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Social Constructivism: Does it Succeed in Reconciling Individual Cognition with Social Teaching and Learning Practices in Mathematics?

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Abstract

This article examines the literature associated with social constructivism. It discusses whether social constructivism succeeds in reconciling individual cognition with social teaching and learning practices. After reviewing the meaning of individual cognition and social constructivism, two views –Piaget and Vygotsky's- accounting for learning from social constructivist perspectives including the differences and similarities between them are argued. This paper also reviews some research that is conducted from a social constructivist perspective.

Keywords: mathematics education, social constructivism, teaching and learning, educational psychology.

1. Introduction

Since the philosophy of mathematics is a main epistemological concern in learning and teaching (Ernest, 1990), there is an argument about the need for an alternative to the traditional absolutist philosophies (Ernest, 1990; Ernest, 1993; Confrey, 1990), which propose that the knowledge occurs outside the mind of the knower (Jaworski, 1994). Thus, constructivism, which is a theory of learning claiming that knowledge is built or constructed actively, (Fox, 2001) has become one of the main research paradigms in mathematics education (Ernest, 1996; Confrey, 1990). Constructivists are mainly influenced by Jean Piaget who is regarded to be one of the most significant early supporters of a constructivist approach to comprehending learning and for whom the individual is the essential part in meaning-making (Lerman, 1996). According to Piaget, knowledge of the world is not found, but made (Bruner, 1997).

From the constructivist point of view, learning is considered as the process of mental construction whereby the individual adds new information onto a constructed understanding and knowledge (Pritchard, 2009). Confrey (1990) describes constructivism "a theory about the limits of human knowledge, a belief that all knowledge is necessarily a product of our own cognitive acts" (p. 108). She argues that the world cannot be apprehended directly in the objectivist's sense; individual's understanding is constructed by way of their experiences.

Although there is a general belief about the existence of various types of constructivism, both radical and otherwise, the main emphasis has been on the radical form by Ernst von Glasersfeld, which focuses on the individual aspects of learning (Ernest, 1993). On the basis of Piaget's 'cognitive adaptation', von Glasersfeld presents the two principles of 'radical' constructivism (Jaworski, 1994).

- "Knowledge is not passively received but actively built up by the cognizing subject;
- The function of cognition is adaptive and serves the organization of the experiential world, not the discovery of ontological reality."

(von Glasersfeld, 1989, page 182)

He pointed out that the first principle would be superficial in the absence of the influence of the second principle. Therefore, acknowledgment of just the first principle is regarded as 'trivial constructivism'. However, the second principle as well as first one is necessary for radical constructivism (Jaworski, 1994). Since radical constructivism emphasizes the individual primarily, this approach has been criticized for its disregard of the social dimension (Ernest 1993; Lerman 1994). Given this, the question of 'how to reconcile the private knowledge, skills, learning, and conceptual development of the individual with the social nature of school mathematics and its context, influences and teaching' is identified as 'a fundamental problem faced by the psychology of mathematics education' by Ernest (1994) (p.62). Therefore, a social constructivist philosophy of mathematics could be seen to address this problem (Jaworski, 1994).

In this paper, whether social constructivism succeeds in reconciling individual cognition with social teaching and learning practices will be discussed. Firstly, the meaning of individual cognition and social constructivism will

be explained. Secondly, the differences and similarities between the two types of social constructivism according to Piaget's way and Vygotsky's way will be argued. Thirdly, theoretical considerations will be discussed. Then, some research reviewed will be examined from a social constructivist perspective and brought to a conclusion.

2. Individual Cognition

Within the psychology or philosophy, cognitive processes are basically defined as being intrinsic in the autonomous problem solving ability of stimuli from the direct surroundings. Thus, cognition requiring 'an inner, situation-independent environment' (p.39) is essential to mental content and the relationship between mental content and outside world. To define cognition narrowly, it can be regarded as the reasoning process (Harder, 1999). In addition to this, the cognitive revolution as a reaction to behaviourism can give the broad definition of cognition. In the late 1950s and early 60s, it was realized that behaviourism neglected the inner process of mind (Gärdenfors, Johansson, 2005) and there were reactions between individual's inputs and outputs (Harder, 1999). Individuals' reactions were associated with their internal states rather than just 'direct, mechanical cause-effect chains' (Harder, 1999, p.40).

