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Effectiveness of training peer tutors to scaffold instruction

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EFFECTIVENESS OF TRAINING PEER TUTORS TO SCAFFOLD INSTRUCTION

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ABSTRACT

The present study examined the effects of training child-tutors to scaffold instruction. Scaffolding is a metaphorical structure which teachers implement to provide temporary support aiding children to learn new skills. Grade seven and eight tutors were taught to apply the contingent shift rule (the CS rule) of giving more support when their grade five tutees failed and less support when the tutees succeeded. Tutors were randomly assigned to one of three training groups: (1) an experimental group trained to use the CS rule, (2) a control group trained to consistently use moderate levels of support and (3) a control group given practice with long-division but no tutor training.

There were eight tutor-tutee pairs in each of the three conditions. In the first session, tutors and tutees were administered various pretests including an audiotaped pretest of spontaneous tutor scaffolding. The second and third sessions consisted of training tutors by group and training individual tutors as they worked with their tutees. The third session was followed by affect posttests. In the final session, posttests were administered to both tutees and tutors.

Results indicated that contingently trained tutors found the strategy difficult to apply and did not, in fact, follow the contingency rule any more frequently at posttest than the other tutors. Not surprisingly, the contingently trained groups showed no evidence of generalization of these skills. Although child-tutors did not learn to employ the complete CS rule more frequently in this study, their ability to acquire the strategy cannot be discounted. It may be that tutoring practice and feedback sessions would have been more effective in teaching the tutors the CS rule if tutee need for task assistance was greater and/or if more training sessions were administered.

Nevertheless, all tutees, regardless of group tended to show improved long-division skills after the tutoring experience. In addition, contingently trained tutors felt more positive about themselves as teachers than did untrained tutors. As well, tutees taught by contingently trained tutors were more positive about the tutoring experience than tutees taught by untrained tutors. Overall, the general ideas of scaffolding based on Vygotskian principles, and described by Wood et al. and others, were consistently supported by the patterns observed across groups.

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Peer tutoring, a system in which students teach other less knowledgeable students educational material, has experienced a revival in America in the last 25 years (Allen, 1976; Ehly & Larsen, 1980; Wagner, 1982). The revival occurred in the late 1960s as a result of anecdotal reports and some empirical evidence of benefits to both tutees and tutors (Cloward, 1967; Ellson, Harris, & Barber, 1968; Gartner, Kohler, & Riessman, 1971; Lippitt & Lippitt, 1968).

The purpose of the present study was to investigate, using the peer tutoring paradigm, whether child-tutors could be trained to employ a scaffolding tutoring strategy, a strategy which involved the provision of more support when a learner failed and less support when a learner succeeded. This strategy has proved to have important effects on children's learning and transfer of training (Savoy, 1989; Wood, 1980). In addition, the study investigated what benefits resulted for tutees and tutors if tutors learned to use this strategy effectively.

The beginnings of peer tutoring are frequently traced to its popularized use in the early nineteenth-century. There is, however, reference to its use in the Roman empire as early as the first century of our era

(Wagner, 1982). The intermittent use of peer tutoring in subsequent years was limited to localized use until the creation of the monitorial system in the nineteenth century (Wagner, 1982).

The monitor system was devised by Andrew Bell (1753-1832) in an effort to deal with the paucity of teachers for the poor in India. Bell was a Scottish member of the clergy, who was also the superintendent of a school in India which had been established for the orphaned children of European soldiers (s.v. "Bell, Andrew." American Academic Encyclopedia, p. 185). In Bell's system, one classroom or group of students was led by an older boy who had a number of younger children assisting him (Allen, 1976). At times the students were given one-to-one tutoring by boys in the class above them (Wagner, 1982). The co-ordination and administration of this educational system was carried out by another group of students and their assistants. Finally, an adult teacher oversaw the entire operation (Wagner, 1982). Bell proposed that students taught under the monitorial system could be provided with reading, writing, spelling and ciphering skills in a co-operative atmosphere (Allen, 1976; Wagner, 1982).

Bell's monitorial system was modified and popularized in England and abroad by Joseph Lancaster (1778-1838) (Allen, 1976; s.v. "Lancaster, Joseph." American Academic Encyclopedia, p. 177). Lancaster provided education for a large number of poor children who at that time were not given state education. The advantage of the monitorial system is attested to by its growth over 20 years to a system of 95 schools serving 30,000 students (s.v. "Lancaster, Joseph." American Academic Encyclopedia, p. 177).

Unfortunately, due to factors such as the inadequate training of student tutors and the introduction of state funded public education, the popularity of peer tutoring went into a decline which was not reversed until the late 1960's when positive reports about peer tutoring were brought to the attention of researchers (Allen, 1976; Wagner, 1982). As various programs were developed in schools of the 1960s, researchers' attention turned to such variables as program length (Fresko & Eisenberg, 1985), frequency of tutoring sessions (Cloward, 1967), criteria for selection as a tutor or tutee (Bierman & Furman, 1981), type of tutoring approach (Judy, Alexander, Kulikowich, & Willson, 1988), and previous training as a tutor (Neidermeyer, 1970).

One of the issues in contemporary peer tutoring research is definition of the term "peer tutoring" itself. Cohen, for example, defines peer tutoring as "a one-to-one teaching process in which the tutor is of the same general academic status as the tutee" (Cohen, 1986, p. 175). Ehly and Larsen define peer tutoring as "children teaching other children, usually on a one-to-one basis" (Ehly & Larsen, 1980, p. 3). Still different is Wagner's definition of peer tutoring as "students teaching other students in formal and informal school learning situations that are delegated, planned, and directed by the teacher" (Wagner, 1982, p. 5).

The above definitions differ directly or by omission on the following items: the number of students involved in a peer tutoring group (two of them specify that peer tutoring is one-on-one tutoring), the academic status of both tutor and tutee, formality of the program, and the person responsible for implementing the program. As well, some studies have referred to the situation in which the tutor is older than the tutee as "peer tutoring" studies, while other studies use the more precise term, "cross age tutoring" (e.g., Lippitt & Lippitt, 1968). Other terms used in the literature instead of "peer tutoring" are listed by Cohen as "`proctoring', `peer teaching', `cooperation', `unstructured tutoring', and `group reinforcement'" (Cohen, 1986, p. 175).

Theorists have naturally attempted to identify the source of peer tutoring benefits. It has been suggested that peer tutoring is advantageous to tutees because they receive individual attention and feedback in a co-operative rather than competitive learning situation. In addition, tutees are given the opportunity to emulate child-tutors who are closer in abilities to tutees than adult-teachers, and communication between tutor and tutee is easier due to similar language skills (Cohen, 1986; Gartner et al., 1971; Lippitt, 1976). For tutors, such features as material review, the opportunity to develop helping skills, and to relate to the needs of learners have all been listed as sources of benefit (Cohen, 1986; Gartner et al., 1971; Lippitt, 1976).

Despite these reasons for believing that peer tutoring should increase achievement and positive affect, research has not resulted in consistent evidence of academic and affective benefits to participants (Cohen, Kulik, & Kulik, 1982; Devin-Sheehan, Feldman, & Allen, 1976; Hartup, 1983). Some studies have indicated increased scores on standard tests while other studies have indicated that tutoring resulted in little or no increase in achievement scores (Hartup, 1983). As well, affective benefits have been reported in some studies (e.g., Staub, 1975), but not in other studies (Cloward, 1976; Cohen et al., 1982).

In order to discover factors in tutoring programs which may influence the effectiveness of tutoring, Cohen et al. (1982) did a meta-analysis of 65 tutoring programs, examining the influence of different variables on achievement. Most of these studies, though not all, involved same or cross-age peer tutoring. Variables included: (1) the type of tutoring program (e.g., structured vs. unstructured), (2) experimental design (e.g., standardized test vs. locally developed test), and (3) program composition (e.g., subject matter selected, program length, age of participants).

