Language games in primary mathematics

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This theoretical paper examines views about the role of language and mathematical discourse in learning mathematics. Current research is still addressing what constitutes a mathematical discourse. As new conceptions of the purpose of language use in mathematics are explored, and associated ontological and epistemic positions are revealed, one might ask: how are we able to reframe our view of language to support a social participation perspective? This paper proposes the consideration of Wittgenstein's philosophy of language games to shift our conception of classroom language use in mathematics to encompass broader contextual features such as participation, patterns of exchange and social norms.

This theoretical paper examines sociocultural theories and practices that considers language as central to learning mathematics. Underpinning these theories and practices is the notion of a strong connection between talking and thinking where social interaction impacts on learning (Barwell, 2018; Sfard, 2007; Vygotsky, 1978). Discourse practices recognise that there are many different factors that contribute to build meaning in a mathematical situation (Moschkovich, 2019). These factors may include the use of symbols or physical materials and written as well as verbal language (Moschkovich, 2019). Importantly for the theme of this paper, a mathematical discourse considers all uses of verbal language, or utterances, to support meaning. Informal language use is not disregarded. Research has demonstrated that particular discourse practices in mathematics assists students to engage more deeply in learning, building meaning, and knowledge in mathematics (Barwell, 2016).

Exploring conceptions of learning, meaning and knowledge relating to language can reveal the influence of an ontological perspective. Stretching the concept of language use to embrace a broader notion of what can be considered a mathematical discourse may involve finding new ways to see language. It is expected that the development of new forms of language use in learning mathematics can be supported by a corresponding shift in underpinning ontology (Murphy, 2015). Exploring Wittgenstein's notion of language games (1953) is a possible means of allowing such a shift (Standish, 1995).

This paper aims to examine how sociocultural theories influence a view of language use in the learning of mathematics; in particular, I attempt to reframe the view of language to support a social participation perspective. I propose that an interpretation of Wittgenstein's concept of language games, which is underpinned by social participation, can be helpful by providing a perspective of classroom language use that avoids seeing words as autonomous entities. Overemphasis on the use of specific words and terms can result in a narrow view of language use in learning mathematics (Barwell, 2016). This view prioritises the correct use of technical vocabulary or formal academic language. Instead, the idea of language games focuses attention on the broader contextual features in which talk occurs, such as participation, patterns of exchange, and social norms.

Wittgenstein's Language Games

Wittgenstein (1953) aimed to demonstrate that words are not defined by reference to the objects they designate, nor by mental representations one might associate with them, but by

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how they are used in the context of social activity. He challenged the idea that the meaning of words is anchored by invariable rules that can be demonstrated in acts of ostensive definition. Wittgenstein also opposed the notion that the rule for how to use a word can be abstracted from all particular uses. The meaning of the word is the use of it, which can only be learnt through such use with other language users. Wittgenstein questioned the idea that we can come to understand the essential meaning or essence of a word. He asked whether the word or concept of game has an essence that can meaningfully be defined in certain terms such as necessary or sufficient conditions (Wittgenstein, 1953):

> Consider … proceedings we call games, I mean all games, card games, board games, Olympic games and so on. What is common to them all? ... If you look at them you will not see something that is common to all, but similarities, relationships, and a whole series of them at that. (p. 66)

Wittgenstein puts forward the idea of language games to illustrate the point that without considering use in context it can be nonsensical to theorise about what words mean; that understanding and meaning are inextricable from the social contexts within which speakers interact. The notion of language games is used to help us to see that the rules that guide how words are used are embedded in the social contexts of such use; they are part of a "form of life" (Wittgenstein, 1953, p. 68).

The idea of a pragmatic theory of meaning contrasts with many commonly held views about how language operates in mathematics (Moschkovich, 2019). The notion that mathematical terms are tightly defined can result in such definitions being placed front and centre as a language feature in learning experiences (Strom et al., 2001). Rather than viewing the meaning of mathematical terms as fixed and the rules by which they are used as invariable we might seek to understand, instead, what are the norms or rules of the language games being played and in which contexts do language experiences support learning?