3. Social Constructivism

Voss et al. (1995) stated that the 'sociocultural revolution' has been recognized in the recent decade. By such a revolution, the emphasis on learning is not only through social interaction but also in out-of-school contexts (p.174). It is argued that people cannot comprehend the individual cognitive development in the absence of the social context in which the individual grows up (Gärdenfors, Johansson, 2005). In Maturana's (1978) words: "Knowledge implies interaction, and we cannot step out of our domain of interactions, which is closed. We live, therefore, in a domain of subject-dependent knowledge and subject-dependent reality… We literally create the world in which we live by living it." (pp. 17-18)

Social constructivism is a philosophical stance which accepts that both social interaction and individual meaning making play pivotal and crucial parts in the learning of mathematics (Ernest, 1994; Ernest, 1998). Social constructivists, thus, consider the process of knowing as the essence of social interaction that leads to higher levels of reasoning and learning (O'Connor, 1998). In addition, the acquisition of intellectual skills is regarded as an active process involving others (Jones, Brader-Araje, 2002; von Glasersfeld, 1989). From the social constructivist point of view, culture and context has an essential role in understanding in order to construct knowledge through this understanding (Derry, 1999).

Learning, in particular the learning of mathematics is considered as a social construction by social constructivists. This is not only because the origin of mathematics is social or cultural but also the justification of mathematical knowledge rests on its 'quasi-empirical' basis (Ernest, 1991). However, the fact that there is a lack of consensus about the term 'social constructivism' as well as its theoretical bases and assumptions is pointed out by Ernest (1994). According to Ernest (1990), a social constructivist epistemology is developed from the two principles of radical constructivism from von Glasersfeld, which are aforementioned. In addition to these, in order to elaborate the epistemological basis of social constructivism, Ernest (1990) extended these principles with the added presumptions of the existence of social and physical reality.

- "the personal theories which result from the organization of the experiential world must 'fit' the constraints imposed by physical and social reality;
- they achieve this by a cycle of theory-prediction-test-failure-accommodation-new theory;
- this gives rise to socially agreed theories of the world and social patterns and rules of language use;
- Mathematics is the theory of form and structure that arises within language."

By the same token, Taylor and Campbell-Williams (1993) (as cited in Jaworski 1994) propose another principle extending the principles of radical constructivism. This principle acknowledges that knowledge is constructed socially by the virtue of its discussion and mediation with others. In addition, it is stressed that language plays the pivotal role in learning and the learner is considered as an interactive co-constructor of knowledge. According to Jaworski (1994), 'the essence of social constructivism is recognition of the power of interaction and negotiation influencing individual construction. Intersubjective or 'taken-as-shared' knowledge can be seen as a product of such interaction where participants seem to agree on certain interpretations represented through discourse and non-verbal communication.' (p.211).

In the next section, the differences and similarities between the two types of social constructivism according to Piaget's way and Vygotsky's way will be put forward.

4. Views Accounting For Learning from Social Constructivist Perspectives

Vygotsky and Piaget proposed different mechanisms to account for learning from social constructivist perspectives; from the former perspective, the social life is of paramount importance, whereas from the latter perspective, the individual is of paramount importance.

4.1 Piaget's Approach

Piaget's constructivist perspective is based on radical constructivism, focusing on the individual cognitive processes, combining with social interaction. Although it accepts the social aspects of classroom interaction, it is the individual aspects of knowledge construction on which it is focused (Ernest, 1994; Rogoff 1990; Wertsch 1985). However, Piaget (1970) said that "…there is no longer any need to choose between the primacy of the social or that of the intellect: collective intellect is the social equilibrium resulting from the interplay of the operations that enter into all cooperation" (p.114).

It is Piaget's belief that children's actions in relation to their external world cause learning and that there is no place for teaching in this state (Jaworski, 1994). The independent work of the individual as well as equality on each other's view is also emphasized in Piaget's theory in terms of inter-subjectivity (Rogoff, 1999). In addition, according to Piaget, social interaction, in discussions between children holding different views, is highly likely to create cognitive conflict, which helps individual's cognitive growth thereby re-establishing equilibrium (Palincsar, 1998). From this point of view, different perspectives which could contradict with their own pre-existing perspectives can be seen through such logical discussions, therefore, giving rise to dis-equilibration, which, in turn, leads the individual to resolve the difference thereby reorganizing and rebuilding cognitions (Tudge, Rogoff, 1999). Piaget stated (1985) that "disequilibrium forces the subject to go beyond his current state and strike out in new directions" (p.10, cited in Palinscar 1998). From this perspective, intellectual development is an active process of dis-equilibration and re-equilibration thereby continuing reconstruction of knowledge (DeVries, 1997). Furthermore, it is Piaget's suggestion that in order to make the social interaction most effective, equals' cooperation is necessary, resulting in comprehension of each other's aspects with reciprocity of their different thoughts (Rogoff, 1999).