Their results indicated that tutoring increased academic performance for tutees in comparison to untutored or control students. The average effect size was modest at .40. This result, however, was quite variable across studies. Only 31% of studies showed effects in the medium to large range; the rest showed small or no effects. Effect sizes were defined as small, medium or large according to the statistical standards in this area (Cohen, 1977).

However, the larger effect sizes occurred in studies having particular features. Specifically, studies which used structured tutoring programs, self-developed achievement tests, were of short duration (0-4 weeks), focused on mathematics, or taught lower-order skills (i.e., skills that could be measured on standard examinations), had larger effect sizes for tutee achievement than studies which were unstructured, used a standardized achievement test, were of longer duration, focused on reading or other skills, or taught higher-order skills.

Tutoring also resulted in increased academic performance for tutors, with an average effect size of .33, and a significantly larger effect size for mathematics (.62) than for reading programs (.21). This meta-analytical study supports the view that tutoring, including peer tutoring, is effective in increasing participant achievement when certain features are incorporated.

One of the above features which was important for both tutors' and tutees' achievement was having mathematics as the tutored subject matter. Many other studies have indicated that peer tutoring is an effective vehicle for teaching mathematics skills (Greenwood et al., 1984; Harris & Sherman, 1973; Maheady, Sacca, & Harper, 1987; Sharpley, Irvine, & Sharpley, 1983).

Sharpley et al. (1983), for example, examined the academic and affective benefits of a cross-age mathematics program for tutors and tutees. Grade five and six students tutored grade two and three students on basic operations. Tutees were randomly assigned to tutors. Non-tutored and non-tutoring control subjects received regular classroom instruction in mathematics while tutoring occurred. All subjects were given a mathematics achievement test, and the tutors and non-tutors were given a self-esteem inventory, both before and after the program. The program lasted five weeks, with four, 30 minute tutoring sessions a week. Tutors received training prior to tutoring and while in the tutoring program.

The experimental groups did not differ significantly from the control groups on the pretest mathematics achievement test. The pretest to posttest mathematics performance gain of both tutors and tutees increased significantly more than did that of their respective control groups on the mathematics achievement test. There was no significant difference in the self-esteem gains of tutors and non-tutors.

Mathematics benefits to participants have been shown in peer tutoring studies at higher grade levels as well. In a classwide peer tutoring study, Maheady et al. (1987) had students in grade nine and ten mainstreamed classes teach each other mathematics skills in teams (3 to 5 members). The mainstreamed students were learning disabled or had behaviour disorders. Team membership was such that each team had at least one student with high mathematics performance skills, one student with average mathematics performance skills and one student with low mathematics performance skills. Members took turns acting as the team tutor. Grade nine students, including mainstreamed students, tutored each other in such topics as ratios and proportions, computations with fractions and fractional percentages. Grade ten students, including mainstreamed students, taught each other applied topics such as gross pay calculation and family budgeting. During the school term, grade nine and ten non-disabled and mainstreamed students increased their weekly mathematics test performance substantially. These studies suggest that children are capable of teaching other children mathematics, and that peer tutoring can bring about important benefits to tutors' and tutees' mathematics achievement.

One of the factors that needs to be considered when setting up a peer tutoring program is the age of the tutor in relation to that of the tutee. The tutor might be the same age as the tutee, or he/she might be older. This latter situation is called cross-age tutoring. There is inconsistent empirical evidence supporting the superiority of any particular age relationship between tutor and tutee (e.g., no difference in age, small differences, large differences, Devin-Sheehan et al., 1976).

Same-age studies have been successful in situations such as those used by Maheady et al. (1987), in which students alternate tutor and tutee roles. This reciprocal peer tutoring process has been successfully used in teaching grade seven students to use reading comprehension strategies (Palincsar, Brown, & Martin, 1987).

In the Palincsar et al. (1987) study, tutees were not initially expected to teach each other, but rather were guided by a same-age student tutor to gradually assume responsibility for using reading comprehension strategies and leading the other students in their use. The authors identified this process of transferring responsibility as "scaffolded" instruction (from work by Wood, Bruner, & Ross, 1976). It is scaffolded instruction in the sense that the teacher supports each student, according to his/her need, until the support is no longer needed.

In this study, tutors modelled reading comprehension strategies by asking the students questions about the text content, summarizing the text, clarifying information, and predicting what would happen next in the story. The tutors were to gradually provide less leadership in the discussion as the students played the role of tutor in leading the dialogue.

Tutoring transcripts showed that the student-teachers were successful in leading tutees to use the reading comprehension strategies in the role of tutor and that students' reading-comprehension skills improved significantly from baseline performance. This study suggests academic benefits when same-age tutoring is employed. However, a control group was not utilized.

A further benefit of same-age tutoring is thought to be the greater likelihood that tutor and tutee will become friends. As a result, the benefits that accrue from a positive social relationship are thought to be greater for same-age than for cross-age tutor-tutee pairs

(Cohen, 1986; Hartup, 1976).

Cross-age programs are thought by some researchers to be more effective on measures such as academic performance than on measures of social skills (Cohen, 1986; Devin-Sheehan et al., 1976; Hartup, 1983). Older tutors are usually more knowledgeable than same-age tutors, they are of higher status than a same-age tutor, and they may not pose as great a threat to tutee's self-esteem or make the tutee as competitive as would a same-age tutor (Cohen, 1986; Lippitt, 1976).

Participation in cross-age programs has been evaluated by Lippitt (1976). In terms of advantages and disadvantages to tutors, tutees, teachers, administrators and family, Lippitt suggests that the advantages procured from cross-age tutoring far outweigh the disadvantages. Finally, tutors and tutees themselves prefer to be involved in cross-age tutoring programs rather than in same-age programs (Hartup, 1983).

The effectiveness of different peer tutoring programs has generally been evaluated through the use of outcome measures (see review by Devin-Sheehan et al., 1976). These outcome measures (e.g., tutee's performance score on a tutoring posttest, tutor's attitude score on an attitude questionnaire) are quantitative and focus on the product of tutoring (Judy et al., 1988; Ehly & Larsen, 1980; Palincsar et al., 1987).

Process measures (e.g., the degree to which a tutor employs certain tutoring behaviours), used less frequently in peer tutoring research, provide information about tutoring effectiveness (Judy et al., 1988; Ehly & Larsen, 1980; Palincsar et al., 1987). For example, Neidermeyer (1970) used the Tutor Observation Scale to examine the tutoring process for trained tutors as opposed to untrained tutors. Two observers recorded tutors' use of seven instructional behaviours. One drawback of this measure is the necessity of having two observers present during tutoring sessions in order to check interrater reliability. The measure was successful, however, in providing a reliable way to examine the effect of training on the tutoring process (results of this study are described below).

A method of examining the tutoring process which does not require the presence of two observers is the audiotaping of tutoring sessions. This method of audiotaping tutoring sessions for later transcription and evaluation has successfully provided a way to measure the accuracy of the tutor's instruction and the extent to which a tutor employs a certain behaviour or instructional approach (Judy et al., 1988; Palincsar et al., 1987).

In the study by Palincsar et al. (1987) mentioned previously, seventh grade remedial reading students were given the responsibility of taping each tutoring session. The transcripts of the session allowed the researchers to measure the frequency with which wrong information was provided to tutees, the success of the tutor in modelling the use of reading comprehension strategies, and the degree to which the tutor scaffolded his/her instruction. In addition, the transcripts indicated the type of feedback provided by the supervising teacher to the different tutoring groups (e.g., helped the tutor with the meaning of difficult vocabulary). Audiotaping in general proved to be a successful method of procuring information regarding the tutoring process and evaluating the effectiveness of factors such as tutor training.

