, Sullivan and Mousley (2001) suggested that pedagogical decision-making, including choice of tasks, should form part of ITE programmes. Bicer et al. (2022) observed that STs' experience of instruction during ITE can profoundly shape their view of effective teaching, and in the best cases can open up new worlds for both them and their pupils. This may, however, present a challenge for teacher educators as they consider how to best prepare STs to choose worthwhile mathematics tasks, while acknowledging that experience plays a significant role. Furthermore, (student) teachers' classroom practice is strongly influenced by personal beliefs about teaching mathematics (Ernest, 1989; Lau, 2022; Watson, 2006). Since teachers tend to pose problems consistent with their pedagogical beliefs (Crespo & Sinclair, 2008), any attempt to change STs' practice (for example, by making task design an explicit focus of ITE programmes) must take account of these strongly held beliefs. Klein (2007) suggests that ST beliefs should be an explicit focus of ITE courses, as failure to recognise their power and influence over STs' practice can hinder the effectiveness of teacher education.

Methodology

The research questions for this study were as follows:

1. What do student teachers consider as the features that make a good mathematics task?
2. How do student teachers' perceptions of the features that make a good mathematics task differ across year groups within Initial Teacher Education?

This research study was conducted in the context of a four-year Bachelor of Education (BEd) degree in Northern Ireland, in which all students, on both primary (ages 4 – 11) and post-primary (ages 11-18) designated pathways, choose a subject specialism and take modules in subject content and subject-specific pedagogy. This course structure is increasingly unusual in the UK and Ireland, but one of its chief advantages is that it offers the opportunity to delve much deeper into subject content and pedagogy over an extended period of time than is often possible in ITE courses. All participants were (or had recently been) enrolled in this course, had chosen mathematics as their subject specialism, and had performed strongly in mathematics at A-level or equivalent. This was a cross-sectional study, involving participants from all four year groups (BEd1 students are in their first year of ITE, BEd2 students in their second year, and so on). As such, it gives a snapshot of STs' views at a particular moment in time.

Data was collected through an online questionnaire distributed to undergraduate STs, as well as to beginning teachers in their first year post-qualification. Several online platforms were considered for the administration of the survey and Microsoft Forms was ultimately selected due to its ease of access for participants, its capacity for a wide variety of question types (short/long, free-text, multiple choice, ranking etc), the functionality to split the questionnaire into sections, and the secure, password-protected cloud storage offered for data collected. Functionality was tested throughout the questionnaire development process, most notably to ensure that earlier sections could not be returned to later. We considered this an important feature to prevent participants from changing answers to what they may have perceived as "correct" after reading later questions. Questions were devised via an iterative process and underwent several revisions before the final version. We enlisted the help of an external mathematics education colleague to check for clarity.

All data was collected anonymously, and participants were given written information about the study before consenting to take part. The questionnaire link was emailed to all mathematics STs in the above BEd course and was open for a period of two weeks. There was a response rate of 84%: 68 questionnaires were distributed, and 57 were received. Responses were evenly distributed between primary (29 responses) and post-primary (28 responses) phase participants, which broadly reflected the proportions of the degree pathway. The response group contained just two qualified teachers, and so the overwhelming majority of responses came from students who were still involved in ITE.

To provide context for participants, and to ensure a broadly shared understanding of the term "task," the questionnaire's preamble defined a mathematics task as "any activity that pupils take part in to accomplish a goal, for example completing questions from a textbook, completing a worksheet, taking part in groupwork, doing investigations, etc." After collecting preliminary demographic information (phase and year of degree programme), the first question asked, "*What do you think makes a good Mathematics classroom task?*" No clarification was given as to what was meant by "good." This was a deliberate decision to elicit possible factors that STs might consider important; we anticipated that while some might interpret this question solely in terms of academic progress, others might also include aspects such as pupils' enjoyment, learning preferences, or other pedagogical factors. This question was a free-text response, and until this question was answered and submitted, participants could not view or access later questions.

Table 2. Task features for ranking in questionnaire.

Practises a skill/Relevance to exams/Curricular need
Mathematically interesting/Higher order thinking/Stretching
Cross-curricular/Real life links
Differentiability
Lends itself to assessment for learning and/or marking
Use of technology
Groupwork/Pair work
Easy/quick to prepare
Easy to explain
Fun/Bright and colourful

The next section presented ten possible features of a classroom mathematics task, and asked participants to rank them from most to least important. The ten were based on those highlighted in literature (see Table 1), as well as including several others to ensure coverage of a range of purposes – pupil and teacher perspectives, and academic, practical, pedagogical, and social considerations. The chosen ten features are shown in Table 2.

