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Scaffolding: A suitable teaching characteristic in one-to-one teaching in Maths Recovery

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This paper examines Bruner's notion of scaffolding in one-to-one teaching of Maths Recovery. The interactions of two teachers working with students were videotaped and then transcribed. The sessions are described and discussed. The results of this study showed that scaffolding is an important characteristic deemed to be suitable in one-to-one teaching of Maths Recovery. However, more study of one-to-one teaching is needed to further understand the types of characteristics that would enhance the teaching and learning process in one-to-one teaching.

In recent years one-to-one teaching programs have come to the fore with a renewed focus to see that all students have a reasonable chance of success in school, and to assist students who are at risk of school failure. But what teaching characteristics in these programs make them effective? This paper focuses on scaffolding, a teaching characteristic identified in a larger study into the effectiveness of teaching characteristics in the Maths Recovery Program, an early intervention program for students who are 6 to 7 years of age and in their second year of schooling (Wright, 1994). This program was developed by Wright over a three year period (1992-1995) and draws extensively on the work of Steffe and colleagues and related work by Wright (Wright, 1994).

Maths Recovery

The Maths Recovery teacher administers an interview-based assessment to students identified by their class teacher as low attaining. The results of this interview are then used by the Maths Recovery teacher to develop instructional activities which are just beyond the cutting edge of the student's current arithmetical knowledge (Wright, 1995). The teacher of Maths Recovery undertakes a yearlong professional development program to learn how to develop a bank of instructional activities; to understand the purpose of the activities; and to present the activities in individualised teaching sessions. The instructional activities are used by the teacher to develop an individualised teaching framework. The framework is evaluated using videotaped records of teaching sessions, written notes made throughout the teaching sessions by teachers and the teacher's on-going reflections and evaluations of their teaching. This is to ensure that the instructional activities are those most likely to advance the student's arithmetical thinking (Wright, 1994).

Wright (1994) asserts that videotaping is crucial to learning the instructional techniques used in Maths Recovery. The teacher is videotaped during individualised assessment and teaching sessions. These videotaped records are used to evaluate the instructional activities, the teaching, and the assessment of children's arithmetical knowledge and the progress over time. Wright, Stanger, Cowper and Stewart (1995) identified nine underlying principles of Maths Recovery Teaching. Following are five of these principles which focus on teacher behaviour and interactions between a teacher and student and seem particularly relevant to an analysis of one-to-one teaching.

1. Teachers use their professional judgement in selecting from a bank of instructional settings and tasks, and varying this selection on the basis of on-going observations.
2. The teacher understands children's arithmetical strategies and deliberately engenders the development of more sophisticated strategies.

3. Teaching involves intensive, on-going observation by the teacher and continual micro adjusting or fine-tuning of teaching on the basis of his or her observation.
4. Teaching supports and builds on the child's intuitive, verbally-based strategies and these are used as a basis for the development of written forms of arithmetic which accord with the child's verbally-based strategies.
5. The teacher provides the child with sufficient time to solve a given problem. Consequently the child is frequently engaged in episodes which involve sustained thinking, reflection on his or her thinking and reflecting on the results of his of her thinking.

Maths Recovery is organisationally similar to Reading Recovery (Wright, 1994). Both focus on the second year of schooling; feature teachers observing, analysing and recording students' behaviours that inform their instruction; the student and teacher are both active participants in the learning environment; and both programs are intensive and individualised. The success of both these programs hinges upon the teacher's ability to make and execute powerful decisions throughout each lesson so that, "instruction leads development rather than waiting for it" (Gaffney & Anderson, 1991, pp. 3-4). In both these programs Bruner's notion of scaffolding can be identified as an appropriate teaching characteristic used to bring about successful teaching and learning in one-to-one teaching.

Scaffolding

Bruner (1985) used the term *scaffold* as a label for the gradual withdrawal of adult control and support as a function of children's increasing mastery of a given task. This is similar to Vygotsky's assertion that every child, with assistance, can do more that he or she can by him or herself but only within the limits set by the state of his or her development. Imitation and instruction are crucial in a child's development. Vygotsky asserts that they bring out the human qualities of the mind and lead the child to new developmental levels. He states that what a child can do in cooperation today he or she can do alone tomorrow. According to Vygotsky "the only good kind of instruction is that which marches ahead of development and leads it; it must be aimed not so much at the ripe as at the ripening functions" (p. 104). Vygotsky states that the lowest threshold at which instruction can begin needs to be determined as well, but the upper threshold must be determined also; instruction must be oriented toward the future, not the past (p. 104).