Wittgenstein's idea of language games does not provide a model of how mathematical discourse should look. Neither are language games part of a theoretical framework that can be mechanically applied. I am suggesting that language games are a way of seeing a mathematical discourse that looks beyond particular words and phrases and attempts to describe the overall purpose of the mathematical activity. The purpose is described in terms of social participation. For example, a language game could be one in which students appear to make a genuine effort to engage with others' ideas. The purpose of this game might be described as recognising other peoples' thinking. A language game could be one that involves trying to trump or better the previous speaker and the purpose is one-upmanship or winning. Yet another game could involve the teacher playing a catch-and-pass role. They chair a discussion by distributing contributions without comment or rephrasing. The purpose is to increase fluent exchange between interlocutors and support connection between ideas. There is not one type of language game, as there is no monolithic form of language (Moschovich, 2019). A description of language games is not intended to be definitive. Using a language games perspective aims to provide a way for teachers and researchers to look at a mathematical discourse that allows a connotation of meaning in terms of purposes for social participation.

References to Wittgenstein's importance for education often acknowledge his influence in providing an alternative view of the role of philosophy and note a corresponding shift in epistemological and ontological viewpoints (Standish, 1995). As new ideas for the purpose of education and the nature of learning are explored, a means of supporting the shift in ways of seeing, analysing, conceiving and acting as researchers and practitioners will also be required. For example, Wittgenstein's opposition to Cartesian conceptions of mind and understanding allows us to reframe our view of the nature of learning and knowledge

(Smeyers, 1998). A change of approach recognises that overvaluing the use of technical or formal mathematical language can be inhibiting rather than enabling and that informal or natural dialogue can be effectively blocked. Viewing the language of mathematics too narrowly can fail to allow the natural use of language to discuss, explain and reason. Such a view can hinder the process of inducting children into mathematical practices (Wagner & Andersson, 2018).

As young children are initiated into the practice of mathematics, they will already be exploring how they can engage in certain discourses to express and develop their thinking. Rather than constraining or obstructing natural use by maintaining too closed a view of how mathematical language should look, emphasis is placed on looking for natural use of language to develop. As a theoretical lens, the idea of language games allows a view of the broader contextual features in which a mathematical discourse occurs.

The following sections will consider sociocultural theories and practices in relation to developing classroom discourse for mathematics. It offers reflections of how Wittgenstein's language games potentially provide a lens for viewing the development of exploratory talk.

Exploratory Talk

A focus of research into classroom language use has been to distinguish between different types of talk. Talk that is rote learnt through repeated procedure or ritual can be considered essential to formative stages of learning (Sfard, 2007). In these formative stages, the role of a teacher is to model and shape how language is being used by students. However, highly practised forms of talk could be considered exemplifications for all classroom language use. Such a view can be normatively restricting. While ritualised forms of language use may be necessary for early initiation into new learning, it is thought that progression through later stages of learning requires more creative and generative uses of language (Sfard, 2007). Exploratory talk involves student-initiated language use that actively communicates about and negotiates meaning. As exploratory talk develops, patterns of classroom language use might be tentative, incomplete or fragmented yet allow for inventive purposes for talk. Overemphasis on polished forms of public speaking, or presentational talk, and on the correct use of formal language, can hinder opportunities for exploratory talk (Barnes, 1976).

The goal of supporting children as they develop use of exploratory talk has been researched on the difference between characterising mathematical language use as 'playing-with' and 'playing-at' (Fleener et al., 2004). Playing-with language use is seen as generative and employed by students to actively invent contexts to extend meanings. In contrast, 'playing-at' language use is considered to be evident when a student merely attempts to provide the teacher with an expected response. The development of exploratory talk requires that teachers are able to recognise and create opportunities for this form of language exchange. Having a tuned ear to help guide or shape verbal exchanges towards exploratory talk is an important skill, as outlined above by the various talk moves a teacher can employ. However, such hermeneutical listening is not easily achieved. To support exploratory talk, teachers are required to use interpretive listening to allow students to expand and relate meanings rather than narrowing them. Attempts to support 'playing-with' language uses will collapse into 'playing-at' games if the teacher appears to feel the need to seek closure to the learning episode and feels pressured to ensure that students have used acceptable mathematical terms and phrases (Fleener et al., 2004).

Using language games as a lens can provide a number of insights into the failure of 'playing-with' language games: It is difficult for a teacher to avoid authoritative control and

to use interpretive listening to guide their own participation (Fleener er al., 2004). The perceived need for students to use mathematical terms correctly can restrict opportunities for exploratory talk. There also seems to be a tendency for both teachers and researchers to focus on the use of specific words or terms rather than notice patterns of exchange or attempts to convey meaning using informal language.

Dialogic Pedagogies

Researchers have identified features of teaching and learning that support the development of dialogue (Hardman, 2019). Common to such dialogic pedagogies are talk-intensive practices that encourage students to engage in extended discourse to share and build a common understanding (Snell & Lefstein, 2018). Dialogic pedagogies are motivated by the idea often attributed to Vygotsky (1978) that regularly engaging in dialogue of a certain nature supports the ability to internalise a reasoning dialogue. An essential component of dialogic theories is the importance of learners interacting with others, including the teacher.