Many researchers have held that tutor training generally enhances the effectiveness of tutoring (Hartup, 1980; Jenkins & Jenkins, 1985; Lippitt & Lippitt, 1968; Neidermeyer, 1970). It has been demonstrated that untrained child-tutors do not spontaneously use principles of effective teaching to the degree that tutors trained to use these principles do (Neidermeyer, 1970). In Neidermeyer's (1970) study, tutors were fifth grade students who taught kindergarten children materials related to their reading program. Tutor behaviour was rated on Neidermeyer's "Tutor Observation Scale", which included seven behavioural measures derived from the goals of his training program. Trained tutors scored significantly higher than untrained tutors on five of the seven instructional behaviours. Trained tutors more often (1) initiated noninstructional friendly communication with the pupils, (2) verbally confirmed correct responses, (3) offered praise, (4) told pupils the correct response when pupils gave an incorrect response, and (5) had pupils make the correct response after an incorrect response before allowing the tutee to proceed. The two groups did not differ significantly in question re-phrasing following no response by the tutee. Trained tutors tended to give the pupil the correct response - treating no response as an incorrect answer rather than a misunderstanding. Untrained tutors silently waited for a tutee response. In addition, trained and untrained tutors did not differ in the degree to which they provided prompting, which was usually unsuccessful. This study indicates that untrained tutors do not use effective tutorial skills to the same extent as do tutors who are trained in the use of tutorial skills.

Researchers differ in their suggestions as to what skills tutors need to be trained to use and what type of training is most successful in promoting skill use. In their cross-age programs, Lippitt and Lippitt (1968) trained tutors in such things as how to relate to the younger students' needs, how to diagnose problems, how to point out errors constructively and how to help tutees achieve a higher level of success. Cohen (1986) suggests that tutors should be trained in helping behaviours and positive reinforcement and that young tutees be trained to ask questions, to explain their learning problems and to ask for feedback and help. Jenkins and Jenkins (1985) suggest that tutors should be trained in such things as measuring and recording tutee performance as well as in the specific content area they will be tutoring. Which of the skills a tutor needs to be trained to use will depend on factors such as the goals of the tutoring program, time available for training and the needs of the tutors (Ehly & Larsen, 1980; Gartner et al., 1971).

Much of the research which demonstrates successful tutoring has included comprehensive training programs. For example, Lippitt and Lippitt (1968) provided weekly in-service training seminars for tutors or tutor conferences with the tutee's classroom teacher. Mobilization for Youth, evaluated by Cloward (1967), provided preservice training around the goals and organization of the program, and about tutor duties and the tutee group characteristics. In-service training was maintained once a week for two hours in order to help tutors deal with problems, learn to respond to tutee needs, and become familiar with the curriculum and with tutoring techniques.

Tutoring programs which are highly structured (e.g., using a specific technique to teach mathematical concepts) may need to provide more specific tutor training. Peer Mediated Instruction (PMI), a structured tutoring approach, was used by Ehly (1975, unpublished doctoral dissertation, cited in Ehly & Larsen, 1980) to teach spelling to sixth grade students. Training included general peer tutoring concerns, specific training in the use of the PMI techniques, and supervised use of PMI during tutoring.

There is evidence that tutor training which teaches tutors to use specific rules, and is highly controlled, is more effective than tutor training which is more general and leaves more decisions to the tutor (Ellson et al., 1968). Ellson et al. (1968) compared the effects of tutors trained to use programmed tutoring (i.e., tutors taught specific rules) with the effects of tutors trained to use directive tutoring (i.e., tutors taught to model the teaching of classroom teachers). The two groups received the same number of training hours and a similar training schedule. Results indicated that first grade children tutored twice a day by children trained in programmed tutoring improved significantly in reading ability in relation to the non-tutored control group. Children tutored by tutors trained in directed tutoring were not significantly better that non-tutored controls. In addition, programmed tutoring was more effective than directed tutoring in improving reading ability. The results indicate that specific rule training is more effective than modelling (a more general training which does not provide specific rule training).

In summary, some peer tutoring programs have resulted in increased participant achievement and/or greater positive affect. Program features have been shown to influence the effectiveness of tutoring programs. One of these features, tutoring in mathematics, has been effective in increasing participant achievement, and somewhat more effective than tutoring in other subject areas. In addition, tutors who are older than tutees are more effective at tutoring a subject for academic gains than tutors who are the same age as tutees. The effectiveness of tutoring programs can be evaluated by using both product and process measures. Process measures, such as audiotaped tutoring sessions, provide a way to measure tutors' use of training strategies. Tutor training has generally enhanced the effectiveness of tutoring and increased child-tutors' use of specific tutoring strategies.

The peer tutoring study proposed in this paper is a cross-age study in which the subject matter is mathematics. Of particular interest is whether tutors can be trained to effectively use a particular tutoring strategy which is based on Vygotsky's (1978) theory of good instruction. Tutor use of this strategy will be evaluated, using audiotaped process measures. Product measures will be used to examine the outcome of tutoring for the participants.

A theoretical framework for investigating and evaluating the quality of good instruction in peer tutoring research can be found in the work of Lev Semyonovich Vygotsky (1896-1934). Vygotsky, a Russian theorist, was relatively unknown in the West until his work Thought and Language, first published in the Soviet

Union in 1934, was abridged (Griffin & Cole, 1984) and translated into English in 1962 (Cole, John-Steiner, Scribner, & Souberman, 1978). The editors of a 1978 collection of Vygotsky's manuscripts specify their main sources as "Tool and Symbol in Children's Development" and The History of the Development of Higher Psychological Functions (Cole et al., 1978). This book, entitled Mind in Society (Vygotsky, 1978), substantially expanded Western access to and understanding of Vygotskian theories (Toulmin, 1978).

In order to understand the criteria that Vygotsky used to judge good instruction, it is first necessary to understand that which his judgement is based on - his view of the relationship between cognitive development and learning (Vygotsky, 1978). Vygotsky proposed that there are two important indicators of cognitive development: that which a child can do independently, which Vygotsky called "actual development," and that which a child can do with the support of a more knowledgeable person (Vygotsky, 1978). The first of these indicators provides information about the child's independent abilities at the present time. The latter provides information about the child's independent abilities in the near future (Vygotsky, 1978). Vygotsky proposed that between the child's present and future independent abilities is an area in which abilities are in the process of development (Vygotsky, 1978; Wertsch, 1985). Vygotsky termed this the "zone of proximal development" (ZPD), and defined it as "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978, p. 86).

Vygotsky proposed that learning occurs when a child is given adult or peer assistance to complete a task which he or she could not complete independently. In other words, learning results from interaction in the child's ZPD and supported by a more knowledgeable adult or peer (Vygotsky, 1978; Wertsch, 1985).

Vygotsky stressed the social nature and origins of all "higher," specifically human, cognitive functions (in contrast to "natural" functions which are shared with other species). In particular, Vygotsky argued that it is only such social interaction which can stimulate these functions as they are in the process of development. Once stimulated, these interactional processes between expert and novice gradually become internalized by the learner, and the child or novice then demonstrates this internalization by the capacity to utilize these skills independent of adult or peer support (Vygotsky, 1978; Wertsch, 1985). The social origin of higher psychological functions is elucidated in Vygotsky's law of cultural development: "any 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 the child (intrapsychological)" (Vygotsky, 1978, p. 57). Thus it is Vygotsky's judgement that good instruction is instruction in the ZPD. Specifically, good instruction is (1) directed beyond what the child is currently able to do independently, and (2) directed at teaching functions which the child can complete only with assistance (Vygotsky, 1978; Wertsch, 1985).

Vygotsky's work was very theoretical and had a limited empirical base, due to his brief period of active work in psychology (Wertsch, 1985). Empirical methods that instantiate his theories within a research context have been examined by some recent writers (e.g., Griffin & Cole, 1984). Two ideas about instructional processes, relevant to the ZPD, have become popular in the West in the 1960s and 1970s (Griffin & Cole, 1984). One of these is the "next-step" conception of development and instruction (Griffin & Cole, 1984). The other idea, "scaffolding" (Griffin & Cole, 1984), which will be elaborated further, describes an instructional process resulting in development (Wood, 1980; Wood et al., 1976; Wood & Middleton, 1975).