Participants were then asked in free-text responses to give reasons for their top and bottom three choices, before suggesting any features they felt were missing from the list. While there was the possibility of some duplication from the initial free-text question, this was included to acknowledge that the list was by definition incomplete, and to avoid privileging the perspective of the research team over that of participants. Additionally, if the given list had jogged the memory of a participant or perhaps clarified what was meant by a good task, this question allowed ideas missed at the earlier stage to be submitted. Finally, participants were asked to explain whether and how their understanding of what makes a good mathematics task had changed over the course of their ITE, and what factors had contributed to any change.

The study used mixed methods, with the questionnaire comprising both quantitative (ranking) and qualitative (explanation) questions. This mixed-methods approach allows us to examine both the priorities STs hold and their reasoning for these choices. A large amount of rich data was generated. Analysis initially examined the quantitative and qualitative aspects separately, using Microsoft Excel and Quirkos, respectively, before conducting a further analysis to integrate the separate findings.

Quantitative analysis focused on looking for trends in the features that STs rated as important for a good mathematics task. This was done by considering the mean rankings of the given features and the variation in rankings given by STs to each feature.

In qualitative analysis, the data were interrogated to find recurring themes and ideas within free-text responses. Each question was coded separately before being aggregated. In the analysis, STs' free responses were initially coded according to the original list of ten features that STs had been asked to rank. This was carried out independently by two researchers, and their codings had high levels of agreement. When there were differences, the researchers discussed and agreed on the final code. The data was then revisited to code ST's free responses that did not fit within any of the ten given features. Two researchers did this collectively and generated a further list of 23 codes. The final list of 33 codes was then re-examined to combine some codes into clusters expressing similar or related ideas. Again, this was done collaboratively by two researchers. Subsequently, the data was broken down by cohort – the Quirkos software used allowed us to scrutinise the proportion of responses within each code/cluster that came from each cohort.

Finally, the results of both analyses were compared to allow each to illuminate the other – the qualitative analysis going some way to explain the quantitative trends observed, and the quantitative data showing the extent to which reasoning, and priorities given in explanations are consistent (or otherwise) across and between year group cohorts.

Ethical Considerations

Ethical considerations were attended to throughout, and full ethical approval was granted by the researchers' institution's ethics committee. As the research team acted as lecturers on the BEd course in question, care was taken to ensure that there was no conflict of interest (real or perceived) and that STs did not experience any pressure to participate, or to answer along particular lines. Participants were emailed a link to the survey and informed that completing it was entirely voluntary and fully anonymous. Informed consent was obtained from all participants. No identifiable data was collected at any point.

Limitations

The questionnaire was checked for readability and clarity by a practicing mathematics classroom teacher outside of the institution, resulting in some minor adjustments. Further psychometric validation (such as reliability coefficients and/or test-retest validity measures) was not carried out, and this should be noted as a limitation of the study. One particular implication for interpretation may be the extent to which terms used in the questionnaire were open to different interpretations. Free-text responses gave insight into how participants understood and used many of the terms, but greater validity testing may have strengthened this area. Additionally, interpretation must also take into account potential differences in using terms between practicing teachers (such as ourselves and the colleague who checked the questionnaire) and student teachers, of whom the latter made up the overwhelming majority of study participants.

