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Interaction in the Mathematics Class: The Shaping Process of Inquiry-based Learning

Stella D. Nika and Alexios V. Brailas

ABSTRACT

This paper focuses on the forms of interaction that occur in a mathematics class. It explores ways to assist students in adopting the practice of questioning and improving their ability to participate in the mathematics lesson. In particular, the study examines how the practice of student questioning can affect communication. By describing the shaping process of an inquiry-based learning class, it proposes an exploratory method to introduce students to the mathematical practice of questioning. The main outcome of the study is that the dynamic presence of student inquiry can significantly transform traditional mathematical communication in the classroom into alternative forms.

Keywords: Community of Practice, Classroom Communication, Inquiry Community, Practitioner Research.

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I. Introduction

The development of verbal interaction in the social context of the mathematics class not only affects students' cognitive structures in mathematics but also their self-perception (Franke *et al*., 2007), highlighting discussions as a key part of effective mathematics teaching (Nathan & Knuth, 2003; Stein *et al*., 2008).

The teacher's role in the formation of fertile dialogue practices is important (Kojo *et al*., 2018). However, researchers point out that the development of these practices is a difficult task, especially in the mathematics classroom (Ball *et al*., 2005). Communication in traditional classrooms is teacher-centered and characterized by the dominance of teachers' 'talk'. It is common to meet teachers who act as "dispensers of knowledge" and arbiters of mathematical "correctness," conduct "show and tell" instructions (Stein *et al*., 2008), or follow the traditional "talk and chalk" approach (Solomon & Black, 2008). They assess what pupils say, distancing themselves from learners' views and their construction (Barnes, 1976; Solomon & Black, 2008). In this way, they reaffirm authority, retain most of the speaking rights, and control both the topic and student behavior (Walsh & Sattes, 2005). These heavily controlled interactions enforce a passive role to students who are just looking for the right answer and are not engaging in processes of inquiring and exploring (Solomon & Black, 2008).

In contrast to this kind of instruction, mathematics education reform requires a shift from traditional teaching practices to alternative forms of dialogue. This alternative form highlights the student's role and give special value to their questions and initiatives (National Council of Teachers of Mathematics [NCTM], 2000). More specifically, the student's role in the communicative context of the mathematics class is "to listen, respond and ask questions to the teacher and each other, introduce problems and questions, make guesses, and present their solutions, trying to convince each other about the reliability of their assumptions, arguments and answers" (NCTM, 1991, p. 45). Students are not just expected to give answers, but also to publicly explain, justify, and defend their reasoning, listen to each other, and understand and examine other students' reasoning (Widjaja *et al*., 2010). In this context, the expected role of the teacher is that of an engineer of learning environments who orchestrates whole-class discussions in ways that advance the mathematical learning of the whole class (Stein *et al*., 2008).

The official mathematics curriculum in Greek primary education has the same orientation that emphasizes the "apprenticeship in procedures of experimentation, investigation, drafting, and control" in which students communicate by expressing themselves, reflecting on their thinking and the thinking of their peers, and cooperating in order to jointly create meaning and achieve an in-depth understanding of concepts and processes (Curriculum of Mathematics in Compulsory Education, 2011, p. 6).

Drawing on observation in a Greek primary school classroom, this paper deals with the following research question. It explores ways to facilitate the practice of questioning by students and traces the shaping process of an inquiry-based learning class. What follows is the basic theoretical background, the analysis of the case study, and final conclusions.

II. Class as an Inquiry-based Learning Community

The prospect of creating the kind of discourse practices described by mathematics education reform is daunting (Hufferd-Ackles *et al*., 2004), invigorating and challenging in terms of dealing with students' ideas and teaching them how to meaningfully participate in discussions (Kazemi & Hintz, 2014). Researchers introduce strategies and frameworks that can guide teachers' work in this area.

Wagganer (2015) proposes five strategies to support the development of meaningful math talk. Students should first understand why math talk is important and learn how to listen actively and respond. Afterwards, the teacher introduces sentence stems as tools to support student participation in discussions. It is important, then, for students to know the difference between explaining and justifying in order to share their reasoning. Finally, students are presented with an example to understand the whole process.

Stein *et al*. (2008) present a pedagogical model of five practices to handle student responses in discussions. These practices anticipate likely student responses to mathematical tasks by monitoring student responses, selecting particular students to present their mathematical views, purposefully sequencing student responses that will be displayed, and helping the class make mathematical connections between responses and key ideas.

