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Scaffolding has become increasingly popular as it provides teachers with an appealing alternative to traditional classroom techniques of teaching. Recent research identified a number of different ways that scaffolding can be used in the classroom to improve students' numeracy levels in primary schools. However, despite the importance of scaffolding, pre-service teachers experience difficulties in understanding the complex techniques of scaffolding and often fail to make connections between theoretical explanations and their practical use. This paper examines current perceptions of scaffolding by a cohort of pre-service teachers, both in its conceptual framework and its practical implications to teaching in the classroom, and to teaching numeracy in particular. The results indicated that the participants appreciated the importance of scaffolding as an alternative to the traditional forms of educational instruction. However, they continue to demonstrate a limited appreciation of the more complex and theoretical aspects of scaffolding.

Introduction

Since the term scaffolding was introduced by Wood, Bruner and Ross in 1976, it has been interpreted and applied to educational research and practice in a variety of ways. As the focus of Australian educational research has shifted to studying the quality of teacher intervention, the notion of scaffolding has become increasingly popular among educators in different areas of teaching. A growing number of educators and researchers have used the concept of scaffolding as a metaphor to describe and explain the role of the teacher in assisting children's learning in the classroom (Stone, 1998; Daniels, 2001). In particular, recent research in numeracy identified a number of ways that scaffolding can be used in the classroom to improve students' numeracy levels in primary schools (Siemon, & Virgona, 2003; Anghileri, 2006; DEST, 2004). However, overall, the interpretation of scaffolding in current educational research is exceedingly diverse and often serves as an umbrella term for any kind of teacher support (Jacobs, 2001). Due to the metaphorical nature of the term and its multiple interpretations, scaffolding does not provide educators with clear and definite guidelines on the ways that it should be used to achieve successful learning. Scaffolding can become a hindrance rather than help in children's learning if taken out of its theoretical context (Stone, 1998; Tudge, 1990, in Moll, 1990). Such a diverse and sometimes conflicting interpretations of scaffolding creates difficulties in teaching this concept to pre-service teachers.

The recent government request for quality teaching has brought into focus issues concerning the role of teacher educators to ensure that pre-service teachers receive appropriate training. Becoming a quality teacher involves the acquisition of subject matter knowledge and the transformation of this knowledge with appropriate pedagogical skills of teaching. The latter includes knowledge about scaffolding. To be able to teach in an ever changing school environment, teachers need to be able to adjust their knowledge and skill to a particular classroom situation and to a particular child. This means that teachers have to be able to reflect upon, and think about, their teaching practices in a critical and creative

manner. A deep understanding of the theoretical framework that support their pedagogical practices are essential for the development of such ability.

Despite the importance of scaffolding, the literature indicates the complexity of the metaphor and the difficulties in its understanding by educators (Stone, 1998; Bliss, Askew, & Macrae, 1996). There is a need to explore the ways that pre-service teachers understand and interpret scaffolding as they relate to specific subject areas of teaching. This paper examines the above issue by exploring current perceptions of scaffolding held by a group of pre-service teachers. Their perceptions of scaffolding, understanding of its theoretical underpinnings and its classroom value were explored in relation to teaching numeracy.

The Role of Scaffolding in Teaching Numeracy

The development of children's numeracy skills depends on a range of factors not least the quality of classroom teaching. The metaphor of *scaffolding* has become increasingly popular because it provides educators with an alternative to traditional classroom techniques such as direct instruction. The metaphor is used to characterise and rationalise the role of teachers (or more knowledgeable peers) in supporting and guiding children's learning and development. It is based on the premise that teaching involves the co-construction of knowledge within student-centred activities (Vygotsky, 1997). The quality of teacher-child interaction is essential to effective scaffolding, which emphasises collaboration, dialogue and negotiation. (Chinnappan, 2003; Rasmussen, 2001).

Over the past decade research has identified a range of explicit scaffolding approaches and techniques that can improve students' numeracy in primary classrooms. Anghileri (2006) identified and classified classroom interactions that can be effective for mathematics learning and are necessary to support the practitioner in reflection and analysis of actual classroom practices. She has developed a comprehensive three-level hierarchical model for scaffolding mathematics which includes planning and organising prompts and stimuli in the learning environment (level 1, environment provision), and different levels of teacher-child interaction which either focus on the task at hand (level 2) or aim at developing representational tools and generating conceptual discourse in the learner (level 3, developing conceptual thinking) (Anghileri, 2006). O'Toole and Plummer (2004) provide detailed analyses of different types of questions that support children's thinking and conceptualisation of the mathematical processes. Morrone et al. (2004) contend the importance of such characteristics of scaffolding as negotiating meaning, transferring responsibility and fostering intrinsic motivation (p.20).