Results

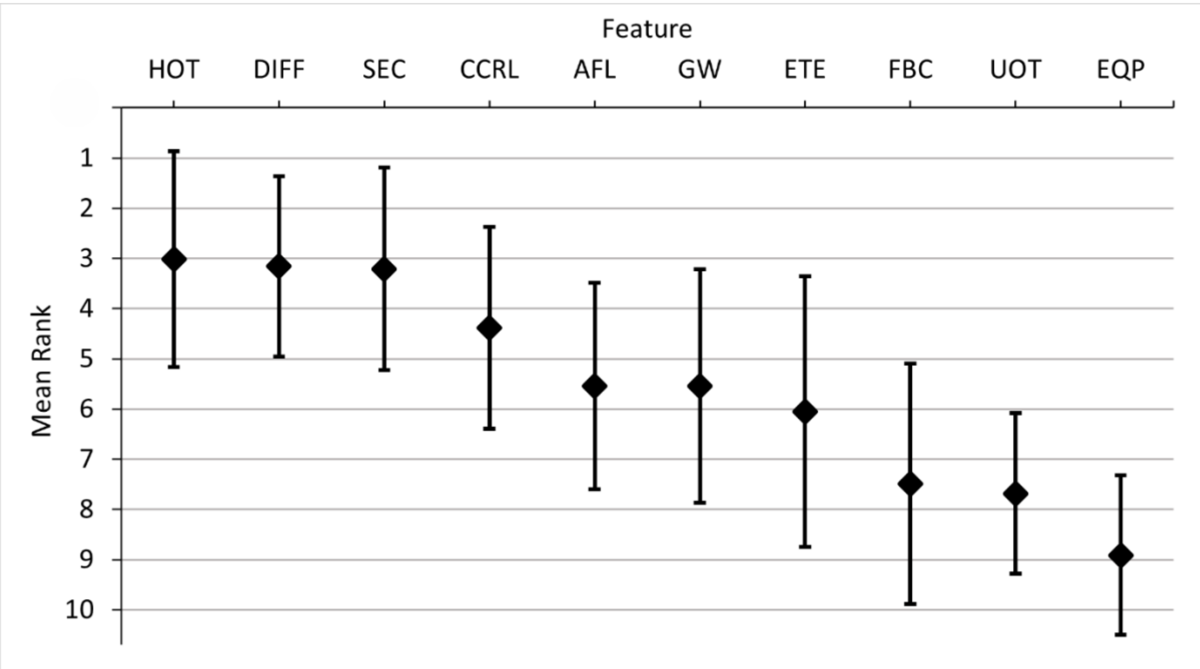
We address our two research questions by first examining which features STs valued most and least, then exploring differences across year groups. First, we examine the quantitative data gained from STs' rankings of various features, summarised in Figure 1. As a reminder, these features are listed below, along with associated abbreviations that are used in Figure 1:

Practises a skill/Relevance to exams/Curricular need (SEC)
Mathematically interesting/Higher order thinking/Stretching (HOT)
Cross-curricular/Real life links (CCRL)
Differentiability (DIFF)
Lends itself to assessment for learning and/or marking (AFL)
Use of technology (UOT)
Groupwork/Pair work (GW)
Easy/quick to prepare (EQP)
Easy to explain (ETE)
Fun/Bright and colourful (FBC)

Research Question 1: What do student teachers consider as the features that make a good mathematics task?

Figure 1 shows the average ranking of each feature from the full cohort of respondents (both primary and post-primary phase STs). The central diamond gives the mean ranking for each feature, and the error bar shows the standard deviation of rankings. When the primary and post-primary cohorts were analysed separately, the means for each feature were all within ± 1 of the overall mean, indicating that the cohorts tended to have fairly similar rankings. The feature that showed the most consistency in rankings was for *Easy/quick to prepare*, and the feature showing the most variation in rankings was *Easy to explain*. It is evident that while there was, of course, a range of views among participants on the relative importance of each feature, there is a high degree of consensus on the top and bottom three features, with a fairly even split within these groups as to the relative positions of the three.

Figure 1. Student teacher rankings of task features.



In summary, the features most valued by the STs in a mathematics task are that the task:

1. Is mathematically interesting/higher order/stretching
2. Has potential for differentiation
3. Practices a skill relevant to the taught curriculum or to exams.

In contrast, STs valued least that the task:

8. Was fun, bright, and colourful
9. Used technology
10. Was easy or quick to prepare.

We now use the qualitative analysis of free-text responses to explore STs' reasons for these choices.

Mathematically interesting/higher order thinking/stretching

Many STs spoke of the importance of higher-order thinking: 32% ranked it as the most important feature, and 65% placed it in the top three. There was widespread agreement that tasks need to appropriately push pupils beyond what they could currently do and that this is best achieved by using tasks that challenge pupils' thinking. Against this backdrop of valuing challenging tasks (and to use a phrase beloved by mathematicians, non-trivial), STs also demonstrated an awareness of the need for tasks to be appropriately pitched for their pupils. The theme of "challenging but manageable" appeared often, articulated in phrases such as "stretch pupils at their own level," "challenging but within means of completion," and "really makes them think, but isn't too challenging where they just give up." With such a caveat placed on the level of challenge, it is perhaps not surprising that the second overall-ranked feature was that of differentiability – ensuring that a task could be pitched and adapted for a variety of learners.