The next-step notion is a neo-Piagetian concept similar to Vygotsky's idea that good instruction is directed at the step or stage just beyond current functioning (Griffin & Cole, 1984). Such neo-Piagetian conceptions depend on analyses of development in a skill or concept domain into hierarchically-ordered sequences of "levels' or "stages". Unlike Vygotsky, however, next-step theorists suggest that a child will move forward in this sequence once the child's experiences indicate that the level currently being used is inadequate (i.e., current rule application leads to problem failure; Siegler & Richards, 1981), rather than when a more knowledgeable person guides the child's learning. For example, Piaget suggests that social interaction (especially with peers) is a factor in the mental development of the child. However, in order for the child to benefit from social interaction, he/she must be at a level, through biological maturation and experience, from which he/she is "prepared" to move on (Piaget & Inhelder, 1969; Wood, 1988). As well, Piaget suggests that learning from social interaction occurs primarily due to children's cognitive conflict with their peers, not through co-operation with peers or adults (Wood, 1988). In general, then, the "next-step" concept, with its focus on programmed developmental sequences or stages, fails to capture the specific role of supportive social interaction in Vygotsky's idea of development in the ZPD (Griffin & Cole, 1984; Wood, 1988).

The other notion, scaffolding, is more closely related to Vygotsky's idea of the ZPD. Scaffolding is an instructional method in which a child is given assistance to complete a task that he or she could not complete without assistance (Wood, 1980; Wood et al., 1976; Wood & Middleton, 1975). It fulfills Vygotsky's requirements of good instruction in the ZPD (Palincsar, 1986) in that: (1) it is instruction on a task which is beyond the child's current level of independent competence and (2) it enables the child through supportive social interaction to develop independent functioning (Wood, 1980; Wood et al., 1976; Wood & Middleton, 1975; Palincsar, 1986). Some authors have used the scaffolding notion as an equivalent form of the ZPD (Griffin & Cole, 1984). However, scaffolding is properly understood as an instructional process used to bring about a child's development (Wood et al., 1976), whereas the ZPD is a concept which represents the area in which development occurs (Vygotsky, 1978).

Scaffolded instruction is not only important as an enactment of good instruction in the ZPD, it is important in its own right. Much attention has been given to the observation of scaffolding and the benefits which are realized by children who receive scaffolded instruction. Scaffolding is of particular relevance to the current study, which examines the efficacy and benefits of training peer tutors to scaffold their instruction based on the conceptions developed by Wood and colleagues (Wood et al., 1976). In this light, scaffolding merits further attention.

The term "scaffolding" originates from a metaphor introduced by Wood et al. (1976). Ordinarily, scaffolding is defined as "a temporary wooden or metal framework for supporting workmen and materials during the erecting...of a building" (s.v. "scaffold," Webster's New World Dictionary, 1970). Wood et al. (1976) used the ordinary meaning of the term to describe what occurs when problem-solving is done in a social context. Wood et al.'s (1976) and Wood's (1980) description of instructional scaffolding is as a "teaching structure" which has a support role, functions as a construction aid, and is temporary in nature.

To detail the metaphor, in instructional scaffolding, the adult builds a temporary framework for supporting children during the learning of a cognitive function. The role of this support structure is to provide the degree of support needed for joint adult-child activity. The purpose of the support structure is to allow the child to proceed on a problem which he or she could not solve unassisted. Once the problem can be completed independently, the temporary support structure can be removed (Wood, 1980; Wood et al., 1976).

There have been different approaches taken to scaffolding in the literature. One approach to scaffolded instruction was used in Palincsar's work (Palincsar, 1986; Palincsar et al., 1987). In Palincsar's (1986) study, first grade pupils were taught reading comprehension strategies by teachers trained to scaffold instruction. The teachers scaffolded student instruction by having the children gradually assume a more responsible role in discussions which followed the reading of a text. For instance, students were encouraged to ask the other students a question about the text. If necessary, the teachers directly modelled questions for the students to ask. Over a period of twenty days, the student-teacher dialogues gradually changed, from being largely directed by the teacher (teacher reviewed the strategies and modelled them) to being led by the students (students used the strategies).

Another approach to scaffolded instruction is scaffolding of the tutoring task so that a child is able to engage in elements of a task he/she can not perform unassisted. The natural use of this type of scaffolding differs among adults (Wood & Middleton, 1975). Wood and Middleton (1975) examined the differences in mothers' use of such scaffolding processes. Wood and Middleton videotaped the interventions of 12 mothers helping their 3 to 4-year-old children build a six-level pyramid. All levels of the pyramid but the sixth, which was a solitary block, were comprised of four interlocking blocks. The size of the blocks was decreased at each ascending level to produce the pyramid shape. Following a demonstration of the pyramid task and an opportunity to try the task, mothers were asked to help their children build the pyramid.

The videotapes of the mother-child tutoring sessions were analyzed. The mothers' interventions were categorized according to a hierarchy of five levels of increasingly direct support. By way of example, the terms and examples of Wood and Middleton for only the lowest (1), intermediate (3), and highest (5) levels of support were: (1) "general verbal instruction" (i.e., the mother asks the child what he or she is planning to do next), (3) "mother indicates material" (i.e., the mother indicates to the child which block is needed next), and (5) "mother demonstrates" (i.e., the mother chooses the correct blocks and builds the pyramid).

Having coded the interventions according to support level, Wood and Middleton determined the proportion of times that a mother directed her level of support in the child's "region of sensitivity to instruction" (p. 185). Wood and Middleton defined the child's region of sensitivity to instruction (RSI) as "that level at which the child failed to follow the most specific or helpful instructions" (p. 185). In other words, the RSI is that level of support which is one level below the least supported level at which the child is successful. Performance at each support level was characterized as successful or not successful by a binomial test on the total distribution of successes and failures. For example, RSI would be level 2 if success rate was significantly above chance at level 3, 4, and 5 interventions, but below chance at level 1 and 2.

The RSI can be viewed as one way of investigating Vygotsky's general notion of the ZPD in precise terms. The RSI is used to study the acquisition of specific skills based on task analysis, while the ZPD is a much broader concept used to discuss education and development in general terms. In a sense, Vygotsky's notion of the ZPD encompasses all levels of support by a tutor, rather than mapping on to a specific level in a series of hierarchical steps, as does the RSI.

Wood and Middleton (1975) also examined the frequency with which a mother provided a level of support which was contingent on the child's previous performance. This was translated empirically as the extent to which mothers provided a higher level of support after a child's failure and a lower level of support after a child's success (Wood & Middleton, 1975). This strategy of providing more support after failure, and less support after success, has since been referred to as using the "contingent shift" (CS) rule (Wood, 1980; Pratt, Kerig, Cowan, & Cowan, 1988).

The researchers found wide individual differences in mothers' use of the RSI and mothers' use of the CS rule. Interestingly, the mothers' proportional use of the RSI and the mothers' proportional use of the CS rule were positively correlated with the children's subsequent independent performance on the pyramid task (choosing the correct blocks and rejecting the incorrect blocks). As well as demonstrating that effective instruction was related to greater use of the RSI and the CS rule, Wood and Middleton demonstrated that these two measures of scaffolding were strongly positively correlated with each other. Presumably mothers who followed the CS rule were better able to locate and operate within the RSI. This increase in RSI use following use of the CS rule follows logically from the definition of the two concepts. Note, however, it is perfectly possible to teach within the RSI and not follow the CS rule. The RSI level by definition is a level at which a child is learning a task with help and is failing at times. Therefore, if a tutor consistently intervened at the same level, which was the child's RSI, he/she would be within the RSI but not using the contingent shift rule which would require shifts in support after each outcome. Clearly, the concepts of the RSI and the CS rule as measured here need not be perfectly correlated.