4.1 Vygotsky's Approach

Vygotsky's way to the relationship between social and individual processes contrasts with Piaget's in a number of essential ways. First of all, Vygotsky prioritized social and linguistic influences on learning and meaning-making and stated that "The social dimension of consciousness is primary in time and in fact. The individual dimension of consciousness is derivative and secondary" (Vygotsky 1978, p.30). From this point of view, "thought (cognition) must not be reduced to a subjectively psychological process" (Davydov, 1988, p.16, cited in Cobb, 1994).

According to Vygotsky, social interaction through participation in a number of joint activities and internalization of the influences of collective working provides learners with intellectual development and the acquisition of knowledge of the culture and the world, if they are guided by a more skilled peer or adult (Rogoff, 1999); the interaction between children and their caregivers, for instance (Palincsar, 1998). In order to account for this social and participatory learning with a teacher or more informed peer, the concept of the zone of proximal development (ZPD) was developed by Vygotsky (1978). He described that as "the distance between the actual developmental level as determined through independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p.86). According to Bruner (1997), "The ZPD is where pedagogy and intersubjectivity enter the Vygotskyian picture." (p.131). Lerman (2000) also defined the ZPD as an instrument to examining individuals' contributions to the learning setting as well as the role of intersubjectivity in scaffolding participants.

Furthermore, semiotic mediation plays an essential part in co-construction of knowledge (John-Steiner&Mahn, 1996). According to Vygotsky, social and individual functioning is mediated by semiotic mechanism-signs and psychological tools (Wertsch, 1991). By semiotic Vygotsky (1981) means : "language; various systems of counting; mnemonic techniques; algebraic symbol systems; works of art; writing; schemes, diagrams, maps and

mechanical drawings; all sorts of conventional signs and so on" (p.137). Internalization of these semiotics assist autonomous problem solving processes as well as the progress of knowledge co-construction (Palinscar, 1998). Most members of the sociocultural thought community accept the significance of semiotic mediation, in particular language, in thinking and the development of consciousness (John-Steiner&Mahn, 1996).

Language has a crucial part to play in mental functioning and conveying the cultural heritage of the groups, such as ethnicity and gender, in which the individual is born into and brought up (Lerman, 1996; Lerman, 2001). From this perspective, in addition to language, cultural context by the virtue of the use of language is necessary for cognitive development in Vygotsky's theory (Bruner, 1997). Since language and knowledge are pre-existing and on the external plane, internalization of the meanings and culture is necessary; namely individuals cannot originate them. Hence, the essence of the Vygotsky's theory is internalization (Lerman, 2000). In Vygotsky's words: "Every function in the child's cultural development appears twice: first, on the social level, and later, on the individual level; first, between people (interpsychological), and then inside (intrapsychological) . . . All the higher functions originate as actual relations between human individuals." (Vygotsky, 1978, p. 57)

Given the different ways of Piaget and Vygotsky regarding social interaction in individual cognitive development, there are various viewpoints of constructivism and the social dimension of work in the literature of mathematics education. Thus, it is a matter of debate. Some believe that these two ways are complementary or incommensurable, while others say that these are contradictory (Lerman, 2000; Ernest 1994). In the next section, some theoretical considerations will be discussed.

5. Theoretical Considerations

The integration of social interactions into constructivism is supported by a number of writers. A group of researchers, Cobb, Wood and Yackel, for instance, argued that these theories are complementary. These researchers (1992) provided an explanatory framework for social interactions drawing attention to complementarity of acculturation and cognitive aspects. 'When we talk of students' constructive activities we are emphasizing the cognitive aspect of mathematical learning. It then becomes apparent that we need to complement the discussion by noting that learning is also a process of acculturation.' (Cobb *et al*., 1992, p.28) Cobb (1994) also stated that mathematical learning should be considered as a process in which knowledge is constructed by an individual actively as well as a process of acculturation into the mathematical practices. He asserts that it is how to integrate these two perspectives in mathematics education that is a fundamental issue instead of debating between them. Cobb and Yackel (1996) conducted a classroom based research project, and developed an outlined interpretive framework for analysing classrooms; this showed that the two perspectives were complementary.