Differentiability

Over 63% of STs ranked differentiability in the top three features. Key convictions under this heading dealt mainly with the variety of learning needs present in a classroom. While many STs considered this aspect primarily in relation to learners with lower prior attainment and ensuring that the task is widely accessible, many others recognised that differentiation is necessary right across levels in a class. Students articulated that differentiation is important

> "to ensure all [pupils'] needs are cared for and pupils at a lower level are not being neglected and challenged with a task they are not capable of which would result in decrease of self-esteem."

They also suggested that "pupils at a higher level should also not be given a task they find unchallenging [sic] as this will not progress their learning."

In this area, it was evident that STs' periods of school placement had a profound impact on their understanding. Several students stated that their eyes had been opened to the variety of needs within a single class, even in settings that they would not have considered to be mixed-ability. We will expand on this later when considering the changes that took place in STs' perspectives.

Practices a skill/relevance to exams/curricular need

The third most important feature was relevance to exams, the curriculum, and/or necessary skills. Over 61% of STs placed this feature in their top three choices. For many of these students, this aspect was an inescapable bottom line in evaluating a mathematics task as "most of school life is tailored for passing exams and reaching certain marks," "skills for exams are the main reason as to why content is taught in the classroom," and "children won't engage with something if they know they don't need it for the exam and therefore won't learn much." Interestingly, these statements come from primary phase STs, showing that awareness of examination and curricular pressure exists at all levels of schooling. That said, as might be expected, there was a greater focus placed on exam preparation by students aiming to be post-primary teachers. Some seemed to view this is a necessary evil, whereas others were more explicit about exams (or exam preparation) being a central aim of post-primary schooling: "Exam preparation especially in KS4/KS5 [Key Stage 4/Key Stage 5; ages 14-18] is the main part of the school year so should be a focus, to help the children succeed" or, even more bluntly, "Ultimately, the pupils are preparing for examinations." These comments highlight that STs' priorities are shaped and constrained not only by their own values and perspectives but by the wider context in which they operate.

A further strand of comments considered the importance of exam preparation from a pupil's perspective, suggesting that exam preparation was important for wellbeing and confidence: "As I'm a post-primary student it is essential that the exam spec is cover[ed] otherwise the pupils will become stressed etc. and this will lead to other issues" and "including exam like tasks will help pupils become more prepared and much more comfortable with dealing [with] the pressure that comes from exams."

We now turn to examine the features that STs deemed least important from the given list, and the reasons given for these low priorities.

Fun/bright and colourful

Many STs rejected the importance of aesthetics, certainly relative to other pedagogical considerations: 60% of respondents placed this in the bottom three features. There was strong consensus that while a colourful appearance or fun task was nice, it was far from essential, and that lesson content needed to take priority: "Mathematical work can be brought to life and made interesting through discussion and conversation, not necessarily through fun/bright colours". Others were more cautious in even allowing this, suggesting that time could in fact be wasted making a task look attractive or include entertaining elements at the expense of more important factors, as exemplified by this comment: "The extra time spent making lessons look nice could be used elsewhere such as ensuring that tasks are tailored to the needs of all students." A small number took issue with the inclusion of "fun" being presented as separate to other factors, arguing that that this set up a false dichotomy and that there is no reason that a meaningful mathematics task can't be enjoyable in its own right, aside from being designed with this as an explicit aim.

Use of technology

Perhaps the most surprising result was STs' near universal reluctance to embrace the use of technology in mathematics lessons, with over 90% of STs placing it in the bottom half of priorities, and 61% placing it in the bottom three. As above, STs fell mainly into two groups on this issue: those who viewed it as a nice optional extra, but by no means essential to a good mathematics task ("It's not really that important as you can just as well use whiteboards and markers"), and those who felt that a good task could be derailed by the use of technology, either because pupils became distracted by the medium, or because pupils' lack of IT skills acted as a barrier ("Using technology is not always the best idea as young children can be easily distracted from the learning"). The prevalent view is well summed up in this statement: "I don't think use of technology is a massive priority in Maths, unless it is more relevant or useful in achieving the learning intentions than the traditional methods."