Recent research conducted by the Australian government has identified and provided an in-depth analysis of *twelve practices of scaffolding learning mathematics* that can lead to improving students' numeracy in primary classrooms (DEST, 2004). These teaching approaches are based on the range of scaffolding techniques used by effective teachers during numeracy lessons. Such practices include exploring children's understanding (*excavating*); *modelling* and demonstrating; *collaborating* and negotiating and so on (DEST, 2004, p.3). This research provides important directions for enhancing pre-service teachers' skills in teaching mathematics, although, the variety of techniques and diversity of approaches can make the task of making this wealth of knowledge available to pre-service teachers quite a complex enterprise.

Anghileri (2006) points out that some teaching still uses minimal scaffolded support to children in the classroom, providing textbook exercises and direct explanations. The study

also highlighted the need for further examination of practitioners' views about scaffolding practices and the potential relationship between teachers' beliefs and subsequent practice that draws on scaffolding techniques. The current study takes up this issue.

Complexity of the Metaphor of Scaffolding and its Implementation

Despite the importance of scaffolding, research indicates that it is a concept which is difficult to master (Stone, 1998; Bliss et al., 1996). For example, Bliss, Askew and Macrae (1996), in their study of teaching mathematics and science, demonstrated that school teachers experience difficulties in using scaffolding in their teaching. They reported 'a relative absence of scaffolding in most lessons' (Bliss et al., 1996, p. 44). and pointed out that the teachers were unable to effectively engage in scaffolded interaction with their pupils: they either tended to use directive teaching strategy, keeping their initiative in the episode, or gave full initiative to the pupils, leaving them to do the task by themselves, without much help from the teacher.

Researchers stress the importance of understanding the metaphor of scaffolding in conjunction with the theory from which it originated. It is argued that if taken out of its theoretical context, scaffolding can serve to constrain rather than enhance children's learning (Tudge, 1990, in Moll, 1990; Stone, 1998).

The term scaffolding, although never used by Vygotsky, was introduced in an attempt to operationalise the concept of teaching in the zone of proximal development (ZPD) (Wood, Bruner, & Ross, 1976, cited in Verenikina, 2004). The ZPD, defined as the distance between what a student can do with and without help (Vygotsky, 1978), is used to explain the social and participatory nature of teaching and learning. Supporting children's active position in their learning and assisting them in becoming self-regulated learners is essential. The main aspiration of teaching in the ZPD is to see students being actively engaged in their learning with the future prospect of becoming self-directed, life long learners. The definition of the ZPD points to the meaning of teaching as the transformation of socially constructed knowledge into that which is individually owned. This type of teaching assumes a specific paradigm of teacher-learner interaction where the role of the adult is that of collaborator and co-constructor. A strong emphasis is made on the active position of the child, which is essential for becoming a self-regulated learner. According to Vygotsky, the educational process should be based on the student's engagement in an individual activity, where "the teacher is the director of the social environment in the classroom, the governor and guide of the interactions between the educational process and the student" (Vygotsky, 1997, p.49). The teacher doesn't influence children directly, but through shaping and fashioning their social environment through indirect instruction. The way that adult interacts with the child is essential to supporting children as active, self-regulated learners (Diaz, Neal, & Amaya-Williams, 1990, in Moll, 1990).

Theoretical Connections

Scaffolding and the concept of the zone of proximal development can be fully understood only in the context of the Vygotskian theory as a whole. Failure to see the connections between the ZPD and the theory as a whole might lead to a symplstic understanding of the concept (Tudge, 1990, in Moll, 1990). Furthermore, there is a danger that a failure to understand the complexity of Vygotskian theory as a whole can lead to interpretation of the ZPD as a domination over a child's initiative and active position as a

learner.

According to Vygotsky, the most important part of children's psychological development is acquisition of the culture to which they belong. Acquisition of mental tools plays a crucial role in the development of children's minds (Vygotsky, 1978). "The role of the teacher is to "arm children" with these tools…It involves enabling the child to use tools independently and creatively." (Bodrova & Leong, 1996, p.3). Children acquire cultural tools in interactions with more experienced members of the society. Moving from shared possession of tools (interpersonal) to individual possession (intrapersonal) is associated with gaining independence and a shift in the development of the child.