Hufferd-Ackles *et al*. (2004) introduce a theoretical framework of four components that elaborate the development of a math talk learning community. The first component, *questioning*, shifts the role of the questioner from the teacher to the students. The second, *explaining mathematical thinking*, focuses on the correctness of answers with the teacher's assistance, then on the students' initial attempts and their fuller explanation, ending in the students' engagement in fully explaining without overt assistance. The third component is the *source of mathematical ideas*, in which a procedural teacher's presentation of the mathematics content shifts to the utilization of student thinking as part of the content. The fourth component is related to students taking responsibility for their own learning.

Chapin *et al*. (2009) present five "talk moves" as tools that teachers can use to implement classroom talk and support mathematical thinking. First of all, teachers can revoice themselves to facilitate students' thinking and understanding, ask students to restate someone else's reasoning, ask students to apply their own reasoning to someone else's reasoning by expressing their agreement or disagreement, prompt students for further participation, and use wait time to allow students to organize their thoughts.

This paper is based on theories of situated cognition, realizing learning as an active process of inquiry (Cheeseman, 2019), participation (Lave & Wenger, 1991), and acculturation (Brailas *et al*., 2015) in communities of practice. Members of a community of practice share the same objectives and develop common tools and working practices through mutual commitment and responsibility that they undertake (Wenger, 1998). Goos *et al*. (1994) convey the concept of "community of practice" in schools and use it for understanding and analyzing the mathematics class. They define the condition for creating a community of practice in the classroom and the framework of teacher-student, and student-student interaction. The transfer of the concept of "community of practice" in schools is extended by Richards (1991), who refers to classes operating as "inquiry communities," namely communities of practice in which one of the norms is an inquiry attitude of its members. Inquiry-based pedagogy can be defined as a way of teaching in which students are invited to work in ways similar to how mathematicians and scientists work (Artigue & Blomhøj, 2013). This means they have to observe phenomena, ask questions, look for mathematical and scientific ways to answer these questions, and interpret, evaluate, communicate and discuss their solutions effectively (Dorier & Maass, 2020).

A necessary presupposition for the establishment of an inquiry community in a class is student questioning that indicates their active participation in class happenings (Walsh & Sattes, 2005). The position of student questions in the mathematics class dialogue has been investigated to a limited extent, but this fact does not negate its special importance (Wong, 2012).

The prevalence of teacher-centered dialogue patterns in math classes, the lack of student questions, and the few effective verbal interactions that take place among learners (Khong *et al*., 2019) are associated with the dominance of the teacher's questions as a social norm of the class (Myhill & Dunkin, 2005).

In a detailed analysis of questioning in twenty lessons (Wragg, 1993), there were fewer than twenty questions asked spontaneously by pupils, and most of these questions were procedural and had nothing to do with the subject content. In the mathematics classroom environment, students are implicitly discouraged from formulating questions that reveal their ignorance, mainly due to the pretext of lack of time (Walsh & Sattes, 2005). Dillon (1990) argued that children are schooled to become masters at answering questions and to remain novices at asking them. Another concern is that student questions are not necessarily the kind that could lead to practical investigations without modifications (Herranen & Aksela, 2019).

Despite the possible challenges in using the students' questions in classroom inquiries, the issue of "student questioning" is closely linked to student performance in school. Students attain higher levels of thinking when encouraged to develop skills in asking questions and when provided with more opportunities for group work and dialogue with classmates about the questions posed and conclusions derived from the information presented (Brailas *et al*., 2016). Questions raised by students focus their attention on the content, activate their prior knowledge, and support their knowledge construction. The process of asking questions provides insights into a student's current understanding of a topic by revealing the quality of their thinking and conceptual understanding (Chin & Osborne, 2008). A focus on questioning increases a student's meta-cognition and develops a better understanding of mathematical concepts (Di Teodoro *et al*., 2011). Encouraging student questioning piques curiosity, arouses motivation and interest in the topic under study (Chin & Osborne, 2008), and increases their motivation to learn (Herranen & Aksela, 2019).