Easy/quick to prepare

Speed/Ease of preparation was the clear "loser" in the questionnaire, with 53% of participants ranking it as the least important feature, and 86% ranking it in the bottom three of the list. In free-text responses, STs were almost unanimous in their (sometimes scathing) assertions that focusing on ease of preparation was incompatible with a child-centred approach. For example, two students responded that "A task should revolve around the pupils and so how long it takes the teacher to prepare doesn't really matter" and "time for preparation should not be considered when preparing a task as this is poor educating and puts children at a disadvantage due to lack of effort from teacher." Other STs suggested that a task being quick to prepare would pose a red flag regarding the quality of teaching and learning, since "a task should take some consideration and planning for the children to achieve success."

In this area, there was a slight difference evident in the views of those at different stages of their teacher education. All the BEd4 and graduate teachers who addressed this low priority did so with measured qualifiers – that "not all tasks that are easy to explain or quick to prepare engage our children" and "although it is nice when tasks are easy and quick to prepare, this does not mean they are useful or relevant" rather than dismissing such tasks out of hand as was generally the case with STs earlier in their ITE.

What other features do STs think are important?

A majority of respondents (60%) were happy that the given list of features was comprehensive and did not add anything to this list, but others did make suggestions. The most frequent of these was the idea that mathematics tasks should be practical and interactive, as seen in the following list of responses from STs:

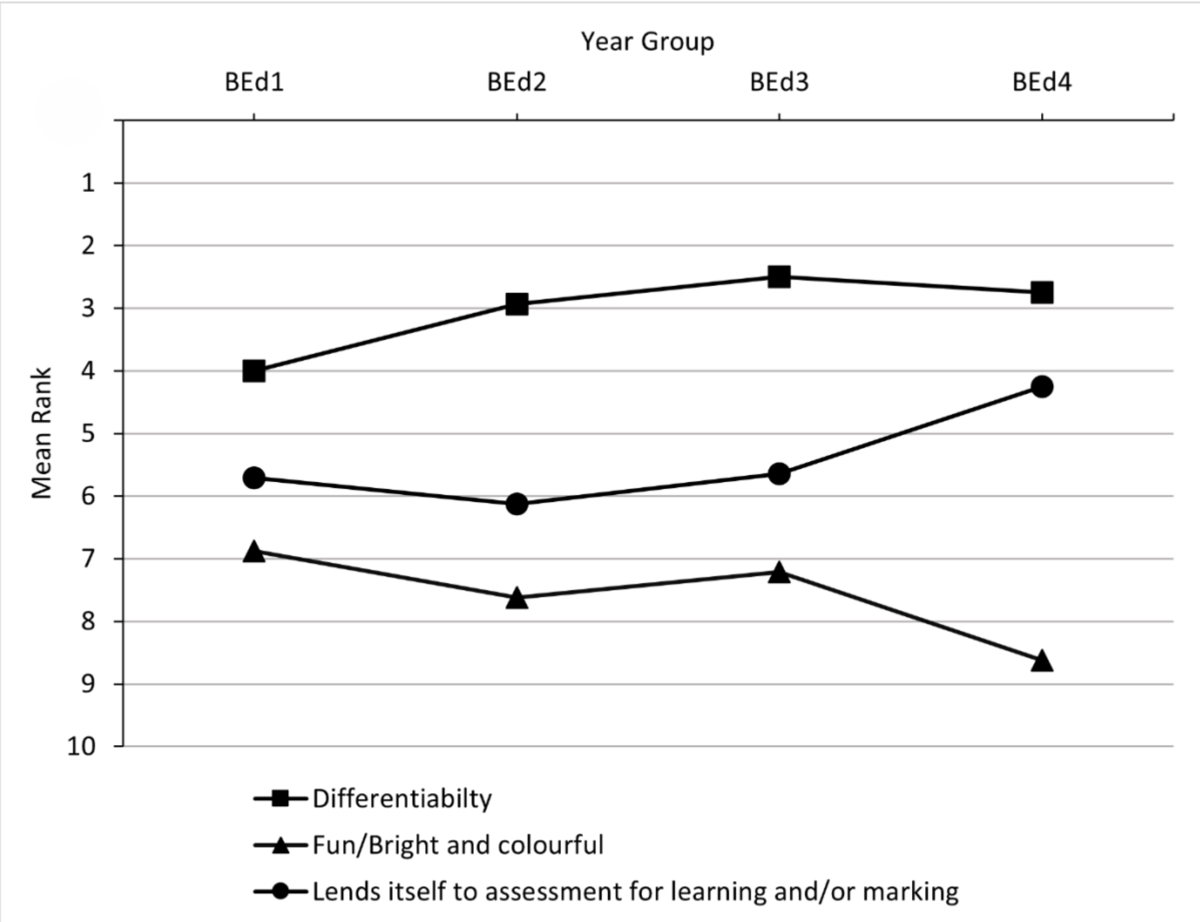
> "Mathematical tasks should be interactive"
> "Active learning"
> "Use of resources/manipulative"
> "Practical work and use of varied materials"
> "Task which is interactive and practical"
> "Hands on practical tasks- good for practical learners"

The rest of the STs' suggestions were too sporadic to consolidate into a salient theme/value.