To understand the complexity of teaching in the ZPD, it is necessary to take into account such concepts as cultural and social mediation of learning, internalisation, intersubjectivity and the active position of the child. When we talk about teaching in the ZPD, we look at the way that a child's performance is mediated socially, that is, the quality of adult-child interaction. This includes the means by which the educator meets the level of the child's understanding and leads the child to a higher, culturally mediated level of development. This connects to the idea of tool mediation, that is, to a consideration of what cultural tools have been provided for the child to appropriate. It also includes a consideration of the techniques that can be used to ensure the transformation of assisted performance into independent performance (internalisation). Stone (1998) called it "knowledge consolidation" (p. 358) .

The above concepts are taught to pre-service teachers in foundation subjects in primary and early childhood teacher education programs including the active position of the child in learning, the quality of interaction and indirect instruction; collaboration and negotiation (child-adult and guided peer joint problem solving, discussion and dialogue), providing conceptual tools and utilising reflective practices (articulation, reinforcing and consolidation) (Vialle, Lysaght, & Verenikina, 2005). It is proposed that understanding the theoretical underpinnings of the metaphor might assist pre-service teachers' learning the variety of scaffolding techniques and making appropriate decisions about their classroom application. For example, understanding of Anghileri's (2006) first level of scaffolding, environment provision, can be enriched if considered in connection to socio-cultural approach to the construction of mathematics curriculum (Renshaw, 1996). The third level of scaffolding, developing conceptual thinking (Anghileri, 2006), can be better understood in connection to the notion of mental tool appropriation (Vygotsky, 1978).

Overview of the Study

In order to explore pre-service teachers' understanding of the main characteristics of scaffolding, its theoretical underpinnings and its value in their professional practice, and numeracy, we adopted a survey design for the present study.

Participants

The survey was conducted with student teachers in their third year of study in Bachelor of Education (Primary/Early Childhood) programs. Eighty student teachers volunteered to participate in the study. The background to this was that the surveyed cohort of student teachers was introduced to the socio-cultural theory of child development in the first year of their undergraduate study at the university, however the concept of scaffolding was not explicitly taught. During the second year of the program, the concept

of scaffolding was taught as part of discipline subjects related to different Key Learning Areas (KLAs) including numeracy. In addition, the students could have learnt about scaffolding from their supervising teachers during their practicum experiences in schools.

Procedure

The survey instrument included a series of open-ended questions that focussed on the following issues: how scaffolding is defined and what value it has for teaching; how scaffolding is different from traditional teaching instruction, what specific techniques it includes and what are its theoretical underpinnings. The questions were formulated in a manner that stimulated the students to provide a descriptive and detailed answer. For example, a question on scaffolding definition was worded as follows, "When a teacher says, *I scaffolded my students' understanding of numeracy*, what do you think they mean by scaffolding? How would you define scaffolding?" The survey was conducted in an anonymous manner and the participation was voluntary. The analysis of the data was assisted by the use of Nvivo software. The responses were coded in accord with the key characteristics of scaffolding such as active position of the child, joint activity, tool mediation, indirect instruction and reflective practices. The students' understanding of different levels of scaffolding was judged upon the characteristics and techniques of scaffolding, present in their answers.

Results and Analysis

Student teachers' (ST) responses demonstrated that they valued scaffolding as a helpful technique for their future teaching. In particular, they stressed the importance of scaffolding mathematics, as *it is a complex subject*. All the participants were quite familiar with the concept and believed it was different to a direct instruction of a traditional classroom.

Significant number of both primary and early childhood students demonstrated an understanding of the importance of the active position of the child in scaffolded teaching (37 responses). For early childhood students, the above view of scaffolding was in tune with the notion of child centred curriculum (27 responses). The following comments were typical:

> *STA:* Traditional classroom instruction can see the teacher providing answers without giving the learner an opportunity to discover/understand for him/her self
> *STB:* Scaffolding is child directed so the children determine their journey of education, the teacher bases their curriculum on the children's interests and knowledge as they build knowledge in the children, firstly with a lot of support and slowly stepping back as the children progress and learn.

Such emphasis on the active position of the learner in scaffolding is highly important. Learners should be given freedom to explore and discover by themselves, at their own pace and by their own means. Initiative and self-determination of the learner should not be hindered by educational instruction.

Learning in social interactions with other people was an essential characteristic of scaffolding pointed out by most of the students. A central feature of such interactions (35 responses) was a joint activity in which teacher and the learner engage. The following responses reflect the social dimensions of working in a group:

> *STC:* It is more of a team effort between teacher and student. They work together rather than being majority teacher directed.

STD: Traditional classroom instruction is just giving the students work, telling them how to do it and that is it.

The quality of teacher-learner interactions in scaffolding was explained in a number of different ways. Sixteen responses from the participants suggested the importance of indirect instruction such as prompting, hinting, guidance and support. For example, STE explained, "It means teachers aren't spoon feeding children. The children are guided, supported and even led at times, though they are putting in the effort too".

