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Critical Mathematics Education: A Dialogic Approach to Mathematics Education

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Abstract

This article aims to investigate the ways in which secondary mathematics can be taught through a dialogic pedagogy. It is part of Ph. D study which was a study of critical mathematics education oriented towards critical citizenship and democracy. The articles indicates that a dialogic teaching of mathematics is possible if it is integrated with collaborative learning and inquiry-based education.

Keywords: Critical Mathematics Education, Critical Pedagogy, Dialogic Pedagogy, Collaborative Learning, Communicative Rationality

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INTRODUCTION

This paper aims to report findings of the research aimed at investigating the ways in which collaborative and dialogic mathematics education can be facilitated to help students to become critical citizens (Avcı, 2017). This longitude study was conducted in the 2015-16 school year in a high school mathematics classroom. It involved a year-long mathematics class with 28 students, aged 14 to 17. Included in this study is data collected from student journals and presentations, as well as field notes and reflective journal.

The research draws on critical theory and critical participatory action research in a public high school math classroom to investigate possibilities and limitations of (CME) critical mathematics education and dialogical teaching of mathematics in the era of standardization and corporatization. The article presents findings of the current research in the light of the literature (mostly theoretical studies) oriented towards dialogical pedagogy.

Dialogue in relation to Collaboration, and Inquiry in Mathematics Classrooms

There has been an increasing emphasis on the importance of dialogue for quality of education 'due to growing frustration at the dehumanising effects of the "standardisation and achievement" approach' driven by neoliberal policies (Aloni, 2013, p. 6). The term dialogue is widely used in a variety of contexts across the education literature and may lead to confusion and misconception about its implications. Therefore, it is necessary to distinguish the concept of dialogue in the context of critical (mathematics) education from traditional approaches to dialogue. Dialogue as a pedagogy takes centre stage in Freire's work and provides a solid foundation for its implications for education. Habermas's theory of communicative action—oriented towards non-dominating communication—provides a complementary framework to consider dialogue as an essential component of emancipatory pedagogy.

Empirical research indicates that in mathematics and science education, teachers tend to use authoritative (non-dialogical) talk, as it makes it easy to transmit axioms and theorems (Alexander, 2005; Mortimer & Scott, 2003; Scott, Mortimer, & Aguiar, 2006). Although this may be justified in the context of instrumental rationality, it raises an important question from the standpoint of CME; namely, to what extent is authoritative (non-dialogical) teaching acceptable in the mathematics classroom? In the CME literature, dialogical teaching is strongly emphasised, but CME writing is mostly theoretical and lacks classroom-based examples, Avcı (2019) working in the high school mathematics classes, go some way to address this gap by providing empirical examples of the dialogic approaches in teaching secondary mathematics lessons.

Approaches to dialogue in education come from two main philosophical-ideological perspectives. As Nicholas and Bertram (2001) explain:

> The contemporary vision of dialogue as a pedagogy that is egalitarian, open-ended, politically empowering, and based on the co-construction of knowledge, reflects only certain strands of its history. Contrasting accounts see dialogue as a way of leading others to pre-formed conclusions; or as a way for a master teacher to guide the explorations of a novice; or as a set of ground rules and procedures for debating the merits of alternative views. (p. 1102)

This statement divides dialogical approaches into two main lines of ideologic-philosophical viewpoints. Dialogue as communicative rationality (the contemporary vision) and dialogue as instrumental rationality (the contrasting account). The theoretical underpinnings of the present study, complementary with Freire and Habermas's ideas, are inspired by the former strand, which embraces dialogue as communicative rationality. From this point of departure, dialogue as pedagogy is endorsed because it democratically promotes horizontal teacher-student relationships; it opens up possibilities by promoting critical and creative thinking; it is liberating by helping students to develop communicative competency and critical consciousness; it is a collaborative process through which students can learn with and from each other. The essence of this approach is that it seeks ways of establishing non-dominating communications and relationships in an educational context oriented towards critical literacy and humanising education. Dialogue, hence, is not only an effective way of learning, but also an end in itself. As such, Freire considers dialogue to be an existential necessity (Freire, 2000).

However, the 'contrasting account' sees dialogue through a lens of technical (instrumental) rationality, considering it to be an effective way to transmit pre-packaged knowledge to students. Habermas (1984) considers this form of communication, in which a pre-set agenda is imposed on learners, as distorted; similarly, Freire defines it as 'banking' education—an oppressive pedagogy in which an anti-dialogical process disseminates dehumanising education (Darder, 2002; Freire, 2013; McLaren & Kincheloe, 2007; Shor, 1987).