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III. The Shaping Process of an Inquiry-based Learning Class

This is a practitioner research case study that focuses on a class of one teacher (first author) with fifteen years of educational experience, who taught in a third-grade elementary class in Greece with twenty-five students. This study focuses on exploring the ways that students can be motivated to adopt the practice of questioning. The issue of student questioning opened a space for reconsidering the prevailing practices in the mathematics class (Vaquero & Sabella, 2018). In the context of approaching the class as a community of practice and learning of mathematics, the teacher investigated one specific issue, which was the participation of community discourse practices. In particular, she started to explore methods that could help students acquire the habit of questioning or, in other words, introduce students to mathematical practice and help them improve their ability to participate (Brown & Haberlin, 2018). As a first step, she began observing and recording the characteristics of the mathematical dialogue conducted in her class. The teacher followed the usual dialogue paths that students were accustomed to from previous traditional classes. The following classroom vignette is typical of a common mathematical dialogue conducted in the classroom. The original dialogue was in Greek and this is a translation. It comes from the area of fractions and starts with a teacher's conclusion.

> Teacher: So, in all these shapes, we split our whole into pieces, and we get one piece. Does anyone disagree? Does anyone want to say something?
> Students: No.
> Teacher: So, these fractions are telling us that we broke something in many...?
> George: Pieces.
> Teacher: Just pieces?
> Students: ...
> Teacher: Any pieces?
> John: Equal pieces.
> Teacher: In many equal pieces and we got...?
> Maria: The one or the two or the three or the six...
> Teacher: These pieces are called...
> Nick: Fractions.
> Teacher: Something different from fractions? They are called fractional...?
> Helena: Units.
> Teacher: They are called fractional units.

In this episode, students maintained a passive attitude by simply answering the teacher's questions. The teacher is the one that carries out the main mathematical thinking; she "thinks aloud" and gives all the explanations. Her questions are rather formal and rhetorical: "Does anyone disagree? Does anyone want to say something?" and she either does not expect a reply to them, or she sets them at the end of the verbal exchange after explaining her own thoughts and assessing if the views expressed are correct. In this way, she does not enable students to ask, explore, submit their own questions, or disagree with the teacher and develops their own solution strategies. The teacher coordinates and directs the dialogue, distributing the speech and contributions. The way of wording the specific questions guides the students through predetermined paths. The teacher constantly makes brief clarification questions, and with continuous guidance, leads students to the expected word or phrase. Students try to "guess" the specific word that the teacher has in mind. The validation and legitimation of knowledge are being performed by the teacher alone, with almost no participation from students. The teacher, at the end of the task, makes a summary of what has been said and draws the final conclusion about the "knowledge that students must learn." The teacher speaks more than her pupils and does not usually give students the chance to formulate their own descriptions.

These findings regarding the existing practices in the class led to the teacher changing the learning climate by establishing new norms in the class. In the following part of the article, the practices and actions of the teacher aimed to help students take ownership of the practice of "questioning," as well as indications of the degree of ownership of student inquiry behavior, are described. In order to facilitate their presentation, researchers chose a linear mode of display (Fig. 1), referring to steps, which do not take the form of "stages" that occur in a strict order. In this case, the focus is on the open developmental process carried out. Moreover, changes occur in two interrelated levels: the level of the teacher and the student. Students, influenced by the teacher's actions and expectations, appropriate new forms of behavior, and the teacher's reflection on the actions and attitudes of students shape new teaching practices in the classroom.

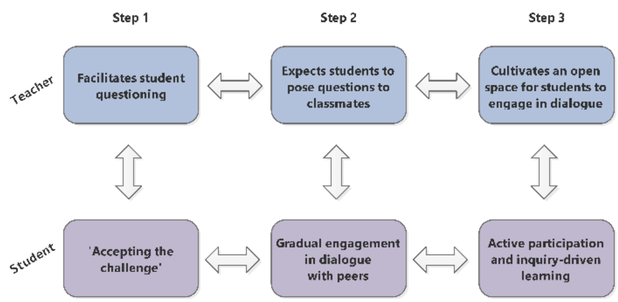

Fig. 1. The interrelated steps present expectations and practices in the inquiry-driven classroom.

As illustrated in Fig. 1, teacher and student efforts follow a long process of development for the shaping of an inquiry class. In order to establish new rules in the class, the teacher considered that she should propose points for student introduction to the "culture" of mathematical practice. So, she initially chose to support students in two ways. She motivated student questioning in the lesson by establishing a special "time for questions" and playing learning games, such as the "game of the expert," where a student was defined as the "expert," and the other classmates asked them questions related to the day's math lesson.