Research Question 2: How do student teachers' perceptions of the features that make a good mathematics task differ across year groups within Initial Teacher Education?

As this was a cross-sectional study, we did not seek to examine how the perspectives of individual STs changed over time. However, we were interested to see if there were any appreciable differences between cohorts at different stages of this four-year ITE course. To do this, we took the mean ranks for each feature given by STs in the BEd1 and BEd4 cohorts and calculated the correlation between them. A high positive correlation would indicate high similarity in the rankings given by first and final year students. Overall, the value of Spearman's rank correlation coefficient (r_s) between the two groups (BEd1 and BEd4) was calculated to be $r_s = 0.788$. This is statistically significant at the 5% level, suggesting that there is a strong consensus between STs at the beginning of ITE and those at the end. However, at the level of individual features, three features did show notable differences in the rankings given by BEd1 and BEd4 students. These are illustrated in Figure 2.

Figure 2. Trends in rankings for selected task features.



The greater importance attached to differentiability by upper-year STs (see Figure 2) is strongly mirrored in the accompanying qualitative data when STs were asked to explain any changes in their thinking over the course of their ITE[1]. Over 20% of students identified that their understanding of differentiation had significantly developed over the course of their teacher education experience. One ST responded that

> "I have come to appreciate the importance of differentiability as I now recognize that not all pupils are at the same level academically and not all learn in the same manner. It is important as a teacher to facilitate the different needs of the class."

Another reflected that "before the teaching course, I didn't think that much into differentiation. I seen [sic] how necessary this was when out on teaching practice." Many STs stated that prior to beginning ITE, they had given this whole area little thought, or had assumed that school practices such as ability grouping would render it unnecessary: "Yes it has made me think of things such as differentiation which I wouldn't have thought much about until I started my course especially as I went to a grammar [academically selective] school." Others had come to realise that differentiation goes far beyond the traditional lower/middle/higher ability divisions and must also consider the way different children learn, and the need to cater for pupils with English as an Additional Language or Special Educational Needs (two separate issues, but which are often conflated by STs):

> "I have realised how important it is to make sure tasks/lessons are adaptable particularly now with the increasing amounts of SEN and EAL children ... which is something that I have never really considered."

A second area that was more important for upper-year STs was assessment for learning (middle line on Figure 2). Fewer comments related to this area, but those that did showed awareness of the importance of pupil progress towards learning intentions, and the role of formative assessment in monitoring and supporting this; one participant explained that "now I know that a lesson is more rewarding when you have evidence that each person in the class has left the lesson successful and have met the learning intention set out" while another said "I have changed my opinion and have seen first-hand the effectiveness of formative assessment in the classroom."

The final aspect that showed a notable difference in ranking was a lesson being designed as fun or bright and colourful (bottom line on Figure 2): BEd4 STs overall valued this less than their first- and second-year peers. Comments suggested that upper-year STs were more attentive to deeper pedagogical factors when evaluating a task, and less concerned with surface appearance, as exemplified by this response:

> "I think my experience in schools has shown me how many resources are made to simply look the part and are all frills but don't necessarily fulfil the need. i.e. I realise the importance of making sure a resource/task is relevant and supports the learning for all students."

It is worth noting that while for BEd1-3, sample respondents were fairly evenly split between primary and post-primary phase students, the BEd4 sample was almost

[1] While the cross-sectional nature of this study did not allow us to determine how the views of different cohorts had changed over the course of ITE, one free-text question asked STs to reflect on any personal changes in their views during their ITE journey, and any factors that had contributed to this.

exclusively made up of post-primary STs. More granular analysis of quantitative data showed that across the year groups, there was almost no difference in the ranking given to differentiation from primary and post-primary students, so the differences in views between year groups are unlikely to have been influenced by this difference in sample composition. However, there is a difference by phase in the other two features: post-primary STs generally consider assessment for learning as more important, and aesthetics as less important than their primary counterparts. It is therefore possible that some of the differences seen for these features in Figure 2 are attributable to the difference in the proportions of the sample cohort for BEd4.