Pratt et al. (1988) proposed that differences in parental scaffolding (use of the RSI and the CS rule) should be related to children's success on a range of tasks during tutoring. The researchers videotaped the interventions of 24 mothers and 24 fathers, separately helping their 3-year-old children complete three tasks. The tasks were (1) building a copy of a block model, (2) classifying tiles in a matrix by various sizes, colours, shapes, and (3) re-telling a story which was originally told by an experimenter.

Pratt et al. (1988) adopted Wood's (1980; Wood & Middleton, 1975) scaffolding measures to examine the relationship between parents' patterns of assistance and the child's success during tutoring. The RSI was defined as "that level just below the least structured one that showed clear indications of predominant success by the child" (p. 834). This definition was quite similar to Wood and Middleton's (1975) definition, but success at any particular level was determined by whether the child was successful on over 66% of the responses for a particular level. For example, if the child followed instructions successfully 80% of the time at level three, but only 50% of the time at level two, the RSI was defined as level two.

Pratt et al. (1988) found that children's success during tutoring (a percentage score) was positively correlated with greater use of the RSI and with greater use of the CS rule. Furthermore, greater use of the RSI was positively correlated with greater use of the CS rule itself. Evidence also indicated that the parents, as a group, became increasingly successful at working within the child's RSI for each task as the session progressed. This suggests that adults in general may use the initial portions of tutoring sessions diagnostically, to "locate" the child's current level of functioning on the task at hand, and then utilize this information to fine-tune their interventions within the RSI.

Not all research which has examined the relationship between tutor scaffolding and child success has demonstrated such clear and strong results. Green (1987) audiotaped mothers helping their 10 to 11-year-old children with long-division problems. Scaffolding patterns (use of the RSI and use of the CS rule), as well as child success (during and after tutoring on a posttest) were analyzed by specific division task component (i.e., estimation, multiplication, subtraction). Generally, the results were dependent on the task component. For example, mothers' greater use of the RSI was positively correlated with tutoring success for the estimation and subtraction components, but not for the multiplication component; use of the CS rule was only correlated with success on the estimation component. One of the most useful outcomes of Green's research was the development of a system for classifying long-division interventions according to levels of tutor support. This system encompasses nine levels of support and has been adapted in the present study to code specific long-division interventions. However, the present study uses simpler terms in its description of Green's levels in order to facilitate the use of the levels by child-tutors.

In a replication and extension of Green's (1987) study, MacVicar, Pratt, and Robins (1990) showed that parents who used scaffolding more effectively (greater CS rule use, more RSI use) had fifth-grade children who benefitted significantly more from their tutoring in long-division homework sessions. In this study, 24 parents were observed assisting their children with long-division homework problems. Improvements from pretest to posttest on these problems for children working independently were found to be positively related to both of these scaffolding indices of parent tutoring, but unrelated to parent education level or to parent general mathematics competence, as measured by the Wechsler Adult Intelligence Scale.

The preceding studies were observational in nature and therefore cannot provide direct evidence regarding the causal role of scaffolding in tutoring. However, experimental studies such as Wood, Wood, and Middleton (1978) and Savoy (1989) have demonstrated the superior performance of children tutored contingently in comparison to children tutored in other ways.

Wood et al. (1978) trained an experimenter in the use of four tutoring strategies. Pre-school children were randomly assigned to a tutoring condition and taught to build a block pyramid. The four conditions were as follows: (1) "contingent tutoring" in which the CS rule was followed, (2) "verbal tutoring" in which a low level of general verbal support (from a five stage hierarchy) was consistently provided, (3) "demonstration tutoring" in which a high level of support (Level 5 in their hierarchy) was consistently provided, and (4) "swing tutoring," in which a pattern of extremes of low support-high support-low support was provided.

Following the tutorial session, each of the children was tested on his/her independent ability to construct the pyramid. Wood et al. (1978) found that the contingently tutored group was by far the most successful on this posttest, followed by the groups given verbal and swing tutoring, with the demonstration group doing the poorest.

Savoy (1989) tutored fourth and fifth grade children on long-division, using four tutoring strategies. She found that children tutored with the contingency rule were more likely to internalize and transfer what they had been taught of this skill than those tutored with other strategies, including high support, moderate support, and sequential support (defined below).

Children in the four training groups were given one-to-one tutoring across three sessions. At each session the children worked on two long-division problems with the assistance of the experimenter. The sessions were approximately every three days.

Levels of support were defined using Green's (1987) system for long-division (see Appendix A for a simplified version). Contingent support was provided following the Wood (1980) rule of more support following failure, and less support following success. High support was defined as consistent support at level seven; moderate support was defined as consistent support at levels three or four. Sequential support was a support strategy which began again with each new task step. At each new problem step, the child was given support at levels one or two and the support was then increased until the child succeeded. Once success was attained, the next task step was begun, and the procedure was started again. There was also a control group that was not given any tutoring experience.

Results showed that children in the contingently-tutored group performed significantly better than the children in all other conditions on the immediate, one week and one month long-division posttests. This superior performance by the contingently tutored children was also apparent on the immediate, one week and one month long-division transfer of training posttests. These generalization tests involved long-division word problems, on which no direct training had been provided. Savoy (1989), together with Wood et al. (1978), provide strong evidence that tutorial encounters in which the tutor directs his or her interventions to a level of support contingent on the child's previous performance, result in important cognitive benefits which other tutoring methods apparently do not provide to the same degree.

Considering the benefits of contingent tutoring, it is notable that those frequently involved in the tutoring of children can be trained to effectively use the CS rule. An example of a training study in which mothers were trained to use the CS rule can be found in work by Robins (1989). The training procedure involved an explanation of the contingent shift rule, along with practice using the rule. Mothers read transcripts of story re-telling tutoring sessions, which they also watched on videotape. The mothers were asked if the tutor had provided the correct level of support according to the shift rule. As well, mothers were asked to explain their decisions and provide the correct level of support when it was needed. In three tutorial sessions, trained and untrained mothers were asked to assist their 4-year-old children in re-telling a story which the experimenter had just read to the children.

The results demonstrated that mothers in the training condition significantly increased their compliance with the CS rule. The training procedure also significantly increased maternal use of the RSI and had some positive effects on children's story re-telling skills.

As a second example, Reeve (1987) demonstrated that mothers could be successfully trained to contingently tutor their own kindergarten children on simple addition problems. In the first part of the experiment, Reeve observed that some mothers offered contingent support ("scaffolding" mothers), some mothers consistently offered a high level of support ("directive" mothers), and some mothers offered support which followed no pattern ("inconsistent" mothers). Reeve trained half of the scaffolding mothers and half of the directive mothers to tutor contingently. Posttest results demonstrated that explicit scaffolding training was beneficial for both scaffolding and directive mothers in terms of both an increase in mothers' scaffolding and the effectiveness of their teaching, as assessed by children's posttest performance.

The results of Robins' (1989) and Reeve's (1987) training studies suggest that it is useful to train mothers in the use of the contingent shift rule. Whether child-tutors could be trained in the effective use of the contingent shift rule has not been examined. However, Robins' training study with mothers provides an example of a successful training pattern which could be investigated in training children to tutor using the contingent shift rule. In order to make predictions regarding the results of training child-tutors to tutor contingently, it is first useful to examine the tutoring practices of untrained child-tutors.

Ellis and Rogoff (1982) compared the tutoring practices of 8 to 9-year-old children with those of adults. The tutors were instructed to prepare the 6 to 7-year-old learners for a memory test in which learners would be asked to place a number of items where they belonged. The location of each item was dependent on its category. Children were either taught which shelf a grocery item belonged on (an activity similar to home activities) or which compartment a familiar object belonged in (an activity similar to school activities). The posttest examined the learner's ability to place studied and unstudied items in the correct category position.