Ernest (1991) and Bauersfeld (1992) also argued for the complementarity of social aspects and individual cognition; they emphasise social convention and the role of the social dimension in individual cognition respectively. However, Bruner (1997) suggested, "The two perspectives grow from different world views that generate different pedagogical strategies, different research paradigms, perhaps even different epistemologies…. Better each go their own way." (p. 135).

Sfard (1998) has proposed that these theories are incommensurable, not incompatible. Since each offers something in contrast to the other, each of them is necessary; namely there is not just one correct theory. According to her, one is highly likely to exist at the same time with the other in peace. She stated that "…theoretical exclusivity and didactic single-mindedness can be trusted to make even the best of educational ideas fail." (p.11). Thus, she suggested that it is a mixture of them that would draw advantage from these theories, while avoiding the disadvantages of each.

Nevertheless, Confrey (1995) argued that there are potential incompabilities between the two theoretical views. It is Confrey's consideration that it is difficult to reconcile the two theories. Her emphasis is that the individual constructivist perspective is crucial. In the absence of it, the diversity of individual constructions, which have a pivotal role in the learning process, is lost from access. In Confrey's words, an "exclusive reliance on 'mathematizing' as 'the interactive constitution of a social practice' could lead social constructivist researchers to overlook much of what Piaget demonstrated and to underestimate or under-investigate the strength and diversity of individual students' constructive processes" (Confrey, 1995, p.219). Thus, she argued that Vygotsky's theories are inadequate to explain the creativity of the individual which is an obvious weak point. She, therefore, put Piaget's ideas into Vygotsky's to correct that weak point. On the contrary, Rogoff (1990) describes herself as a supporter of Vygotsky, that the integration of social interaction into Piaget's individualistic approach cannot achieve Vygotsky's view that it is crucial to comprehend cognition within social context.

In Lerman's 1996 and 2000 articles, he argued that these theories are contradictory. Thus, combining one with the other would create incoherence. Lerman (1996) stated that, 'attempts to incorporate intersubjectivity into radical constructivism make it an incoherent theory.' (p.148). In contrast, Steffe and Thompson (2000) asserted as a reply to Lerman that it is interaction rather than intersubjectivity that was an intrinsic component in radical constructivism from the very beginning. As support for their statement, they emphasized that von Glasersfeld is interested in comprehending 'the nature of human communication and language' (p.194). However, it is Bruner's (1997) view that Piaget's theory is lacking in intersubjectivity. Tudge and Rogoff (1999) also argued that "social influences on development are not central to Piaget's theory" (p.34) and explain their view that Piaget's approach was to "focus on the individual as the unit of analysis" in contrast with Vygotsky's focus on "social activity" as the unit of analysis (p.30).

According to Lerman (2000), due to the fact that these theories have completely different origins, the social dimension should not be integrated into radical constructivism. He also stressed that Piagetian and radical constructivist approaches cannot give an account of why and how children fail. However, Solomon's (1998) explanation for the failure is "cognitive immaturity on the part of the child, inadequate teaching on the part of the teacher" (p.377).

Having discussed various viewpoints of constructivism and the social dimension of work in the literature of mathematics education, some of the empirical research reviewed will now be examined in order to analyse how social interactions promote individual cognition and learning and enhance our understanding of social constructivist perspectives on teaching and learning.

6. Research Review

From the social constructivist perspective, interpersonal interactions in the course of classroom discussion and discourse are considered as important tools for the development of individual cognition. Cobb et al (1993), conducting a project for a year-long teaching experiment in one second grade classroom, investigated the extent to which children engaged in inquiry mathematics when they worked together in both small group and whole-class settings. Their initial view focused on the individual as they stated that "social interaction was a catalyst for autonomous individual cognitive development" (p.92), but changing the path of theoretical commitment through their study, they then articulated that "mathematical activity can be viewed as intrinsically social in that what counts as a problem and as a resolution has normative aspects" (p.93). However, they tend not to make the individual secondary "...we are attempting to avoid any tendency that subordinates the individual to the social and loses sight of the reflexive relation between the two." (Cobb et al., 1993, p.96)

Cobb et al. assert that there are numerous ways in which individual learning can be developed through social context. A significant stress of their research is on which mathematical meanings are negotiated collectively by the teacher and students and the negotiation of discourse norms and "sociomathematical norms", involving collectively doing mathematics in the classroom, are achieved collectively.