In addition to the differences seen in rankings between successive cohorts of STs, free-text responses also revealed a significant shift in attitude towards the importance of pupil-centred engagement and the related role of the teacher:

> "At the beginning I had the intention of going in and teaching math. Teach the pupils math and then they do questions. Over time I have realised the importance of creating tasks that are enjoyable [and] include higher order thinking."

There was recognition that overreliance on textbooks and worksheets was insufficient as a diet of learning and often failed to engage pupils as much as STs hoped. They also identified the timing of tasks as important in ensuring pupils are engaged; a good task can quickly cease to be so if it is allowed to drag on for too long. Other desirable features highlighted were interactive learning and ensuring relevance to pupils' interests and perspectives. Some STs demonstrated an increased appreciation of the pivotal role that the individual teacher plays. One suggested that "I believed before starting this course that a confident and engaging teacher would get the most out of their students. However I have come to realise a competent and well prepared teacher can be much more effective" while another reflected that "It is these tasks where teaching ability shines through that a good teacher can make a boring task more lively for the pupils."

Discussion

Research Question 1: What do student teachers consider as the features that make a good mathematics task?

The results of this study show that STs overwhelmingly value pupils' engagement when considering what makes a good mathematics task. This central idea of engagement had three main elements: mathematical, individual, and pedagogical.

First, mathematical. At the heart of this is the need for a task to be mathematically interesting, meaningful, and relevant. Many allied factors contribute to this, but STs are clear in their minds that the meaningful mathematics must be at the centre of a good mathematics class task: "It should [be] mathematically relevant and interesting" and "The task needs to have a mathematical focus." While such a conclusion may seem unremarkable, it is worth restating that this conviction is by no means universal among student (or practising) teachers (Crespo & Sinclair, 2008). As such, these results can be considered highly encouraging, while acknowledging that theoretical convictions can diverge from actual classroom practice in this area: tasks may differ as designed, explained, and enacted (Stein & Smith, 1998; Zwahlen, 2014). However, the priority given to mathematical rigour and interest bodes well for future pupils of this cohort of STs, as such an approach has long been recognised as a non-negotiable foundation for providing pupils with meaningful mathematical experiences (NCTM, 1991).

Second, individual. Meaningful mathematics must be accessible and engaging for individual pupils with a variety of strengths and needs. STs believed (increasingly as their ITE developed) that differentiation and adaptation must be a central consideration within every classroom, for every task. As stated above, this was the area in which STs most often expressed that their views had changed over the course of their ITE, and where practical classroom experience played the biggest role in changing beliefs and attitudes. A clear picture emerged of STs adopting child-centred beliefs and appreciating the vast array of differences across even a single class of pupils. This theme captured attitudes around academic differentiation but also showed an awareness of the need to design and adapt learning to be relevant for pupils and to connect with their interests and circumstances.

Third, pedagogical. STs recognised the need to make sound, well-justified pedagogical choices, which are driven not by personal preference or passing educational whim, but by what will serve the learning of pupils, and the communication of the mathematics at hand. For example, the prominence given to higher-order thinking demonstrated that STs recognised the pedagogical value of tasks that go beyond rote learning or factual recall. Additionally, by the high priority they attached to differentiation, STs indicated the importance of tasks being pedagogically appropriate for a wide range of pupils. Looking across the participants, students at the beginning of their ITE were more likely to view relevance, appearance, and cross-curricularity as important features, while those in higher year groups placed more value on differentiability, meaningful mathematics, and potential for assessment - factors that are more pedagogically driven. As such, we can see STs developing a deeper understanding of engagement, as well as a deeper understanding of teaching as a craft, rather than a science; a profession that while following clear and helpful general principles, cannot be reduced to a formulaic approach, and requires detailed knowledge of subject, pedagogy and children, closely akin to Shulman's (1987) knowledge base for teaching.

Research Question 2: How do student teachers' perceptions of the features that make a good mathematics task differ across year groups within Initial Teacher Education?