Ellis and Rogoff found that child-tutors provided less verbal instruction and category information than adults. Results on the posttest demonstrated that the learners taught by adults correctly placed items (studied and new items) more frequently than children taught by child-tutors. Although this result was not conditionalized on the number of correct responses during the training session, a pretest demonstrated that the child-learners could identify the name or function of all the task items. Finally, child-tutors elicited as much verbal participation from the learners as adults on the school task, but less participation on the home task. Although children appear to be less effective teachers than adults, this study indicates that on school tasks children may try to incorporate strategies which have been used to teach them, specifically learner participation. The nature of the participation of learners in this study was analyzed more thoroughly by Ellis and Rogoff (1986).

In a later report (Ellis & Rogoff, 1986), the researchers found that child-tutors in comparison with adults were unskilled at eliciting learner participation which was appropriate for the learner's level of performance. Specifically, on the school task the child-tutors tended to give inadequate hints, leaving the learners to participate by guessing at both item placement and rationale. On the home task the child-teachers tended to demonstrate without involving the learner and without explaining the rationale for item placement. Apparently, then, child-tutors fail to operate at intermediate levels of support in these tasks. In contrast, adults elicited the learner's participation (e.g., learners placed items or provided rationales) and supported the learner according to his or her level of performance.

However, child-tutors modified their instruction over the tutoring period. For example, as the session progressed on the school task, child-tutors moved away from hints to more specific instructions. This adjustment over the session leads one to believe that with training in the use contingent principles, children could learn to guide their instruction in the learner's region of sensitivity. This result may also indicate that simple tutoring practice would be enough to do so eventually.

Houston (1987) observed untrained child-tutors' use of the RSI and the CS rule and the relationship between the use of these scaffolding techniques and tutee success. Grade three and grade five children were videotaped teaching grade one and grade two children a block model copying task, similar to the block design subtest of the WISC-R. Analysis of child-teacher interventions on the block construction task was completed using a coding system adapted from the work of Pratt et al. (1988). A hierarchy of six intervention levels, from tutee-regulated (0) to teacher demonstration

(6), was established. The effectiveness of child-tutors was measured by the overall success percentage of the learners over the course of the tutorial and by the learners' posttest scores.

Houston found substantial individual differences among child-tutors in use of the RSI and the CS rule. Greater use of the RSI was correlated with a greater percentage of tutee success during the teaching session, better tutee performance on the posttest, and less extreme shifting of support levels by tutors. Greater use of the CS rule was correlated with a greater percentage of tutee success during the teaching session, and a greater ability of tutors to find and operate in the tutees' RSI. Although scaffolding strategies in general led to successful performance, the overall frequency of using these strategies was generally low. For example, use of the RSI was 19.9%; indicating that teachers operated within tutees' instructional zones less than 1 in 5 times when they intervened.

Informal observations of the tutoring sessions revealed that the child-tutors showed considerable patience with their younger peers, and that the tutees were respectful of and receptive to their older peers. Although it appears that child-tutors have much room for improvement in their ability to operate in the region of sensitivity to instruction, both Houston (1987) and Ellis and Rogoff (1986) suggest that they have the potential to learn to operate more frequently within it.

In summary, an examination of observational studies of tutoring encounters has demonstrated the strong relation between teaching in the region of sensitivity and contingent tutoring, as well as a relationship between the use of these two scaffolding strategies and effective teaching (e.g., Pratt et al., 1988; Wood & Middleton, 1975). Experimental studies have demonstrated that contingent tutoring results in effective teaching and important cognitive benefits (Savoy, 1989; Wood et al., 1978). Training studies have shown that it is possible to teach adults to use the contingent shift rule more effectively (Robins, 1989; Wood et al., 1978). Finally, comparison studies of adult and child teaching and an observational study of children as tutors have demonstrated children's tendency to tutor noncontingently as well as their potential to learn to tutor contingently (Ellis & Rogoff, 1982, 1986; Houston, 1987).

Based on this review, it is hypothesized that training child tutors in the use of the contingent shift rule should increase child-tutors' tendencies to direct their instruction within the learner's region of sensitivity on the task. It should also bring about stronger task performance benefits than those realized when children are left to their own less contingent method of teaching.

One of the outcomes of contingent tutoring which was not covered in detail in the previous literature review is the affective response of the participants. Perhaps one of the benefits of contingent tutoring is that it leads to more positive feelings about the sessions.

Savoy (1989) compared the affective benefits of contingent tutoring for tutees with those of three other instructional strategies. Savoy used a series of Likert-type scales to examine both positive and negative affect. Results indicated that children given either contingent or moderate levels of support in tutoring felt less negative about the tutoring sessions than children in the sequential condition. Children in the sequential condition were given low support at the start of each task step which was gradually increased until the child succeeded. There were no differences in negative affect among children in the sequential, high support or control (no tutoring) conditions. Savoy (1989) suggested it may have been tutees' low level of successful compliance in the sequential condition (37.86%), relative to the contingent (70.67%) and moderate (54.5%) conditions, which led to feelings of confusion, frustration and task difficulty in this sequential teaching.

However, children tutored contingently did not demonstrate more positive affect (i.e., enjoyment, willingness to participate in a similar tutorial session in the future, lack of boredom) than children in the high, moderate, or sequential conditions (Savoy, 1989). This suggests that of the factors that may influence children's self-report of positive feelings (e.g., tutor's treatment of the learners, duration of tutoring, novelty of being tutored), tutoring strategy did not make a significant difference. There is, however, some evidence from other work to suggest that tutoring strategy influences the strength of positive affect in some contexts and that this affect is demonstrated in the tutees' subsequent social relationship with the tutor (Wood, 1988).

Wood (1988) described an informal observation made when conducting the Wood et al. (1978) study with preschool children. As mentioned previously, one of the four tutoring strategies used in this study was verbal instruction at low levels of support (compared with contingent, demonstration, and swing tutoring strategies). Children tutored by the verbal tutoring strategy, which was previously shown to lead to less competence than contingent tutoring, did not seem to have as positive a social response to the tutor as children tutored contingently (Wood, 1988).

Due to this observation, Wood (1988) carried out an experiment which examined the social relationship between learners and their tutor following verbal or contingent tutoring. The social relationship was assessed during a videotaped snack time which followed the tutoring session. The child was given a snack by the tutor and then the tutor turned to a book. The tutor made no attempt to communicate with the child learner for the first two minutes of reading, but did respond if the child initiated contact. During this time, each of the children who was contingently tutored initiated contact with the tutor (e.g., asked a question). In contrast, none of the children who were verbally tutored initiated contact with the tutor. In light of this study, it seems that the tone of the tutor-tutee relationship, at least for young children, is strongly influenced by the type of tutoring employed.

An alternative explanation might be that contingent tutoring leads to greater success than verbal tutoring and this success leads to more positive affect, not the tutoring style itself. Although further experimental work would be required to determine the specific cause of the positive interaction in this paradigm, Savoy (1989) found that tutees who experienced a high degree of success in the demonstration tutoring condition actually had more negative affect toward the situation than tutees in the contingent tutoring condition who experienced lower levels of outcome success.

One explanation for this finding may be that the degree of tutor control employed in demonstration tutoring influenced the tutees' concept of themselves as learners. More specifically, demonstration tutoring, with its high degree of tutor control, may have led the tutees to feel less competent as learners and therefore more negative about the tutoring experience than in contingent tutoring.

Wood (1988) reasoned that during tutoring, if the children are frequently given high levels of support and are not allowed to practice the tutored task and increase their skills, the children will be receiving the message that they are incompetent. This type of "overscaffolded" instruction was observed by Houston (1987) to occur frequently in peer tutoring when child-tutors were untrained. She found that tutees taught by untrained child-tutors were subjected to high degrees of control, with 43% of the child-teaching interventions directed at the highest possible support level, namely, demonstration. If much of the tutoring carried out by untrained child-teachers is "overscaffolded", the child-tutee's internalization of the social interaction may result in a negative concept of "self-as-learner." This negative self-concept may then be reflected in the tutee's subsequent social relationship with the tutor.