Significant to Bruner's notion and Vygotsky's assertion is Diaz, Neal and Amaya-Williams' (1990) explanation that a teacher who scaffolds, keeps a task at a proper level of difficulty, always encouraging independent learning and avoiding unnecessary frustration. This links with von Glasersfeld's (1990) constructivist theory and Vygotsky's (1934/1962) zone of proximal development and sociocultural theory discussed in the larger study. According to von Glasersfeld (1990) constructivist theory of knowing, "knowledge is not an iconic representation of an external environment, but a mapping of ways of acting and thinking that are viable to the acting subject in attaining experiential goals" (p. 37). Von Glasersfeld explains that knowledge is the result of, "an individual subject's constructive activity, not a commodity that somehow resides outside the knower and can be conveyed by linguistic communication" (p. 37). He asserts that, "language is not a means of transporting conceptual structures from teacher to student, but rather a means of interacting that allows the teacher to constrain and guide the cognitive construction of the student" (p. 37). Vygotsky claims that a child's mental functions need to be fostered and assessed through collaboration with a teacher. He proposed that through collaboration the teacher is able to determine the distance between actual development and the potential development of the child, that is, a child's zone of proximal development (Hedegaard, 1990, pp. 349-350). A child's zone is not static, but instructionally sensitive. It must be recalibrated constantly to accommodate a child's new learning. The teacher, therefore, is supporting the child at the cutting edge of his or her competencies. For the child to achieve at the cutting edge the teacher provides minimal support and is constantly adjusting the amount of scaffold, to take account of the new learning's of the child. The abilities of the child are developed and strengthened through quality social interaction between the child and the teacher. Not only does this advance a child's development of higher mental function, as well, the organisational features of the social context are internalised and reflected in the child's performance (Gaffney & Anderson, 1991, p. 4).

Clay and Cazden (1990) assert that both the teacher and child share knowledge and responsibility for the task. However, the scaffolds are adjustable and temporarily used to help extend the range of work and accomplish tasks not otherwise possible. Similar to Clay and Cazden, Gaffney and Anderson (1991) assert that teachers must find tasks that engage the learner in performing at the upper level of his or her potential. This, Bruner (1985) asserts, can only be done:

> If a child is enabled to advance by being under the tutelage of an adult or a more competent peer, then the tutor or the aiding peer serves the learner as a vicarious form of consciousness until such a time as the learner is able to master his own action through his own consciousness and control. When a child achieves that conscious control over a new function, it is then that he is able to use it as a tool (p. 24)

According to Diaz, Neal and Amaya-Williams (1990), the work of Wood (1975-1976) has shown that "successful scaffolders focus children's attention on the task and keep them motivated and working throughout the session" (p. 140). Wood divides the learning task into accessible components and directs the child's attention to the essential and relevant features. Diaz et al. (1990) assert that "the teacher who scaffolds, demonstrates and models successful performance while keeping the task at a proper level of difficulty, avoiding unnecessary frustration and encouraging children's independent learning" (p. 40). This supports Clay and Cazden (1990) who state that within the zone of proximal development the child is not a passive recipient of the adult's teaching, nor is the adult simply a model of expert, successful behaviour. Rather the adult and child engage in joint problem-solving activities, where both share knowledge and responsibility for the task (p. 218). The Maths Recovery teacher performs the crucial function of scaffolding the task to make it possible for the child to reflect on the strategies and thinking involved and gain confidence in their own solutions, reducing the need to continually refer to the teacher for approval. Determining the optimal amount of scaffolding requires a high degree of craftsmanship and regulation on the part of the teacher. Scaffolds are adjustable and temporarily used to help extend the range of work and accomplish tasks not otherwise possible. The Maths Recovery teacher is constantly adjusting the amount of scaffold, to take account of new learning's of the student and anticipating and supporting the student's next step.