In considering the factors that contributed to the different values between year groups, results highlighted the seminal role played by school placement in developing STs' beliefs and understanding. More often than not, it was time spent in school that caused the cognitive dissonance necessary for STs to rethink their practice and approaches. Darling-Hammond (2006, p. 308) observed that STs can learn "powerful experiential lessons" during their periods of school placement. In this study, STs at later stages of ITE, who have spent more time on school placement, showed a more in-depth grasp of the complex process of learning, a greater understanding of the diverse needs of pupils, and a heightened appreciation of the pivotal role a teacher plays in ensuring effective learning. Overall, these students demonstrated a deeper awareness of the multifaceted nature of classroom teaching and the associated range of knowledge and skills that they need to develop as teachers.

Such knowledge and skills can be conceptualised via Shulman's (1987) framework of the knowledge base for teaching. The aspects of his framework which are most pertinent for this study are, first, pedagogical content knowledge (PCK), "that special amalgam of content and pedagogy" (p. 8) that transforms curricular content into teachable material, and second, knowledge of learners and their characteristics. Knowledge and understanding of both these aspects are more strongly evident in STs at later stages of ITE. Regarding PCK, these STs prioritised the substance of learning, focusing on learning intentions and effective assessment. These perspectives were largely absent for their peers in earlier year groups, and there was some evidence to suggest that younger STs were more concerned with the mechanics of lesson construction and adherence to formal lesson components. In relation to knowledge of learners, more experienced STs demonstrated a much stronger appreciation of the need for careful differentiation to ensure that lessons are challenging yet accessible for a wide range of pupils. Although this is not a longitudinal study, their responses often indicated that this had been an area of personal growth over the course of ITE, suggesting that increased awareness of differentiation may be related to STs' learning on the BEd programme, especially modules involving periods of school experience.

Overall, we characterise STs at later stages of ITE as having greater insight into the complexity of teaching, and an attendant perspective on the resulting complexity of designing and choosing good mathematics tasks. Given our hope that ITE will contribute to enabling STs to design and enact good tasks, the question then arises: How can mathematics ITE best support STs to this end? Learning what makes a good mathematics task is both a theoretical and practical journey, as STs' developing professional judgement and identities interact with increasing experience of real classrooms and real pupils. Mathematics teacher educators must therefore seek to provide STs with the best possible learning experiences and help them place their experiential learning within a wider theoretical context. Pedagogical and subject courses in ITE have a key role to play here, in providing STs with a framework through which to evaluate their experience in school, and to link such experiences with theory and literature (Korthagen, 2010). Without this framework, given the power of in-situ learning, there may be a danger that STs make choices which are predominantly pragmatic, rather than pedagogical.

This leads us to consider the area of reflective practice. In Northern Ireland, where this study was conducted, reflective practice is considered so important that the standards governing all teachers are titled "Teaching: the Reflective Profession" (GTCNI, 2007). Reflective practice offers an additional source of knowledge for practitioners, often typified by Schön's (1983) reflection-on-action (reflection after a situation has arisen). We suggest that in an ITE context, reflective practice can also provide the necessary framework (mentioned above) for STs to evaluate their practical experience in school, and to link it to their theoretical learning. For example, the experience of the STs in this study bears out Schön's (1983) suggestion that effective reflection often arises in response to a surprise or difficulty. STs' explanations as to how their views had changed almost invariably involved an experience of a previous view "not working," or of observing a teacher successfully implement an approach they would have previously dismissed. Very few asserted that their perspective had been fully vindicated throughout their in-school experience. Again, teacher educators have an important part to play here in helping STs learn to reflect meaningfully and providing them with external lenses to facilitate this.

In doing so, and in seeking to support STs as developing, reflective professionals, the findings from this study also helpfully circle back to ITE's raison d'être. ITE is not an end in itself but must retain its focus on the school pupils who will be its ultimate beneficiaries.

Possible Directions for Future Research

This study investigated STs' perspectives on the features of a good mathematics task, and to a lesser extent, differences in views between different cohorts of STs. Future research could profitably adopt a longitudinal approach, tracking and exploring any changes in individual STs' views as they progress through ITE. Furthermore, this study was conducted with STs with a strong mathematics background, and future research could explore the perspectives of STs who lack this subject-specific expertise. There is also potential to interrogate more closely the relative impact of university-based ITE courses and periods of school placement in shaping STs' understanding of good mathematics tasks. Finally, it would be interesting to probe the extent to which STs' classroom practice while on placement aligns with their espoused theoretical views on good tasks, and to consider any factors that may cause divergence in this area.

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