Rogers (1995) advocates that teachers adopt a facilitative attitude, as opposed to an authoritarian one, and thereby create a liberating classroom environment. He distinguishes between dialogic and traditional classrooms. According to Rogers, in traditional education,

•The teachers are the possessors of knowledge, and the students the expected recipients.

•The lecture, or some means of verbal instruction, is the major means of getting knowledge into the recipient. The examination measures the extent to which the students have received it. These are central elements of this kind of education.

•The teachers are the possessors of power, the students the ones who obey.

•Rule by authority is the accepted policy in the classroom.

•Trust is at a minimum.

•The subjects [students] are best governed by being kept in an intermittent or constant state of fear.

•Democracy and its values are ignored and scorned in practice.

•There is no place for whole persons in the educational system, only for their intellects. (pp. 295–297)

However, Rogers (1995) also articulates a 'person-centred' education which draws on a dialogic approach, as follows:

•Teacher as authority figure should be 'sufficiently secure' within herself /himself 'in relationship to others' to generate trust.

•The teacher, as facilitator, shares 'responsibility of learning' with students.

•The teacher designs inquiry-based projects derived from students' life.

•The students organise their own learning project [collectively or individually].

•An atmosphere that is conducive to learning from and with each other.

•Learning how to learn is the main focus.

•A facilitative classroom environment that promotes self-discipline, refection, and learning which tends to be deeper. (pp. 299–301)

Although these clarifications draw a thick line between two interpretations of dialogue, they raise an important question in context of CME. In mathematics classrooms, can direct teaching or lecturing be done through a liberating dialogue, when students are introduced to a new concept or subject? More specifically, how can a mathematics teacher avoid 'banking education' as she teaches a mathematical axiom or theorem, for which the lecture is often a preferred teaching method? The findings of the current research is consistent with that of Nicholas and Bertram (2001) who argued that a lecture (direct teaching) could be structured dialogically.

In a comparative international project concerned with the dimensions of classroom talk, Alexander (2001, 2015) found that dialogical teaching is rare in classroom interactions. Instead, teacher practices mostly involved strategies such as rote memorisation, repetition, recitation, and direct instruction. These types of talk usually lead to instructional moves formalised as initiate-respond-evaluate (IRE) and initiate-respond-feedback (IRF). This finding replicated research conducted in the U.S. by Mehan (1979). In a comprehensive analysis of classroom talk, Freiberg and Freebody (1995) demonstrated the limitations that an IRE interactive structure places on the

interactive potential of students. Alexander (2015) argued that although IRE and IRF might teach students some analytical skills, they do not foster critical literacy and they draw on instrumental rationality.

Dialogic interaction has been shown to be a key in children's development of thinking and understanding. Its implications extend across at least five domains: neuroscientific, psychological, sociocultural, political, and communicative (Alexander, 2001). From this point of view, Alexander (2015) argues that

> Rote, recitation, instruction, and exposition are frequently used: indeed, worldwide they are probably the default modes of teaching talk. There is always a place for them, but discussion and dialogue are less common, and children need to experience them much more frequently. Discussion and dialogue require learners not merely to listen and answer, but also to think, engage and take decisions about their learning. By using discussion and dialogue we seek to empower learners both cognitively and socially, not merely to tell them things or test what they know already. (p. 3)

Nystrand (1997) and Edwards-Groves, Anstey, and Bull (2014) agree that a more dialogic approach to instruction motivates and engages students since it values students' contribution to the learning process, evokes interest in students' thoughts, and makes them feel included. Alexander (2015) acknowledges pedagogic implications of dialogic teaching, arguing that the dialogical approach is much better than the 'best-practices' paradigm imposed by the neoliberal educational movement. But he considers non-dialogical (authoritative) approaches as a necessary part of dialogical classrooms.

A similar approach is put forward by Mortimer and Scott (2003). In their view, authoritative classroom discourse is appropriate when mathematics and science teachers introduce new concepts or topics, but when students' ideas and views are being exposed informally, a dialogic approach is more appropriate. This perspective is based on instrumental rationality and can therefore produce functional literacy only. However, when Mortimer and Scott (2003) suggest that authoritative talk is inevitable in dialogic classrooms, they pose a conundrum that CME has to deal with, both theoretically and practically. The findings from the current research address to this issue indicating that teaching mathematics by nature can be directive and must include lecturing as well; as long as being directive does not evolve into manipulation and authoritarianism, it would not contradict with dialogical teaching of mathematics (Avcı, 2019). This finding is aligned with Darder's (2012) point.