In Wright, Stanger, Cowper and Stewart's underlying principles of Maths Recovery teaching (1995), the teacher is involved in ongoing observation and continual micro adjusting of teaching based on his or her observations. Micro adjusting is informed by the student's performance on a task. When a student is not succeeding, the teacher adjusts the task to one closely related to the original task. A student's program must be adjusted from lesson to lesson and from moment to moment within lessons. That support keeps a student at the cutting edge of his her competencies, in his or her continually changing zone of proximal development.

The literature indicates that scaffolding is a useful characteristic to support children as they learn mathematics, and in particular those children who are seen to be at risk of failing. In the context of a one-to-one intervention program, namely Maths Recovery, this project seeks to investigate the ways in which teachers effectively scaffold children's learning.

Method

Scaffolding was identified from a larger study of one-to-one teaching, as an appropriate characteristic to analyse in Maths Recovery because it seemed highly consistent with Wright, Stanger, Cowper and Stewart's (1995) underlying principles of Maths Recovery teaching. Videotaped transcripts of teachers teaching in the Maths Recovery Program were used in the research. These were made available from Bob Wright, founder of the Maths Recovery Program. Initially, four teachers of Maths Recovery were observed for their teaching characteristics. From these observations two teachers were selected because they embodied a good number of positive (ie. appropriate) characteristics appropriate for Maths Recovery teaching and were particularly suitable in terms of the characteristic scaffolding.

Analysis

To illustrate the analysis being adopted in the present study, videotaped excerpts of interviews and teaching sessions were used. A video camera was set up to record the teaching environment, that is, the teacher, student, and tasks used during the teaching sessions. According to Wright (1994) the videotapes inform "research into children's learning; research into teaching; assessment of children's arithmetical knowledge; documentations of children's progress over time; and evaluation of instructional activities". For this study videotaped recordings of teachers teaching Maths Recovery to students were analysed. Transcripts were selected based on how well they informed the research literature on scaffolding. These transcripts were then written in the form of protocols. Two protocols using numeral identification, counting and subtraction are used to provide findings for this paper, however the project was considerably larger.

A necessary feature of scaffolding is that it can be applicable across settings and tasks. During a Maths Recovery teaching session on numeral identification and counting tasks, scaffolding from the teacher was identified. The student placed the numeral cards from "12" to "16" in order on the table. The teacher asked the student to identify the numerals on the table.

1. T: Right, count these ones for me.
2. C: (Uses finger to point at numeral cards) twelve, eleven.
3. T: Twelve. What comes after twelve?
4. C: (Pauses for four seconds) eleven.
5. T: Twelve. You count up to twenty for me.
6. C: One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve, thirteen, sixteen, sixteen.
7. T: Start again and I will point to the numbers when you get to them.
8. C: One, two, three, four, five, six, seven, eight, nine, ten, eleven, twelve (stops after "12") twelve.
9. T: (Pauses for seven seconds points to numeral cards "12" and "13") ten, eleven, (indicates with an upward inflection).
10. C: Thirteen, fourteen, fifteen, sixteen.
11. T: Let's try that again. We'll start with number ten, eleven (points to numeral card "12").
12. C: Twelve (pauses for six seconds) twelve, eleven.
13. T: Ten.
14. C: (Immediately responds) ten.
15. T: Eleven, twelve.
16. C: (Counts with teacher) eleven, twelve, thirteen, fourteen, fifteen, sixteen (as teacher points to numeral cards).
17. T: Right (with an upward inflection in the voice to indicate the child's success).

The Maths Recovery teacher performed the crucial function of scaffolding in this task to make it possible for the student to reflect on his thinking. The teacher asked the student to count the numeral cards that were placed on the table by the student. In Line 3 the teacher prompted the student by asking him what comes after twelve. At this time the teacher provided sufficient time for the student to reflect and think about the task. Gradually, the scaffolding was increased as the teacher realised that the student was not able to identify and count on from a given numeral. This is evident in Line 5. From Line 7 to 10 scaffolding had been adjusted to instructionally support the student so that he could accomplish the task. This was evident when the teacher invited the student to count with him. The teacher broke the task into simple components, paused and allowed time for the student to think about the task and supported the student's next step. The teacher was successful with keeping the student focused and working through the task to the point where the student successfully counted with the teacher. This was evident in Lines 15 and 16. This embodies Diaz, Neal and Amaya-Williams' (1990) explanation that a teacher who scaffolds, keeps the task at the proper level of difficulty, encouraging independent learning and avoiding unnecessary frustration.