Simultaneously, she was discussing with students, on a card, examples of different types of questions. This form of guidance was limited to a short period. It was expected for students to submit not only clarifying questions but questions of method, reasoning, and application (Wong, 2012) that could help the progress of the mathematical task. Thus, gradually, the class norm about what constitutes a "mathematical question" started to change. Student responses in these first steps were positive. Within the framework of the "space" and the degree of freedom provided, students increased the number of their questions during points for participation in the course, initially in a mechanistic way but later full of enthusiasm, excitement, and growing interest due to the playful form that these actions took.

A second goal set by the teacher was linked to the development of internal communication among students — the teacher expected students to pose questions to their classmates that expressed an opinion. Questions had to focus on a specific point that needed to be explained or justified and not on a vague view. The teacher provided more time to students who stopped using the card with the examples of the questions and started a gradual involvement in the dialogue with their peers. Students attended more carefully to their peers' views, asked questions, and engaged in the dialogue, seeking clarifications and explanations. In this way, students co-created an inquiry climate where mathematical ideas were subject to meaningful feedback and the "judgment" of the other class members.

Afterwards, the teacher's efforts were directed to engaging students in whole-class discussions. She gave students more "space and time" to think, pose questions, participate in the dialogue, and take the initiative. She was consciously withdrawn from the scene, giving priority to the students. She reduced her own questions, posing exploratory and less prescriptive questions (Mason & Wilder, 2004). She positively evaluated student contributions and renegotiated with students the class norms.

Within the open-class climate that was established, students participated actively in the dialogue, and questioning turned into a spontaneous and authentic investigation instigated by the genuine interest of students to hear other views and engage in mathematical discussion. Gradually, the form of the dialogue conducted in the class changed. The next excerpt is an attempt to capture the dialogue's evolution and study the changes that have occurred. The excerpt is from the teaching area of fractions and decimals. Students are talking about a classmate's attempt to compare decimal numbers, ordering them from smallest to greatest. They are looking to find the error in the following order:

$$1.1 < 12.0 < 31.3 < 48.0 < 102.0 < 0.6768$$

Teacher: Does anyone wish to comment on Sofia's reply?
Maria: Sofia, I cannot understand why you put the numbers in that order.
Helen: Me neither.
Maria: Can you explain it to me?
Sofia: I have tried to figure out the biggest and then put them in order.
Johana: How did you find the biggest?
Sofia: … (she does not reply)
George: I think that Sofia was influenced by the length of the number and considered that the largest number is the longest one.
John: I believe that Sofia has not understood that the value of each digit depends on its order in the number. I mean that the zero in the last decimal number, 0.6768, which is placed before the decimal point does not have the same value as the zero in the previous number, 102.0. where zero is placed after the decimal point.
Sofia: Do you mean that the error is in the last decimal number?
John: Yes.
Sofia: I see it. The last number is not the largest. I should pay attention to the integer part of the decimal.
John: That's right.
Sofia: So, the last number is the smallest because the integer part of the decimal is zero.
Teacher: Does anyone have something to add?

In the above excerpt, we observe characteristic features of an alternative form of mathematical interaction. In particular, the conduct of the participation and contribution of the class members, made by the teacher, is assigned to students and follows the conditions created by the evolution of the dialogue. The alternation of speakers in the dialogue is carried out naturally, without students having to seek permission from the teacher in order to ask a question or take the floor. Students are actively involved in meaningful mathematical activity and explain and justify their views. They pose questions, creating an atmosphere of inquiry in the classroom. Disagreement is expected, completely accepted by the students, and supports the collective construction of mathematical meaning. Questions and comments of classmates are perceived as alternative contributing views on the matter, the investigation of which is of particular interest. The final conclusion to a mathematical task is derived from students while the teacher just follows the discussion.

IV. Concluding Remarks

The original form of interaction in the mathematics class described above revealed that students were expected to "learn mathematics" and not to "do mathematics," adopting a passive role with minimal involvement in the emerging class dialogue. In the context of the (re)shaping process of the inquiry class, the form of the interaction changed from teacher-centered to student-centered, facilitating interaction among students (Brailas *et al*., 2017), and "planning time for children to pose and to solve their own problems, and watching and listening but intervening only to inspire children's mathematical investigations" (Cheeseman, 2019, p. 11).

The procedure of transforming a traditional mathematics class can be a particularly challenging process for a teacher who is constantly experimenting to improve their teaching. Practitioner research in this direction can provide practical ideas and the shaping process of the inquiry-based learning class that was presented in this paper attempts to provide helpful insights toward this direction. The presented strategy employs "student questioning" to set the stage for meaningful dialogue and stimulate students to move from the sidelines to the forefront of the mathematics class. Other teachers could build on it and extend it based on the specific situations in their classes. What this research suggests is that any teaching strategy is always in the becoming, a developmental process of actions aiming to facilitate students to take responsibility and become the creators and administrators of their own math learning.