Researchers suggest different ways to assess whether teaching is dialogic or not. Burbules (1993) proposes two criteria for dialogic teaching: (a) Is the lesson critical and inclusive? (b) Is the lesson oriented towards a single answer, or does it allow students to make their own interpretation?

Alexander (2015) outlines a more comprehensive perspective, suggesting five criteria for dialogic teaching (of mathematics):

•Collective: Participants address learning tasks together.

•Reciprocal: Participants listen to each other, share ideas, and consider alternative viewpoints.

•Supportive: Pupils express their ideas freely, without fear of embarrassment over 'wrong' answers, and they help each other to reach common understandings.

•Cumulative: Participants build on answers and other oral contributions and chain them into coherent lines of thinking and understanding.

•Purposeful: Classroom talk, though open and dialogic, is also planned and structured with specific learning goals in view. (p. 4)

Alexander (2015) does not provide any consistent philosophical background for his criteria, but combining these five conditions, it can still be concluded that dialogue in classroom is not simply a conversation. Dialogue is therefore considered a much more comprehensive approach to teaching and learning. Even informed by instrumental rationality, classroom talk should have certain characteristics to be considered dialogue. Even though Alexander (2015) does not address asymmetrical power relations between students and teacher, and does not think of critique as an educational task, a theory of critical education would not necessarily disagree with his proposal, but it would pose a fundamental question: What if students reach a common understanding through a free discussion and that common understanding is in contrast with the official or dominant understanding in a given society? There is no glimmer of an answer to this question in Alexander's approach.

Drawing on theories of Habermas, Freire, and Vygotsky, Flecha (2000) proposes seven criteria for an interaction to be a dialogic learning: egalitarian dialogue, cultural intelligence, transformation, instrumental dimension, creation of meaning, solidarity, and equality of differences. From this standpoint, dialogue as pedagogy generally aims to transform individuals and society, rather than helping students to passively adapt to existing conditions. This perspective differentiates dialogue based on communicative rationality from dialogue based on technical or instrumental rationality. However, Flecha (2000) indicates that dialogical learning does not reject the instrumental dimension of knowledge. For example, students in algebra class need the quadratic formula to solve second-degree equations. A dialogical stance is not against learning this formula; instead, it problematises ways in which the formula is taught and learned.

Along these lines, Darder (2002), in Reinventing Paulo Freire, engages Freire's notion of teacher directivity or the directive nature of education. She quotes Freire as follows:

> All educational practice is directive by its very nature, the question the coherent progressive educators must deal with is what do they need to do to diminish the distance between what

> they say and they do as not to allow directivity into authoritarianism or manipulation. (Freire, 1993, p.116)

Elaborating on Freire's assertion, Darder (2012) writes:

> Rather than placing emphasis strictly on the directive quality of instructional methods (e.g., lecture, worksheets, vocabulary list, science manuals, etc.) that may be employed for the introduction of required content in different subject areas—an absolutely legitimate and necessary component of teaching and learning—a revolutionary practice is concerned with the underlying intent and purpose of knowledge that is being presented and the quality of dialogical opportunities by which students can appropriate the material to affirm, challenge, and reinvent its meaning in the process of knowledge production. (p. 114)

A dialogic classroom implies interactions not only between the teacher and students, but also among peers. This brings us to a point at which inquiry-driven and collaborative learning approaches need to be incorporated into the dialogic classroom. In critical pedagogy, according to Shor (1987, p. 95), dialogue is both 'the form of study' and 'a democratic model' of teacher-student and peer relationships. Dialogic teaching and learning are closely associated with collaborative and inquiry-based education, in which dialogue takes place between students and teacher and among students (Shor, 1987). The results from the current research suggest that dialogical teaching of mathematics cannot happen without collaborative and inquiry-based learning (Avcı, 2019).

There are theoretical approaches that triangulates dialogue, collaboration and inquiry driven education—such as Vygotsky's social constructivist learning theory—that combine dialogue, collaboration, and inquiry in a classroom. Vygotsky (1978) introduced the concept of the zone of proximal development (ZPD), which is crucial to understand the dynamic in classrooms where students are engaged in inquiry-based learning, and knowledge is constructed collaboratively (Skovsmose & Alrø, 2004). According to ZPD theory, a student's intellectual abilities drastically differ when performing alone compared to when performing with the assistance of the teacher or a more competent classmate in small-group work. The concept of ZPD has evolved with contributions of many educators, thinkers, and researchers. Specifically referring to peer interaction in mathematics classrooms, Cesar (1998) suggests that ZPD can happen even without a more competent peer in the group.

