Extending Valsiner's zone theory to theorise student-teacher development

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This paper sketches an extension of Valsiner's 'zone theory' to theorise student-teacher development in inquiry classrooms. The paper is structured as follows. We begin with the empirical classroom study that grounds the theoretical extension we propose. We then provide the basic ideas of Valsiner's zone theory, the Zone of Free Movement (ZFM) and the Zone of Promoted Actions (ZPA) followed by illustrative results. The final section presents the substance of the paper, that over the course of the study there were transformations of students' ZFM/ZPA, of teachers' ZFM/ZPA and these transformations were interrelated.

The empirical classroom study

Abdul Hussain (2010) investigated the effect of a school year intervention to introduce inquiry methods into mathematics teaching and learning in four Bahraini state primary schools (only one school reported on here). The aim was to understand the intervention at three levels: 1) the mathematics classroom level, the extent to which mathematics classroom activity was transformed; 2) the teaching level, the views, actions and decisions of mathematics teachers, senior mathematics teacher and the teacher supervisor; 3) the whole school level, the obstacles and challenges facing senior managers, the senior mathematics teacher and the teacher supervisor. In levels 2 and 3, changes in participants' views and beliefs were investigated.

Inquiry is viewed as a social construct with various forms arising from Western 'reform' movements in the 1980s. Inquiry is viewed an active quest for knowledge that arises in activity, often investigative activity in mathematics classrooms. The study was greatly influenced by Jaworski's many papers on inquiry, e.g. Jaworski (2006) which describes three inquiry practices: inquiry in mathematics; inquiry in mathematics teaching; and inquiry in research. Our three level approach takes its cue from this division.

The first author, a Bahraini primary school supervisor under post graduate study secondment, provided initial training on inquiry classroom approaches for participating teachers at the beginning of the school year and provided support/advice, following classroom observations, during four 3-week periods over the course of the 2007-08 school year. The overriding theoretical framework is socio-cultural in as much as: teaching and learning are viewed as person, tool and sign mediated activity; the ZFM and the ZPA arose from investigations into Vygotsky's Zone of Proximal Development (ZPD); methodological tools were appropriated from explicitly socio-cultural researchers, e.g. Mortimer & Scott (2003).

With regard to methodology we only report on aspects of the study relevant to this paper. Four interrelated research questions focused on: the extent to which the three level approach changed adults' beliefs about primary mathematics teaching and learning; the extent to which the implementation changed classroom discourse; the key characteristics of instructional actions in the process of transforming classrooms into inquiry communities; the main obstacles in implementing inquiry communities. The study used a design experiment approach in a developmental research paradigm.

Four 4-week teacher preparation/support coupled with data collection periods were distributed over the school year. Data collection at the three levels included: school level – interviews with teacher supervisors and senior management, field notes and documents; teaching level – interviews with teachers and senior teachers, field notes and documents; classroom level –observations, interviews, field notes and documents.

Data analysis to address the research questions focused on beliefs, instructional actions and obstacles included data reduction (documents) and open coding of interview transcripts followed by iterative comparison of emergent themes. Data analysis to address the research question on classroom discourse included analytic induction (Flick 2006) on an initial framework, on transcripts of classroom observations related to the first and last stages of the intervention. The initial framework used Halliday's (1989) discourse constructs to extend Mortimer & Scott's (2003) account of science classroom discourse. This framework (which was tested and developed during the study) employed Halliday's constructs of field, mode, tenor and register to extend Mortimer & Scott's categorisation of teacher-student discourse along two dimensions (interactive-non-interactive and dialogic-authoritative) and teacher interventions **(**shaping ideas, selecting ideas, marking key ideas, sharing ideas, checking student understanding). Classification of classroom social and sociomathematical norms (Yackel & Cobb 1996) as well as analysis of classroom discourse, i.e. initiation-response-evaluation (I-R-E), were a part of this framework.