Wood (1988) suggested that for the tutee, the social relationship with the tutor is based on the concepts of "self-as-learner" and "other-as-teacher". If the learner feels incompetent in his/her role, this feeling is likely manifested somehow in the social relationship with the tutor. A reasonable hypothesis might be that the less effective a tutoring strategy is at building competence, the less competent learners will perceive themselves to be, and the tutee-tutor relationship will accordingly become less positive.

If child-tutors are trained in the use of the contingency rule, tutees will be allowed to practice the tutoring task and exercise some control over their learning. In fact, the level of control tutees will have over their learning will be matched to their levels of competence - and thereby their competence as learners should be confirmed. It follows that tutoring carried out by child-tutors who are effectively employing contingent tutoring, should leave the tutees with a positive concept of "self-as-learner." This positive self-concept should then be reflected in the tutee's subsequent relationship with the tutor.

Conversely, the notion that tutees form a concept of themselves as learners could be extended to child-tutors, who are in the process of developing as teachers. For the child-tutor, the social relationship with the tutee would be based on the tutor's concepts of "self-as-teacher" and "other-as-learner." The less effective a tutoring strategy is at building real competence and perceived competence in the learner, the less competent the teacher may feel and the tutee-tutor relationship may be less positive. Child-tutors trained in contingent tutoring would more likely have more positive concepts of "self-as-teacher" than would child-tutors who are untrained, and thus engage in less contingent teaching.

It should be noted however, that Robins (1989) did not find that contingently-trained mothers felt more effective during tutoring than untrained mothers. Robins gave mothers one training session followed by two tutoring sessions. Robins suggested that in order to obtain a realistic measure of the affective benefits to tutors trained to use the contingent tutoring procedure, the tutors would need to feel they were correctly using the procedure which they had just been trained to use. That is, if the tutor is still mastering the training procedure when measures of teaching effectiveness or positive affect are taken, judgements of effectiveness (due to the strategy) are confounded by limited practice at using the strategy. Furthermore, mothers' concepts of themselves as tutors may be less malleable than those of children.

It is proposed, then, that if training is extended, the tutee's concept of "self-as-learner" and the tutor's concept of "self-as-teacher" will be more positive when the tutor is trained in the use of the contingent shift rule than when the tutor is untrained and teaches as Houston (1987) reports. However, it is possible that the tutor's concept of self-as-teacher will actually be more negative after training in the use of the CS rule, because he/she will be more able to monitor their own adherence to the contingency rule.

The necessity of extended training in the use of the CS rule is congruent with the many demands placed on the tutor in actual tutoring situations. The skills required of the tutor using the CS rule include monitoring of one's own compliance with the CS rule and monitoring of the tutee's level of performance, among others. Such monitoring cognitions in learning and instructional situations have recently been described under the topic of "metacognition."

"Metacognition is the knowledge and control children have over their own thinking and learning activities" (Cross & Paris, 1988, p. 131). It has been shown, for example, that direct instruction in metacognitive strategies has increased learning disabled children's metacognitive awareness and improved their memory performance, reading comprehension, math competence, and writing (Palincsar & Brown, 1987). Metacognitive awareness is also brought about through experience (Flavell, 1979). Flavell (1979) suggests that a person is particularly likely to learn metacognitive skills (e.g., realizing that a strategy is not working) if a situation demands step by step planning and subsequent evaluation (c.f. Markman, 1981). Flavell suggests that these situational demands draw the person's attention to his/her conceptions of the learning task and process.

With their limited (Flavell, 1979) and still developing, metacognitive skills (Kurdek & Burt, 1981), children may benefit from using a teaching strategy which requires next-step planning and evaluation. Contingent tutoring not only requires these skills, it requires skills listed by Rigney (1980) as important self-monitoring skills. He includes the following skills as self-monitoring skills: (1) keeping one's place in a long sequence of operations, (2) knowing when a subgoal is obtained, (3) the ability to detect errors, (4) the ability to recover from errors (correct or retreat to the last known correct operation), (5) the ability to "look ahead" and "look back." The views of Rigney and others are representative of those of a growing number of theorists emphasizing metacognitive skills in academic performance (e.g., Brown, 1978; Caroll, 1980; Flavell, 1976).

Such a perspective can be applied usefully to the process of contingent tutoring. In order for a tutor to employ the CS rule, he/she must (1) know the level of support he/she provided before a success or failure response and the level of support that he/she will therefore provide next, (2) know when a component of a task is completed so that the tutee is given the appropriate level of support on the following component, (3) decide if the tutee's response to an intervention is a success or a failure, (4) be able to keep in mind the level of support a tutee last required for a particular component of a task (e.g., the estimation component in long-division), and (5) remember the CS rule.

Tutors taught to use the CS rule should benefit from their teaching by being required to use skills considered important self-monitoring skills to monitor the performance of the tutees. It seems possible that tutors taught to use the contingency rule, which engages important monitoring skills regarding the learning process, will not only use these skills to monitor tutees' performance more, but may transfer these monitoring skills to their own learning. If so, tutors trained to use the CS rule should demonstrate greater metacognitive awareness than untrained tutors, on problems which require monitoring skills similar to those required for the tutoring task.

The present study will examine the effects of training child-tutors to scaffold instruction. Tutors will be taught how to apply the CS rule when teaching tutees long-division. Tutors will be randomly assigned to one of three training groups: an experimental group trained to use the CS rule (Wood, 1980), a control group trained to consistently use moderate levels of support (levels three and four according to Green's, 1987, hierarchy; see Appendix A), and a control group given practice with long-division but no training as tutors. The moderate support condition will control for effects due to the overall average level of support which results from contingent tutoring, following the work of Savoy (1989). The no training conditiion will provide a baseline for practice effects and for children's spontaneous untrained tutoring ability. Predictions about the effects of the experimental manipulation will be discussed in the order of direct training predictions, generalization predictions and then affect predictions.

Hypotheses

Direct training predictions involved tutors' use of the CS rule, tutors' use of the RSI, and tutee math performance. It was hypothesized, based on Robins' (1989) training study and Savoy's (1989) study of tutoring strategies, that tutors trained to use the CS rule would demonstrate a greater increase in use of this rule from tutoring pretest to posttest than would moderate support controls and untrained controls.

In addition, it was hypothesized that tutors trained to use the CS rule would demonstrate a greater increase in RSI use from tutoring pretest to posttest than would moderate support controls and untrained controls. This hypothesis was based on the relationship between the CS rule and the RSI (Wood & Middleton, 1975; Pratt et al., 1988).

Finally, based on Savoy's (1989) study, it was hypothesized that tutees instructed by tutors trained to use the CS rule would demonstrate a greater increase in long-division achievement from the long-division pretest to posttest than would tutees taught by moderate support controls and untrained controls.

Generalization predictions involved tutors' transfer of training, tutors' transfer of teaching strategy, and tutors' metacognitive awareness (measured by estimation accuracy). Applying Savoy's (1989) finding, it was hypothesized that tutors trained to use the CS rule would use scaffolding techniques more than would moderate support controls and untrained controls on a tutoring posttest of generalization which requires tutors to teach a novel, but related, mathematics task.

Based on Rigney's (1980) list of important self-monitoring skills, it was hypothesized that when tutors trained to use the CS rule are asked how they would teach multiplication to a grade four student, they would more frequently describe steps related to contingent tutoring than would moderate support controls and untrained controls.

In addition, it was hypothesized that tutors trained to use the CS rule would demonstrate a greater increase in the accuracy of estimating their own mathematics achievement from prediction pretest to posttest than would moderate support controls and untrained controls.

Affect predictions involved tutors' affect and concept of self-as-teacher and tutees' affect and concept of self-as-learner. It was hypothesized that tutors trained to use the CS rule would have more positive feelings about the tutoring experience and about themselves as teachers at posttest than would moderate support controls and untrained controls.

In addition, it was hypothesized that tutees instructed by tutors trained to use the CS rule would have more positive feelings about the training experience and about themselves as learners at posttest than would tutees instructed by moderate support controls and untrained controls. These affect predictions were based on findings of Wood (1988) and Houston (1987).