Working in each other's ZPD, students learn with and from each other. The relationship between students and teacher is similar. As Wells (1999) indicates, ZPD shifts the teacher from being 'primarily a dispenser of knowledge and assigner of grades' to 'a fellow learner whose primary responsibility is to act as leader of a community committed to co-construction of knowledge'; in short, the teacher also learns with and from their students (p. 331). This aligns with Freire's notion of horizontal student-teacher relations. Wells (1999) summarises the significance of ZPD:

•'It is constructed in the interaction between participants in the course of their joint engagement in a particular activity'.

•It creates an educational ambiance in which each can learn with and from others.

•ZPD 'leads to development of identity as well as of skills and knowledge'. The quality of the interaction between students is crucial. 'Learning will be successful when it is mediated by interaction that expresses mutual respect, trust and concern'.

•Learning in the ZPD leads to both individual and societal transformation as each one is dialectically connected to the other one. ZPD does not aim at a fixed or pre-determined end. 'The ZPD is thus a site of conflict and contradiction as well as of unanimity; the transformation it engenders leads to diversity of outcome which may radically change as well as reproduce existing practices and values' (p. 333).

These dimensions lead to the conclusion that ZPD provides a solid framework for critical mathematics teachers as they develop and teach lessons that are inspired by a more dialogic approach, engage in collaborative study to co-construct knowledge, and use inquiry as a way of dealing with uncertainty. Wells (1999) considers communities of inquiry as 'joint-will' to find answers to shared questions: 'The aim of inquiry is not knowledge for its own sake, but disposition and ability to use the understandings so gained to act informally and responsibly' (p. 121). In this sense, a community of inquiry fosters individual and social agency as they are dialectically connected. Inspired by Vygotsky's theory, Kennedy (2009) argues that through dialogue, inquiry, and collaboration, a mathematics classroom can become a community of inquiry. The findings from the current research corroborates the argument of Kennedy (2009) that dialogic pedagogy, collaborative learning and inquiry-based education should be oriented towards transforming classroom into a community of learners to make critical mathematics education sustainable teaching practice (Avcı, 2019). Turning a mathematics classroom into a community is central to dialogic teaching.

In this approach, collaboration and dialogue are not seen as instrumental tools to improve learning—dialogue is the end in itself, as it is in Freire's dialogic pedagogy. Kennedy (2009) elaborates on this inquiry system further, arguing that community of inquiry theory can help to create conditions for the 'ideal speech situation' as defined by Habermas (1990). From this perspective, as Flecha (2000) points out, dialogic learning requires egalitarian and reflexive dialogue between the teacher and students, as well as among students. When knowledge is constructed by a course of communication, it draws on a validity claim, not a power claim.

These ideas date back to the work of educationalist and philosopher John Dewey (1916). Dewey envisioned inquiry as an essential part of an education that would help students become competent democratic citizens. He explicitly criticised transmission styles of education: 'Education is

not an affair of "telling" or being told, but an active construction process' (p. 38). Dewey envisioned inquiry as a collective activity and a process of becoming members of a community.

As for potential obstacles to dialogic pedagogy, Flecha (2000) anticipates three factors that may prevent dialogue: cultural, social, and personal. That leads to another question: How do we overcome these barriers? Unfortunately, there is not enough research to answer following practical questions: What if an individual student in a group self-assigns him- or herself as leader? What kind of skills, values, and knowledge do students need in this process? How do we consider power relations among students in the class? What consideration, if any, should be given to the physical organisation of the classroom? How should students be grouped, and by what criteria? Is peer tutoring regarded as collaboration or not? These results from the current study provides relatively satisfying answers to these questions (Avci, 2019). However, more research in different contexts are needed to provide more comprehensive answers to these important questions.

Rogers (1995) argued that collaborative learning could occur in a community of learners when there is dialectical connection between individuals and the community:

> The sense of community does not arise out of collective movement, nor from conforming to some group direction. Quite the contrary. Each individual tends to use the opportunity to become all that he or she can become. Separateness and diversity—the uniqueness of being 'me'—are experienced. (p. 190)

The type of community Rogers (1995) described is one that differs from a herd, which is formed by collective compliance. In his view, a teacher's facilitative attitude—as opposed to an authoritarian attitude—plays a significant role in creating such a community of learners:

> When teachers are empathically understanding, their students tend to like each other better. In an understanding classroom climate, every student tends to feel liked by all the others and has more positive attitudes towards self and school. This ripple aspect of the teacher's attitude is proactive and significant. (p. 161)