The basic ideas of Valsiner's zone theory

Valsiner (1987) introduces the ZFM and ZPA in relation to Vygotsky's ZPD. The ZFM characterises the child-environment relationship, at a particular time and in a certain environment, "the child's freedom of choice of action (and thinking) is limited by a set of constraints" (ibid, 97). The ZFM is a social construct that is created through mutual cultural interactions between the child and the adult. We note that the ZFM shapes specific cultural norms and values about permissible future actions that might occur. The ZFM plays a key role in structuring current and future actions of the child in a given environment and is dynamic, not fixed, and can be reconstructed according to the situation. The ZPA refers to the "set of activities, objects, or areas in the environment, in respect of which the child's actions are promoted" (ibid, 99-100). The ZPA is typically a sub-zone of the ZFM which has a non-binding nature, i.e. the child has the option to comply with or to reject what the adult promotes. However, the ZPA can restructure the ZFM: through encouraging the child to go beyond existing boundaries of the ZFM; through becoming a 'zone of required actions' where the child has no options, i.e. the adult turns the ZPA into the ZFM. These two zones interact and "work jointly as the mechanisms by which canalization of children's development are organized" (ibid., 101).

Valsiner's concern is child development but his zone theory can be used for adult development and his zone theory has been used in accounts of teacher practice, e.g. Blanton, Westbrook & Carter (2005). Our approach is, to our knowledge, unique in applying it to both child (student) and adult (teacher) development.

Illustrative results

We present extracts from classroom work and discourse at the start and towards the end the intervention. The teacher is Moneer, the class has been working on long division. The start of intervention lesson we provide extracts from involved 4 tasks and we consider the third task:

A group of 732 tourists arrived at Bahrain International Airport. How many buses are required to transfer these tourists if the capacity of each bus is 48 passengers?

Moneer wants to involve the students in collaborative learning and organises them into seven groups of four students each. He asks the students to open their textbooks to page 43, writes "exercises" as the title and encourages students to employ a "read and understand" strategy. The extract starts with Moneer's opening remarks and then skips to later in the lesson.

2 Moneer: Right, everyone knows which problem … I told you now, read and see the ideas, then determine the main ideas. Describe the task … and start.

53 Moneer: What are your ideas?

54 Student: 732 tourists arrived at Bahrain airport and the capacity of the bus is 48 passengers.

55 Moneer: Right, these are the givens of the question. Do you have anything to add more on the ideas of what was given? What did you do here, boys?

56 Student: A group of 732 tourists arrived at Bahrain International Airport.

57 Moneer: [Interrupting] At the outset I have to know the number of tourists in the group that arrived at the airport. How many? The number of the tourists.

58 Students: 732

We summarise the analysis of the lesson from which this extract is taken.

Approach Interactive/authoritative.

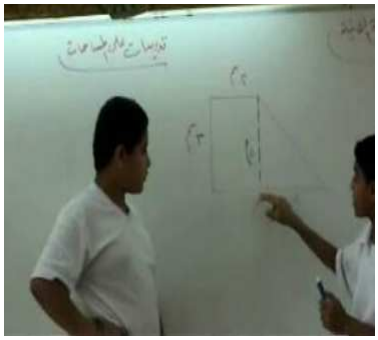
Patterns of interaction I_T-R_S-E_T and I_T-R_S-F_T-R_S-F_T

Teacher interventions Shaping, selecting, sharing, reviewing students' ideas.

Cultural norms Teacher determines what counts as an acceptable answer. Teacher is not obliged to accept students' ideas and mistakes. Students are not obliged to express their non-understanding or to negotiate their solutions with each other.

We interpret the approach, patterns of interactions, teacher interventions and cultural norms as similar to Valsiner's interpretation of a lesson "the children's ZFMs in the situation equals the ZPA – they can act only in the ways that are allowed by the teacher" (ibid., 103).

We contrast this lesson with a lesson with the same class and teacher towards the end of the intervention. Moneer designed an open task with Ahmed (senior teacher) to introduce a new topic, finding the area of a trapezium. The extract below focuses on two students, Hussain and Sayed, volunteers from one group who are at the board explaining their solution but we begin the extract with extracts that show how Moneer framed the collaborative task to the students.



11 Moneer: Now try to find the area by yourself.

12 Ali: Without a rule?

13 Moneer: Who knows, it might be that there is a rule … Don't undervalue whatever you know. Record it.

22 Hussain: At first, we constructed a line from the beginning of the angle [pointing to the dotted line]. After that we measure it and we got umm 2.5 cm.