Future research should explore other aspects of questioning as well, as there is a wide variety of ways to include student questions in inquiries. An issue that would be of particular practical interest is the required degree of guidance teachers should provide to create a questioning environment where students have a crucial role in orchestrating the whole inquiry process. The teacher's role in this procedure is complex and requires further investigation. Nevertheless, adopting an inquiring stance (Currin, 2019) enables educators to transform their teaching toward a more student-centric and participatory classroom.

References

Aksela, M. (2019). Towards student-centered solutions and pedagogical innovations in science education through co-design approach within design-based research. *Lumat: International Journal of Math, Science and Technology Education,* 7(3). https://doi.org/10.31129/LUMAT.7.3.421.

Artigue, M., & Blomhøj, M. (2013). Conceptualizing inquiry-based education in mathematics. *ZDM,* 45(6), 797–810.

Ball, D. L., Goffney, I.M., & Bass, H. (2005). The role of mathematics instruction in building a socially just and diverse democracy. *The Mathematics Educator*, 15 (1), 2–6.

Barnes, D. (1976). *From communication to curriculum.* Harmondsworth, England: Penguin.

Brailas, A., Avani, S., Gkini, C., Deilogkou, M., Koskinas, K., & Alexias, G. (2017). Experiential Learning in Action: A Collaborative Inquiry. *The Qualitative Report*, 22(1), 271–288. https://doi.org/10.46743/2160-3715/2017.2551.

Brailas, A., Koskinas, K., & Alexias, G. (2016). Design and implementation of a web-based system to support collective reflective practice. *International Journal of Designs for Learning*, 7(3), 95–104. https://doi.org/10.14434/ijdl.v7i3.18864.

Brailas, A., Koskinas, K., Dafermos, M., & Alexias, G. (2015). Wikipedia in Education: Acculturation and learning in virtual communities. *Learning, Culture and Social Interaction*, 7, 59–70. https://doi.org/10.1016/j.lcsi.2015.07.002.

Brown, B., & Haberlin, S. (2018). Engaging in Practitioner Inquiry and Critical Dialogue to Explore Student Engagement in a Fifth-Grade Classroom. *Journal of Practitioner Research*, 3(1). https://doi.org/10.5038/2379-9951.3.1.1062.

Cazden, C. B. (2001). *Classroom Discourse*: *The Language of Teaching and Learning (2nd edition)*. Portsmouth: Heinemann.

Chapin, S. H., O'Connor, C., O'Connor, M. C., & Anderson, N. C. (2009). *Classroom discussions: Using math talk to help students learn, Grades K-6.* Math Solutions.

Cheeseman, J. C. (2019). Young Children are Natural Inquirers: Posing and Solving Mathematical Problems. *Waikato Journal of Education*, 24(2), 11–22. https://doi.org/10.15663/wje.v24i2.664.

Chin, C. & Osborne J. (2008). Students' questions: a potential resource for teaching and learning science*. Studies in Science Education,* 44:1, 1–39. https://doi.org/10.1080/03057260701828101.

Cobb, P., Wood, T., & Yackel, E. (1991). A Constructivist Approach to Second Grade Mathematics. In E. Von Glasersfeld (Ed.), *Radical Constructivism in Mathematics Education* (pp. 157–176). Springer Netherlands. https://doi.org/10.1007/0-306-47201-5_8.

Currin, E. (2019). From Rigor to Vigor: The Past, Present, and Potential of Inquiry as Stance. *Journal of Practitioner Research*, 4(1). https://doi.org/10.5038/2379-9951.4.1.1091.

Dillon, J. T. (1990). *The practice of questioning*. Routledge.

Dillon, J. T. (1988). *Questioning and teaching: A manual of practice*. Croom Helm.

Di Teodoro, S., Donders, S., Kemp-Davidson, J., Robertson, P., & Schuyler, L. (2011). Asking good questions: Promoting greater understanding of mathematics through purposeful teacher and student questioning. *The Canadian Journal of Action Research*, 12(2), 18–29.

Dorier, J. L., & Maass, K. (2020). Inquiry-based mathematics education. *Encyclopedia of Mathematics Education.* 384–388.