By the same token, Jaworski's (1994) initial view was that of a radical constructivist focusing on individual knowledge construction. However, she expressed her observation in the classrooms in terms of students' learning from a social constructivist perspective after her recognition of different views of the social aspect of classroom learning. As a result of the research conducted by Jaworski (1994), which focused on both individual and social aspects, she asserted that individual students' construction of meaning was promoted substantially by the social dimension. "It manifested itself in language, discourse and physical action within the classroom walls – the activities initiated by the teachers, the group work and discussion, and general emphasis on a supportive and respectful classroom ethos." (p.211). According to her, social interaction and mediation provided established conventions that could be considered as knowledge arising from discussion between students, namely 'intersubjective' knowledge (p.209). She pointed out the difference between radical and social constructivism, that although the impact of social interaction on individual cognition is not excluded by the radical constructivist approach, the fact that knowledge occurs outside the individual is excluded.

She pointed out classroom discourse in a lesson on Vectors that fostered individuals to verbalise their knowledge; through this discourse, individuals negotiated their ideas and perceptions. Although it can be seen from a radical constructivist view that each individual has their own understanding autonomously, teacher and students discussed and negotiated their perceptions for the shared meaning and developed a common understanding. "As the discourse progressed, classroom meanings developed (interpsychologically) and from these students developed their personal meanings (intra psychologically)" (p.210). Thus, it appeared to her that the meaning in the classroom was as a consequence of social interaction. She concluded that "There seems no

doubt that the discourse and its language were functional in students' development of meaning." (p.209). This is related to Vygotsky's suggestion that individual understanding improves by the virtue of language and social interaction.

The pivotal role that the teacher plays in creating a classroom atmosphere that encourages pupils to learn through engagement with the mathematical tasks in classrooms was demonstrated in the research of Goos (2004). In this two-year study of the inquiry into the senior years of secondary school children, the researcher captured some positive examples that teachers make efforts to increase pupils' participation and to initiate them into the use of mathematical tools and conventions in a community of inquiry in order to improve pupils' learning. In this analysis, 'scaffolding', ' peer collaboration', and 'the interweaving of spontaneous and theoretical concepts' (p.282) were delineated for a teacher and pupils to create ZPDs. In order to assign mathematics knowledge in cultural context, such ways emphasise the teacher's role in helping pupils in a Grade 12 and a Grade 11 class. Although the teacher's attempts for students' involvement in mathematical tasks critically and autonomously were resisted by some students, the teacher's position was that of facilitator, inducting students into mathematical activities as well as orchestrating student action.

Lampert (1990) considers her own classroom activities of teaching mathematics where she has had a significant part to play in classroom discourse. She assumed that 'changing students' ideas about what it means to know and do mathematics was in part a matter of creating a social situation…' (p.58). Thus, she took part in discussions not as a settler of a dispute but as a knowing participant thereby sharing the responsibility of mathematical judgement as a community of mathematical intellects established in the classroom. She draws her perspective of classroom discourse primarily on mathematics as a discipline. Consequently, her emphasis is mostly on the interaction between students and teachers while talking about mathematics and doing it. Furthermore, Cobb et al. (1997) analysed reflective discourse in first a grade classroom for a year-long teaching experiment focusing on the positive effects of discourse in the classroom on the mathematical development of participants and contributors which is complementary to Lampert's analysis as the researchers stated.