23 Moneer: OK boys [addressing the class], pose your questions.

24 Ali: Why, why is it 2.5?

25 Hussain: Because we computed it

26 Mahmood: Why not 3 so they become equal?

27 Ali: You computed it! Why not 3?

28 Mahmood: The length of this must be equal to the length of this, why are they different?

29 Hussain: Ha? [meaning 'say it again']

30 Ali: Why is this one 3 [the left vertical side of length 3]?

31 Mahmood: Why didn't you make them equal?

32 Hussain and Sayed: [Discussing on the board]

33 Ali: I'm saying why is it 3?

We summarise the analysis of the lesson from which this extract is taken.

Approach Interactive/dialogic

Patterns of interaction Student-student but also I_T-R_S-F_T-R_S-F_T

Teacher interventions Marking, shaping, sharing, reviewing students' ideas

Cultural norms Teacher obliged to listen to students' ideas and mistakes.

The ZFM/ZPA complex system at work here is different to that in the lesson at the start of the intervention. Students are obliged to express their ideas and negotiate solutions with each other. Students collectively determine warrants for an acceptable solution and are obliged to express their non-understanding. Mistakes are acceptable.

Interrelated transformations

We now come to the heart of this paper. We see the above illustrative extracts and analysis of lessons as evidence of a transformation of 'ZFM/ZPA complex systems' (ZFM/ZPA complex hereafter) over the course of the year but of who's complex systems are we referring – the teacher's or the students' or both? We argue that it is both and that these transformations are interrelated. Our argument is in four parts: (i) the teacher's ZFM/ZPA complex promotes the students' ZFM/ZPA complex; (ii) the actions of senior staff afford and constrain the development of teachers' ZFM/ZPA complexes (in this paper we focus, for reasons of space, on a senior teacher and workshops provided by the first author but the actions of other senior staff were also important); (iii) incremental changes in students' ZFM/ZPA complex provided positive feedback to teachers with regard to their beliefs about what students were capable of doing and about the nature of school mathematics; (iv) the cumulative effect of (ii) and (iii) over the intervention period resulted in a significant transformation of both teachers' and students' ZFM/ZPA complexes. We now consider (ii) to (iv) in turn (we omit the case for (i) as this seems uncontroversial) and provide illustrations of actions and events over the course of the intervention.

With regard to the influence of the actions of senior staff on the development of teachers' ZFM/ZPA complexes we briefly consider the start of intervention workshops and the joint work of Moneer and Ahmed. At the start of the intervention the first author conducted four 2 hour school-based workshops for all mathematics and senior teachers and one teacher supervisor. These were received enthusiastically. These workshops provided opportunities for all to discuss: inquiry-oriented learning tasks and how they might engender collaborative learning and facilitate students' interactions within groups; how to create inquiry norms; metacognitive strategies and skills; and how to pose questions that promote inquiry processes. These workshops had an immediate effect on teachers' and students' ZFM/ZPA complexes, what

teachers were free to do and promote their students to do. As evidence for this statement we point to Moneer's start of intervention lesson (extract above); Moneer continued many of his prior to intervention classroom practices but he did attempt to involve students in collaborative learning and organised them into groups for this purpose. We will record this change symbolically to emphasise (by arrows) promoted actions (subscripts indicate base and incremented states):

(prior to workshops) $ZFM/ZPA_{teacher1} \rightarrow ZFM/ZPA_{students1}$

workshops ↓

(after workshops) $ZFM/ZPA_{teacher2} \rightarrow ZFM/ZPA_{students2}$

With regard to the joint work of Moneer and Ahmed, they enacted an 'inquiry cycle' which they maintained over the intervention. This cycle involved:

1. planning together
2. implementing and monitoring the lessons
3. reflecting on what was going on
4. enacting modifications and/or consolidating successful pedagogical practices.

Although we have a penchant for this cycle we do not reify it as a cycle that should be used in inquiry practice. It was a practice recommended in the workshops that was appropriated by the teachers and senior teachers in the intervention. We present below extracts from interviews, conducted towards the end of the intervention, which illustrate teacher activities and outcomes in this cycle: teacher collaboration; collaborative task design; restructured roles.