In the next protocol the student was asked to solve a subtraction problem "55-11" using bundling sticks. When the student was asked the question, "How did you know that?" She was able to describe confidently the strategy she used. Had the teacher not supported her and been willing to be involved in meaningful dialogue she may not have explained her strategy so clearly.

1. T: Fifty-five take away eleven (places five bundles of "10" sticks and five sticks under cover, removes one bundle of "10" and one single stick and covers these). I'll leave it uncovered (removes cover from eleven). I took away eleven. Fifty-five take away eleven.

2. C: (Reflects for ten seconds appears to be thinking and points to covered card) was that fifty-five?

3. T: Fifty five was under there (points to covered card) and then I took eleven away.

4. C: (Immediately) forty-four.

5. T: Very good girl. How did you know that?

6. C: Because you took one of each away. (Removes cover from "55") there was five in here (places single stick with group of four, points and counts) one, two, three, four, (checks again) one, two, three, four, five. And then there was five in here (places single bundle with group of four bundles) ten, twenty, thirty, forty, fifty. Then you took away one which was four (removes one stick) then you took away ten (removes one bundle) which would make four.

Here the teacher and student, both shared their knowledge and responsibility for the task. In Line 2 the student reflected for ten seconds, and sought clarification for part of the problem. The teacher repeated the problem, keeping the task at the same level of difficulty. She did not micro-adjust but allowed the learner to master her actions through her own consciousness and control. This is a good example of what Bruner (1985) asserts, "an adult serves the learner as a form of consciousness until the leaner has master consciousness and control" (p. 24). This was evident in Line 4 and Line 6. The student was asked how she solved the problem and responded in a manner that indicated that she was motivated and working throughout the task. When the teacher and student interacted meaningfully like this, opportunities were there for the teacher to understand and negotiate meaning with the student.

Discussion

Both teachers in this study were similar with scaffolding when the students seemed to be experiencing difficulty or seeking clarification of the task. This served to minimise frustration on the part of the students and kept the them focused and working on the task that was nevertheless at a reasonable level of difficulty. Both teachers micro-adjusted their teaching depending on the student's success on the task. Both teachers provided instructional support based on continual observations of students. This kept the students at the cutting edge of his or her competencies. The notion of scaffolding affirms Vygotsky's (1934/1962) theory of a zone of proximal development and sociocultural theory "every child can do more with assistance, than they can by themselves but only within the limits of their development" (p. 103). Significant in the teaching of both teachers was their confident approach to one-to-one teaching, which, in turn, seemed to engender motivation and confidence in their students. Evident in the teaching of both teachers was the underlying principles of Maths Recovery discussed earlier and particularly the forth principle, the teachers built on each of the student's intuitive, verbally-based strategies which will serve as a base for the development of written forms of arithmetic.

Conclusion

The conclusion of this study indicates that the research literature about scaffolding is appropriate for developing an understanding of one-to-one teaching in Maths Recovery. However, this research highlighted the need for more study of one-to-one teaching to establish what teaching characteristics bring about successful teaching and learning in a one-to-one setting. There was minimal research literature available which specifically focussed on one-to-one teaching. From this data, it would appear there is a need to research teaching characteristics such as scaffolding, further, to establish just how successful teachers of one-to-one teaching are and to develop a bank of characteristics deemed suitable to use in teacher education and training.

Recently there have been many debates about how teachers teach, and how effective they are at using their skills and abilities to meet the demands of the curriculum and students. In the past the assumption was that teachers were considered effective if their students sat quietly and listened to the teacher, completed all the necessary work, responded correctly to teachers' questions and passed tests. It was considered important that the teacher is in control and the students were required to adapt to the teacher's environment (Lyons, Pinnell & DeFord, 1993). While some aspects of this are important they are a small part of teaching. The notion of scaffolding appears to have an impact on the teacher and student. A teacher who consistently exhibits this characteristic is more likely to enhance learning and be a more effective teacher. A teacher's observational skills and reflective practice enables them to make important decisions at crucial moments in a student's learning. They create a learning environment that supports good teacher and student interaction, where students are not passive recipients but active, motivated participants who are supported throughout their learning.

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