Franke, M. L., Kazemi, E., & Battey, D. S. (2007). Mathematics teaching and classroom practices. In F. K. Lester Jr. (Eds*.), The second handbook of research on mathematics teaching and learning* (pp. 225–256). Charlotte, NC: Information Age.

Hufferd-Ackles, K., Fuson, K. C., & Sherin, M. G. (2004). Describing level and components of a math-talk learning community. *Journal for Research in Mathematics Education,* 35(2), 81–116.

Herranen, J. & Aksela, M. (2019). Student-questionbased inquiry in science education, *Studies in Science Education*, 55:1, 1–36. https://doi.org/10.1080/03057267.2019.1658059.

Goos, M., Galbraith, P., & Renshaw, P. (1994). Collaboration, Dialogue and metacognition: The mathematics classrooms as a community of practice. In Bell, G., Wright, R. Leeson, N., and Geake, J. (Eds.), *Proceedings of the Seventeenth Annual Conference of the Mathematics Education Research Group of Australasia*, Lismore, Australia: Mathematics Education Research Group of Australasia.

Kazemi, E., & Hintz, A. (2014). *Intentional talk: How to structure and lead productive mathematical discussions.* Stenhouse Publishers.

Khong, T. D. H., Saito, E., & Gillies, R. M. (2019). Key issues in productive classroom talk and interventions. *Educational Review,* 71(3), 334–349.

Kojo, A., Laine, A., & Näveri, L. (2018). How did you solve it? – Teachers' approaches to guiding mathematics problem solving. *Lumat: International Journal of Math, Science and Technology Education,* 6(1). https://doi.org/10.31129/LUMAT.6.1.294

Lave, J., & Wenger, E. (1991). *Situated learning: legitimate peripheral participation*, Cambridge: Cambridge University Press.

Mason, J., & Wilder S. (2006). *Designing and using mathematical tasks.* Tarquin.

Ministry of Education (2011). *Curriculum of Mathematics in Compulsory Education.* Athens.

Myhill D., & Dunkin F. (2005). Questioning Learning, *Language and Education*, 19 (5), 415–427.

Nathan, M. J., & Knuth, E. J. (2003). A study of whole classroom mathematical discourse and teacher change. *Cognition and Instruction*, 21(2), 175–207. https://doi.org/10.1207/S1532690XCI2102_03.

National Council of Teachers of Mathematics (1991). *Professional standards for teaching mathematics*. Reston, VA: National Council of Teachers of Mathematics.

Richards, J. (1991). Mathematical discussions. In E. von Glaserfeld (Ed.), *Radical constructivism in mathematics education* (pp.13-51). Kluwer Netherlands.

Solomon, Y., & Black, L. (2008). Talking to learn and learning to talk in the mathematics classroom. *Exploring Talk in Schools* (p. 73–90).

Stein, M. K., Engle, R. A., Smith, M. S., & Hughes, E. K. (2008). Orchestrating productive mathematical discussions: Five practices for helping teachers move beyond show and tell. *Mathematical Thinking and learning,* 10(4), 313–340.

Vaquero, A., & Sabella, L. (2018). A Pre-Service Math Teacher's Analysis of Practice through the Lens of Research. *Journal of Practitioner Research*, 3(1). https://doi.org/10.5038/2379-9951.3.1.1071.

Wagganer, E. L. (2015). Creating math talk communities. *Teaching Children Mathematics,* 22(4), 248–254.

Walsh, J. A., & Sattes, B. D. (2005). *Quality Questioning: Research-based practice to engage every learner.* Corwin.

Wenger, E. (1998). *Communities of Practice: Learning, meaning and identity.* Cambridge: Cambridge University Press.

Widjaja, W., Dolk, M. and Fauzan, A. (2010). The role of contexts and teacher's questioning to enhance students' thinking, *Journal of science and mathematics education in Southeast Asia*, 33(2), 168–186.

Wong, K. (2012). Use of student mathematics questioning to promote active learning and metacognition, *12th International Congress on Mathematical Education*, 8 July – 15 July, 2012, COEX, Seoul, Korea.

Wragg, E. C. (1993). *Classroom Teaching Skills*. Routledge.

Wragg, E. C., & Brown, G. (2001). *Questioning in the secondary school.* Routledge.

Yackel, E. & Cobb, P. (1996). Sociomathematical norms, argumentation, and autonomy in mathematics, *Journal for Research in Mathematics Education,* 27, 458–477.

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