Other participants, however, had difficulties in articulating the quality of interaction in scaffolding and described it in general terms. For example, the following definitions are quite uncertain in what scaffolding actually is and what kind of support it includes:

STF: I think scaffolding is the way that teachers help children to understanding their tasks properly and direct them and keep children on track of doing the tasks

STG: A teacher/tutor etc. is alongside the child as a task is being tackled; areas of weakness can be identified immediately and applied to the task at hand. There is no delay in advising the student..

Interestingly, breaking the tasks into smaller, more manageable parts, as well as modelling and demonstration techniques were highly popular (34 responses). It was not surprising that these techniques were attractive to the students as they are easy to grasp and implement. However, they do not constitute the essence of scaffolding and can be used as part of any teaching style, e.g., a classroom based on traditional behaviourism.

Some students (10 responses) directly connected scaffolding to the ZPD. The most frequently mentioned technique was challenging the learner, for example:

STH: I would define scaffolding as demonstration and encouraging people to work in their zone of proximal development that is working outside their comfort zone to increase their knowledge and improve tasks.

A technique of changing of the amount of support while the learner is gaining the expertise is an essential characteristic of scaffolding as it refers to the changing level of a learner's expertise and moving from shared to independent performance. For example, STI made the following comment:

It allows students to develop skills over time, working from what they can do with a lot of assistance to what they can do with a little assistance and finally towards independent mastery of the skill being taught: begin with a lot of support from the teacher; slowly remove support; remove support until there is no support and the students are working independently

Just few students mentioned some more in depth characteristics of scaffolding. For example, only one student saw scaffolding as a technique that provides new learners with cultural tools that are essential for becoming an independent learner. Another student (STJ) highlighted such a subtle but crucial characteristic of scaffolding as knowledge construction and consolidation:

Traditionally one teacher would instruct a class how to add numbers together, for example, and then give them a worksheet to do it for themselves. The child has to digest the information the first time in order to be able to complete the task.

The lack of awareness of some in depth characteristics of scaffolding indicated that the students might have some difficulties in understanding them and more explicit connections of scaffolding to the theory needed to be made.

Discussion and Implications

The results of this study indicate that, on the whole, pre-service teachers were aware of the practice of scaffolding and appreciated its potential use in their day-to-day teaching of numeracy. The participants see the scaffolding metaphor as a useful concept that allows pre-service teachers to move away from the direct instruction of a traditional classroom and search for a richer and more sophisticated educational tool.

While experiencing the need to find an alternative to the traditional forms of educational instruction, student teachers look for a variety of new teaching techniques that are provided by modern pedagogy. They demonstrated understanding of the differences in the quality of teacher-child interaction when scaffolding approach is used as opposed to direct instruction. A variety of indirect techniques such as questioning, hinting and prompting were mentioned. However, a few participants expressed confusion about the quality of teacher-child interaction. In addition, a high proportion of students' responses suggested a lack of understanding of the relationship between learning environment provided by the teacher and its impact on children's use of prior knowledge. This issue has received a great deal of attention in other studies of meaningful mathematical engagement (Chinnappan, 2003).

The majority of student teachers displayed understanding of some basic techniques of scaffolding such as breaking the tasks into smaller pieces, modelling and demonstration, which are relatively easy to grasp and implement.

The more complex levels of scaffolding did not receive much attention in students' responses. Just a small number of answers indicated pre-service teachers' awareness of some in depth scaffolding characteristics such as quality of teacher-student interaction and acquisition of cultural tools (these characteristics can be associated with the third level of scaffolding mathematics of Anghileri, 2006). The lack of students' awareness of such characteristics of scaffolding suggested that they might have difficulties in their understanding.

While it is not the aim of this paper to generalise on the basis of findings of this limited sample, the results do seem to suggest that pre-service teachers lack a clear understanding of the conceptual basis of scaffolding practices in general and in relation to teaching numeracy in particular. Further research needs to explore students' understanding of the use of specific techniques of scaffolding in authentic activities of their use. A combined effort of lecturers in mathematics and foundation subjects might be beneficial for designing such activities. This level of teacher education will provide a basis for the integration of the concepts across KLAs, which is a key requirement for teaching numeracy (Beswick, 2005). The understanding of the theoretical principles of scaffolding will allow pre-service teachers to anchor their repertoire of scaffolding techniques provided by recent research. A next step of inquiry could focus on the ways that pre-service teachers' perceptions actually impact on their practicum and beyond.

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