Prior to the intervention, teacher planned alone, senior teacher observed and fed back. As the year progressed there was increased collaboration:

> Moneer: I went to his house about what we are going to do tomorrow… We sit and make a complete plan, the types of activities, the stages, designing the questions… directed to the student … Then, on the next day we saw and measured through an evaluation process …
>
> Ahmed: When we design a task together we want the students to be speakers so … the student will come and talk and present… Sometimes during my classroom observation which covers the whole lesson … If I don't intervene then there will be great loss… of an idea.

With regard to collaborative design of learning tasks:

> Moneer: The school curriculum … presents the rule …What we do now, always … present a problem to the student… so he will feel the problem

With regard to restructured roles:

> Ahmed: Indeed, the teacher abandoned some roles … to give sufficient opportunities for the student to become a speaker.
>
> Moneer: My roles at the beginning were too much toward intervening. At the end of the experiment gradually I …withdrew some of my authorities … I try to keep the student to be in the centre of everything and I merely intervene …

We record this change symbolically to emphasise promoted change:

(state at a certain stage) $ZFM/ZPA_{teacher(n)} \rightarrow ZFM/ZPA_{students(n)}$

collaboration/cycle ↓

(state after collaboration) $ZFM/ZPA_{teacher(n+1)} \rightarrow ZFM/ZPA_{students(n+1)}$

We now consider incremental changes in students' ZFM/ZPA complex that provided positive feedback to teachers with regard to their beliefs about what students were capable of doing and about the nature of school mathematics and promoted change in teacher ZFM/ZPA complex. We illustrate this with one (of many)

unexpected student solutions (a rarity prior to the intervention). Figure 1 presents a task (a) a student (group) solution (b). This is followed by teacher comment.

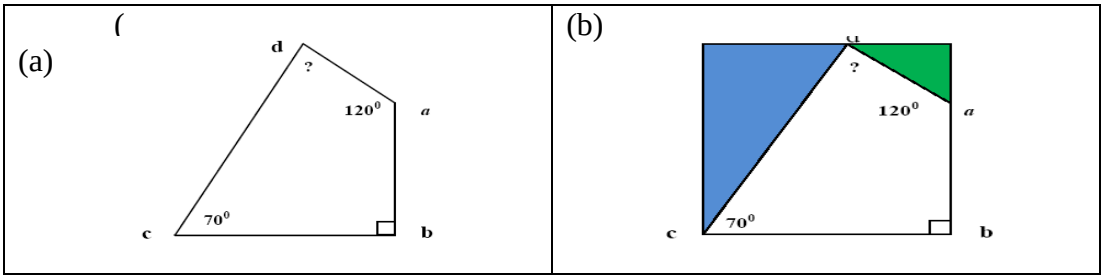


Figure 1 A task and a student (group) solution (students were expected to calculate 360-(70+90+120))

> Moneer: I extended the time for something, because …I could not overlook students' ideas. This is why it was quite long, I liked to give all of them the opportunity. Lot of thing came out from the students… New non-expected solution and also the critiques, views, articulations. Now to be honest, I can say a half or 3 quarters of the class can express and talk about what is inside, describe the shapes, bring out mathematical inferences and that by himself only.
>
> Ahmed: the articulation of ideas became a routine practice for the students.

Students' actions influenced Moneer's transformation to include: greater confident about students' capabilities (a belief); a review of students' mistakes; increased commitment to inquiry norms; a review of time (from an obstacle to an opportunity). We record this change symbolically to emphasise promoted change:

$$\text{ZFM/ZPA}_{\text{teacher(n)}} \rightarrow \text{ZFM/ZPA}_{\text{students(n)}}$$
$$\text{students' action} \downarrow$$
$$\text{ZFM/ZPA}_{\text{teacher(n+1)}} \rightarrow \text{ZFM/ZPA}_{\text{students(n+1)}}$$

The cumulative effect of student and senior teacher promoted changes resulted in a significant transformation of both teachers' and students' ZFM/ZPA complexes.

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