Alexander (2006) classroom-based research showed that when learning activities were collaborative rather than competitive, whole-class discussions and dialogical teaching were most effective: A classroom ambiance that generates a feeling of collaboration nurtures dialogical interaction. The results from the current research over collaborative learning are consistent with that of Kohn (1992) who elaborates this argument in his seminal book, *No Contest: The Case against Competition*. He explains that competitive learning undermines students' self-esteem, confidence, and overall development. Competitive learning generates anxiety and encourages students see their peers as obstacles to their success. This eventually creates a toxic environment that is not conducive to humanising education. Kohn also acknowledges that competition in the U.S., in education and other

domains of life, has become a kind of sacred belief imposed by the state. He argues that competitive learning does not serve the needs of students as human beings.

Similarly, Hooks (2003) consider competitive learning as dehumanising. In her view, competitive learning creates an atmosphere where the sense of community and solidarity is lost:

> Competition in the classroom disrupts connection, making closeness between teacher and students [and peer relationships] impossible…. Competition rooted in dehumanising practices of shaming, of sadomasochistic rituals of power, preclude communalism and stand in the way of community. (p. 131)

Moreover, Hooks (2003) concludes that competition in the classroom may result in atomised individuals and selfish consumers—just as envisioned in neoliberal ideology.

Skovsmose and Alrø (2004) conducted classroom-based research in a secondary mathematics classroom in Denmark, as part of the research initiated by the Centre for Research in Learning Mathematics, to investigate connections between qualities of communication and qualities of mathematics learning. They concluded that dialogue cannot be separated from action, and therefore they put forward an inquiry community (IC) model—a critical approach to communication in the classroom that resonates with dialogic teaching. According to the IC model, dialogue as inquiry in a mathematics classroom aims to challenge the traditional, non-critical approach to mathematics education. The IC model (Skovsmose & Alrø, 2004) includes elements such as the following:

1. Getting in contact: as an entry stage of inquiry, students know and confirm each other.
2. Identifications of mathematical ideas.
3. Answering why-questions.
4. Reflections through thinking aloud.
5. Reformulation of collaborative understanding.
6. Challenging though hypothetical questions.
7. Evaluation.

Skovsmose and Alrø (2004) stated that the empirical evidence did not prove their hypothesis, but their classroom observations still guided them to certain conclusions. The IC model represents a set of dialogical actions in the mathematics classroom: ‘Such an act involves making an inquiry, running a risk, and maintaining equality’ (Skovsmose & Alrø, 2004, p. 15).

Skovsmose and Alrø (2004) point out that the dialogic approach runs the risk of unpredictability of direction in the classroom; it ‘can stir up emotional problems as well as cause enjoyment’ (p. 122). Equality is an interpersonal relationship essential for dialogue, because ‘in a

dialogue, there is no demonstration of power' (p. 124). In this view, dialogical teaching and learning reconnect mathematics education with democracy, in the sense of Dewey: 'the significance of dialogic teaching and learning in mathematics has to do with the critical relationship between mathematics education and democracy. Dialogic teaching and learning are significant for classroom practice that supports a mathematics education for democracy' (Skovsmose & Alrø, 2004, p. 136; emphasis in original).

CONCLUSION

The current study is aligned with the findings of existing research concerning the importance of a dialogic approach to mathematics education. Further, the study provided data allowing us to reinterpret the existing literature to distinguish dialogic pedagogy in CME that draws on communicative rationality from other dialogues that draw on technical (instrumental) rationality (Avci, 2019). Dialogic pedagogy in CME should be egalitarian, which is crucial for an inclusive process of teaching and learning. Dialogic pedagogy in CME should be structured through inquiry-driven learning materials to create communicative space in the classroom. To be motivational, these materials must reflect students' lived experiences; because they focus on significant issues, they act as catalysts to open spaces for unpopular ideas to be considered. Based on the results from the current research, a dialogic approach, which draws on communicative rationality, to mathematics education can be framed as follows: a) Dialogue should be egalitarian, non-hierarchical, and not authoritative. b) Dialogue should be an end in itself, rather than instrument of something else. c) Dialogue should aim for transformation, not adaptation.

In the final analysis, this study created small openings in a high school classroom and initiated an egalitarian community of mathematics learners. By doing so, it showed that a classroom could be transformed into a community of learners and thus authoritarian and non-dialogical pedagogy could be countered. With the creation of many more small openings, these promising results could be expanded to show that a dialogic teaching of mathematics and a more democratic education is possible, even within educational conditions that are contradictory to the larger emancipatory vision of critical mathematics education.

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