It has been recognised that the development of a dialogic pedagogy takes a certain skill set of the teacher (Khong et al., 2019). Research has aimed to explore and describe effective roles for teachers to provide practical support within classrooms. These roles include asking probing and clarifying questions, encouraging students to elaborate on their ideas, acknowledging and validating students' proposals, and encouraging sustained discussion (Sedova et al., 2019). Such 'talk moves' are designed to help teachers to interact with students and are also used to prompt and encourage peer-to-peer interaction. Different focuses of research into talk moves include: initial moves to engage discussion, moves to follow up ideas, moves to encourage students to interact with each other's ideas and moves to make student thinking visible (Ritchhart et al., 2011; Webb et al., 2014). Encouraging students to relate their thinking to a previous expression is an example of talk move that helps to build connections between ideas and prompt interaction.

Dialogic pedagogies emphasise the importance of collective participation and surfacing social norms that guide and shape the purpose of talk. Describing the purpose of a language game will also surface social norms. A language game could be one sided or balanced and interactive. A language game might prioritise authoritative use of technical language or allow novice attempts and informal expressions. A language game is a situated, social activity. Describing a classroom language game makes explicit the purpose, manner or intent of social participation.

Philosophical Positions

Opportunities for the development of exploratory talk may require more than teachers employing a set of techniques. It may also help if ontologies or epistemologies are reframed. The normative persuasion of a received ontology can imply that a shift in a teacher's views about knowledge is required to support the introduction of exploratory talk in mathematics (Murphy, 2015).

Ontological and epistemological views of mathematical knowledge will likely translate into different approaches towards engaging students in talk when learning mathematics. For example, a positivist perspective that sees mathematical knowledge as a set of stable patterns or universal invariants will likely influence teachers to lead students towards making correct interpretations (Radford, 2006). From this perspective, talk is more likely to be viewed merely as a means of reporting. For example, talk is used to allow students to report the

current state of their knowledge. Alternatively, a non-positivist perspective, which sees learning in mathematics as a generative process of meaning making or gaining understanding, will frame a view of knowledge in different terms. Exploratory talk is associated with the concept that knowledge is generated through collectively social activities (Barwell, 2018). So, increasing opportunities for use of exploratory talk in classrooms would appear to require that teachers are able to shift or reframe their epistemological perspectives.

How a teacher participates in mathematical talk with students could provide some insight into their views about mathematical knowledge. Using a language games lens, a teacher's influence on patterns of language use can be interpreted to uncover tacit beliefs about the purpose of language and the status of mathematical knowledge. If there is a causal connection, connections can be inferred between teacher ontology and observable features of classroom discourse. Increasing opportunities for exploratory talk may then require shifting a teacher's views about the nature of mathematical knowledge.

Learning-as-Participation

If interpersonal language use is seen to be necessary for the development of thinking then language exchanges and children's participation in such exchanges, with each other and with the teacher, are central to learning. Through our participation with other language users we become able to use language ourselves and develop our own thinking. This social participation approach sees learning mathematics as an initiation into using language in new ways. Learning is defined by participation in social practices rather than the acquisition of concepts or knowledge. Here the conception of learning and knowledge is reframed. The enterprise of learning mathematics is seen as becoming initiated into using a mathematical discourse and the goal is for students to eventually become participants in the use of exploratory talk (Sfard, 2007).

From this perspective, language is considered in much broader terms than just involving the utterance of words or phrases. As many features of a context are considered to give sense to the social activity in which language use occurs, it is no longer possible to examine language as an isolated or autonomous phenomenon (Gee, 2014). Ontological implications associated with the concept of discourse can appear to contradict commonly held views about the nature of mathematical knowledge. This conflict arises when the effect of background influences in shaping meaning appear in the concept of discourse. These background influences are often implicit, but powerful factors which are posited by sociocultural theories of language to shape the overall meaning and intention of a discourse.

Common to sociocultural theories of language is the idea that the terms of exchange take their meaning, intention or purpose from the contexts in which they are used. However, any attempt to pin down or isolate what it is about a particular context that conveys meaning to the discourse situated therein can seem impossible when considering a myriad of possible features (Gee, 2014). Further, the notion of context is not restricted to any particular instance of use, but extends to all previous uses. Terms of exchange have historical context: meaning has been shaped and formed through all previous uses and continues to be reshaped by each particular instance of use. In this view, language appears to be a fluid phenomenon with innumerable factors that influence meaning (Sierpinska & Lerman, 1996).