Taylor and Cox (1997) have also focused on the social aspects of the learning of mathematics. They conducted a study with fourth graders; in addition to a classroom control, there were two peer interaction clusters, a socially assisted learning grouping following reciprocal teaching and a modeling grouping, namely a basic form of cooperative learning. The quiz results obtained pointed out that both peer interaction groups were more competent in solving complicated mathematical problems than the control group, however, children in the socially assisted learning environment were superior to the children of the modelling environment. Reflective questioning, scaffolding, and shared ownership were used in the socially assisted learning group differently from the modelling group. According to researchers, such learning is succesful by virtue of shared ownership that promotes the negotiation of meaning through working all together, the externalization of thoughts including wrong answers and the coming to an agreement as well as the transfer of regulations from the adult to the children. They concluded that 'Keeping in mind that math is not just numbers, but a meaningful, social, and cultural domain is the first step toward reaching this larger goal.' (p.223)

Mercer and Sams (2006) conducted a study to investigate teachers' roles in assisting children to develop their use of language as a tool for effective reasoning collectively, thereby improving individual learning and mathematical understanding during mathematical activities in primary schools in Year 5. This study involved an intervention teaching programme called "Thinking Together" that included both group-based peer group activities and teacher guidance. The findings of this study indicated that collaborative activities enabled students to construct answers for themselves through talk that reinforced the result of the research of Yackel et al. (1991). The evidence of Mercer and Sams's research also indicated that it is the teacher that has a crucial role in children's use of language while working on mathematical tasks and reasoning; and that talk-based group activity can help the development of individuals' mathematical reasoning, understanding and problem-solving. Empirical data in this work also supported the Vygotskyian perspective which asserts that language-based, inter-mental activity, namely social interaction has a developmental impact on intra-mental activity, namely individual thinking. Thus, there is an indication from Mercer and Sams's study that "if teachers provide children with an explicit, practical introduction to the use of language for collective reasoning, then children learn better ways of thinking collectively and better ways of thinking alone." (p.525)

However, social interaction was analysed in the context of children's' fraction learning in computer micro-worlds by Steffe and Tzur (1994) and they found that not all social interaction between students contributed to learning. Thus, the suggestion of the researchers was that mathematics educators should constitute communication mathematically with children as well as among them and create autonomous mathematical activity in students while interacting with others. In addition, they should create learning positions in which the generation of

perturbations that appeared to contribute to the learning are essential. Furthermore, Sfard and Kieran (2001) examined interactions between two 13-year-old boys learning algebra in two months in order to understand the mathematics learning through social interaction. They comprehended that 'the merits of learning-by-talking cannot be taken for granted" (p.70). According to these researchers, the collaboration between the two students appeared to be not helpful because the communication between them was ineffective. However, they stated that "...based on theoretical arguments and ample evidence from other research, we still believe in the didactic potential of talking mathematics." (p.71).

7. Conclusion

There is a tendency to believe that a radical constructivist perspective disregards, or at least under elaborates, social interaction and the position of language in cognitive development (Lerman, 1994). Hence, social constructivism is gaining ground with some researchers in the psychology of mathematics education as an alternative view to radical constructivism; the relationship between social interaction and cognitive development from a social constructivist perspective has been paid attention to by educators.

Having examined the ways in which two influential theorists have conceptualized these relations, there are some differences between their theoretical positions, particularly the role of social interaction in individual cognition. According to Vygotsky, more skilled peers or adults play a crucial role in the development of individual cognition, and such development is promoted by cooperation in the individual's zone of proximal development. Piaget considered that, although development could be assisted by interaction between peers instead of adults by the virtue of resulting in 'cognitive conflict', individuals are working alone to construct knowledge through the physical, logical, and mathematical material of their world (Tudge and Winterhoff, 1999). However, different perspectives of certain writers make the situation debatable. Many of them, such as Cobb, Ernest, Bauersfeld, have made efforts to integrate social interaction into constructivism to reconcile individual cognition with social aspects of teaching and learning.

Having reviewed the research literature from social constructivist perspectives in the previous section, it could be summarised that since discourse is the paramount meditational instrument for cognitive development from social constructivists' perspectives, studies conducted of interactions through classroom activities and discussions generally contribute to the development of learning and understanding. However, the form of discourse produced is essential to the benefits; interpretive discourses tend to constitute more substantial learning gains. As researchers examined teachers' involvement in individuals' learning, it was found that teachers have a pivotal role in fostering such learning through scaffolding, the use of language and participating in classroom discourse as well as identifying constitutive aspects of teaching such as providing mathematical communication. Thus it could be concluded that although there is a potential for the ineffectiveness of communication through social interaction and therefore less contribution to learning than expected, learning mathematics in an interactive way is generally supportive to individual cognition as many research empirical and theoretical evidence confirmed (see Lampert 1990; Goos, 2004; Cobb et al. 1993; Mercer and Sams 2006).

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