A language games perspective is consistent with a view of learning mathematics in discursive terms. Knowing mathematics is seen to be synonymous with being able to participate in a mathematical discourse (Sfard, 2007). However, viewing this participation and recognising forms of engagement does not necessarily require that we attempt to identify definitive sources of meaning. Wittgenstein suggests that philosophical theorising about

ideas such as certainty or meaning can lead us to have unrealistic expectations about language. The idea of language games is useful in allowing us to escape the trappings of theoretical dogmatism. That is, thinking that we need to pinpoint the meaning of terms used in a mathematical discourse is based on the idea that there are direct referents for the meaning of terms. A language games perspective is not based on this idea of objectivity. Using a language games lens involves looking in an adaptable and flexible way at the meaning of mathematical communication within social contexts.

Everyday Language and Mathematical Discourse

Proponents of a view of classroom mathematical language use that recognises a broad conception of contextual meaning emphasise that natural or ordinary language use allows for less complicated assimilation of practice (Moschovich, 2019). The ease of using everyday language can be contrasted with the difficulty of learning technical or formal language. A distinction between everyday language and academic language seems straightforward. However, some researchers argue that this distinction oversimplifies the complexities of relationships between language, communication, and learning (Moschkovich, 2019). It is then recommended that everyday and school mathematical practices are not presented as a dichotomous distinction (Gutierrez et al., 2010; Schleppegrell, 2010).

While cautioning us to avoid drawing impermeable lines between everyday and mathematical language uses, Moschkovich (2019) does see value in clarifying the differences between mathematical ways of talking and formal ways of talking mathematically. Here, we are asked to open our conception to a broader view of what an authentic mathematical discourse can be in a classroom. We are encouraged to move away from a simplified view of language framed in terms of words, phrases, vocabulary or a set of definitions and expand our view of the mathematics register. The proposed shift of focus is towards reasoning rather than accuracy and towards precision as an object of inquiry rather than a requirement of engagement: "instruction should move away from interpreting precision to mean using the precise word, and instead focus on how precision works in mathematical practices" (Moschkovich, 2019, p. 6). We are asked to share a progressive view of mathematical discourse that allows language use to flourish with attention on active negotiation of meaning within mathematical situations.

Likewise, avoiding an instrumentalist view that sees mathematics and language as sets of tools or competencies that provide a means to an end can allow us to see mathematics as a way of thinking or reasoning which is part of our general existence; "the capacity to think mathematically is inseparable from the capacity to reason in general and should be seen as an essential part of the latter" (Rider, 2017, p. 504). Rejecting the assumption that a child's world is not in some way mathematical before they enter school helps to reframe our enquiry into practices of instruction; the problem of "how can mathematics instruction recognise the pupil's experience?" is misconceived from the outset. The question should rather be "how can instruction make children recognise the mathematical in their experience?" (Rider, 2017, p. 511).

The question of what constitutes a mathematical discourse could be considered pivotal for theories that see learning in discursive terms. But rather than seeing the benefit of such theories hinge on a need to define what is meant by a mathematical discourse, they can be considered useful in providing a perspective for inquiry that explores this very notion. Using the idea of language games to see students as participants in discourse practices might reveal complexities, such as the relationship between everyday and mathematical discourses. This

perspective could help teachers and researchers shift away from oversimplified views of language (Barwell, 2016). Seeing learning mathematics in discursive terms is not an attempt to provide a definitive description of a mathematical discourse, but a way to view how classroom language is actually being used within rich social contexts as students grapple with new mathematical situations.

Conclusion

Learning can be seen as the change that takes place as students become participants in a mathematical discourse. A view of learning mathematics in discursive terms emphasises the importance of patterns of social interaction and recognises progression of learning in mathematics as a move towards more uses of exploratory talk (Sfard, 2007). Exploratory talk is thought to extend learning in mathematics by allowing generative and collaborative discourse (Murphy, 2015). The adoption of dialogic pedagogies may benefit this form of classroom talk. However, overemphasis on the correct use of formal academic language can impede the development of exploratory talk in learning mathematics (Barwell, 2016). In discursive terms, rather than seeing mathematical terms as autonomous and with objective referents, the broader context of a mathematical discourse is considered to give meaning and purpose to learning. Thus, Wittgenstein's idea of language games is suggested as a useful perspective for seeing learning mathematics in discursive terms. This perspective could be useful in providing insight into the influence of a teacher's views about mathematical knowledge on the development of exploratory talk. Language games could also support the development of an expanded view of a mathematical discourse.

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