Although based on previous research, these predictions were not simply a synthesis of previous findings, but went beyond previous research in the scaffolding paradigm in several specific ways. Unlike previous research this study was unique in its training of children to use the CS rule. This represents the first experimental application of this approach to a peer tutoring context. In addition, this study examined the effects of CS rule training on a number factors not previously investigated: the ability of tutors to generalize their training to teach a novel task, the degree to which tutors demonstrate metacognitive awareness on problems which require monitoring skills similar to the tutoring task, and the effects of training on learner/teacher self-concepts.

Method

Participants

The participants were fifth-, seventh- and eighth-grade students from two schools located in two different middle-class communities of South-Western Ontario. Twenty-six seventh and eighth graders volunteered to tutor 26 fifth graders on a one-to-one basis. Consent was obtained from the parents as well as the children. Two of the initial 26 tutee-tutor groups were excluded from the analysis because the tutees were operating at ceiling before tutoring. Tutors were screened on the basis of their pretest long-division scores. The 24 tutors were composed of 11 grade seven and 13 grade eight students. However, tutor grade was confounded with school; that is, tutors were from grade eight at one school and grade seven at the other school. This situation was somewhat unavoidable because the discovery that one school did not have a grade eight class was not made until after the consent forms had been distributed to the grade eight students at the other school. The demands of the study were such that it would not have been fair or possible to ask the school with the grade eight class to allow a change to the grade seven class.

At each school, all participants were randomly assigned to one of three experimental conditions. Then, within each condition, tutees were randomly assigned to tutors. Each experimental condition was represented by eight tutor-tutee pairs. Gender matching was not performed as there was no empirical evidence that same-sex tutoring pairs result in different learning outcomes than opposite-sex tutoring pairs (Cohen, 1986; Ehly & Larson, 1975). This random assignment of tutees to tutors resulted in 11 tutor-tutee pairs in which the participants were of the same gender and 13 pairs in which the participants were not of the same gender. The study was conducted rather late in the school year (April-May), due to unforeseen delays.

Design

The experimental design was a 3 x 2 mixed factor design. The training group (contingent training, moderate training, no training) was the between-subjects factor and the time of testing (pretest and posttest) was the within-subjects factor.

Measures

A time schedule for the implementation of the various measures used in the present study is presented in Figure 1.

Figure 1

Time Schedule for the Use of Measures

Week 1	Week 2	Week 3	Week 6
Tutee Math Pretest	Tutor Training Session 1	Tutor Training Session 2	Tutee Math Posttest
Tutor Math Criterion	Tutoring Dyads with Training	Tutoring Dyads with Training	Tutor Math Estimation
Tutor Math Estimation		Tutee Affect and Self-Concept Measure	Tutor Use of Strategy
Tutoring Pretest		Tutor Affect and Self-Concept Measure	Tutoring Posttest and Transfer

The measures will be described in the following order: criterion (tutor math criterion), direct training (tutor use of the CS rule, tutor use of the RSI, tutee math pretest, tutee math posttest), generalization (tutoring transfer, tutor use of strategy, tutor estimation) and affect/concept measures (tutor affect and self-concept measure, tutee affect and self-concept measure).

Criterion Measure

Tutor Math Criterion. Tutors were given five long-division problems (two digit divisors with three or more digit dividends). All tutors met the criterion score of three or more correct (see Appendix B). The average score was 4.1 out of 5.

Direct Training Measures

Tutor Use of the CS Rule. Tutors' use of the CS rule was determined from the tutoring pretest and posttest transcripts. Tutor shifting of support level was considered correct when the tutor provided less support after a tutee's success and more support after a tutee's failure. For example, if an intervention was at level 4 (e.g., "how many times will 3 go into 12?"), and was followed by a tutee failure (e.g., "5"), a correct shift in support was at level 5 (e.g., "that looks like too many times"), while an incorrect shift in support was a level 3 intervention (e.g., "you have to divide these numbers"). There was one exception: As in previous research, if the shift was in the right direction, but more than two levels away from the preceding intervention, it was considered an incorrect use of the CS rule (Pratt et al., 1988).

Shifting was coded within episodes of the long-division steps of estimation, multiplication and subtraction. However, as there were not sufficient data by component, analysis was completed as a summed score of CS rule shifts on the long-division steps. At times, shift interventions were not clearly categorizable as specific estimation or multiplication interventions but were an integration of both components. Interventions of this type were coded as both estimation and multiplication interventions when coding components and were included in the summary calculation only once. The total number of correct shifts was divided by the total number of opportunities, to give a percentage score for CS rule use, ranging from 0-100%.

Tutor Use of the RSI. Tutors' use of the RSI was measured prior to tutor training on the tutoring pretest, and three weeks after training was complete on the tutoring posttest. Transcripts of audiotaped tutoring sessions were used to determine tutors' use of the RSI. The transcripts were coded on the level of tutor support for each intervention (Green, 1987; see Appendix A) and for tutee success or failure following each intervention. A tutee response was considered successful if it was a correct answer or if it was a progression towards solving the long-division problem. Consistent with previous research (Pratt et al., 1988), RSI level was defined as the level directly below the lowest level of support at which the tutee, with assistance, succeeded over 66% of the time. RSI levels were calculated independently for each component of the long-division task: estimation, multiplication and subtraction. Again, there was not sufficient data for component analysis of RSI use. Analysis was completed as a summed score of RSI use and, similar to the calculation of the CS rule, interventions coded as both estimation and muliplication component interventions were counted once only. Interventions in the RSI for each long-division component were summed to give the total number of interventions in the RSI. This number was divided by the total number of interventions (which will differ by tutor) to give a percentage score for RSI use.

Tutee Math Pretest. The mathematics pretest was given in order to determine a tutee's pre-tutoring performance on long-division mathematics problems. Savoy's (1989) mathematics pretest was employed in this study (see Appendix I). This pretest consisted of eight long division problems. Four of the questions were easy (one digit divisors into two or three digit dividends) and four were more difficult (two or three digit divisors into three, four or five digit dividends). The four easy questions were presented in randomized order followed by the four more difficult questions in randomized order. Tutees were given one minute for each of the easy questions and four minutes for each difficult question. A child's score on each problem was, according to Savoy's (1989) coding, his or her percentage correct across all steps of the five components into which the problems were divided: estimation of dividend, multiplication of divisor and dividend, subtraction, bringing down the following digit, and correctly obtaining the remainder (see Appendix J).

Tutee Math Posttest. Tutees were given Savoy's (1989) posttest of long-division skill (see Appendix K) prior to the tutoring posttest. This test consisted of four difficult problems as defined above. The order of questions was randomized across subjects. In the same manner as the pretest, the score was calculated by total percentage of success on the components on all of the problems.

Generalization Measures

Tutoring Transfer. As part of the tutoring posttest, tutors instructed the tutees on two long-division word problems (see Appendix F). This measure was used by Savoy (1989) to test learners' transfer of training. Transcripts of the session were used to code tutor support levels and tutee response. Levels of support for transferring trained long-division skills to a word problem were adapted from Green (1987) (see Appendix G). Tutors' use of the RSI and use of the CS rule were calculated as described above from these levels codings.

Tutor Use of Strategy. Tutors were asked to describe what they would do to help a grade four student learn to do multiplication (see Appendix C). They were asked to list specific steps that they would use. The answers were scored as to whether they mentioned: (1) breaking down the task into component steps, (2) ordering the steps as to degree of support, (3) assessing the learner's response to the support given, and (4) provision of a support level which is contingent on the learner's performance.

Tutor Math Estimation. Tutors were given a pretest of mathematics problems suitable to their age group (see Appendix D). A different form of the test was used for the posttest (see Appendix E). The tutors were asked to estimate the number of questions which they answered correctly out of the questions they had just completed ("postdiction"). This procedure was used rather than pretest prediction due to grade 7 and 8 children's tendency to overestimate pretest predictions (Pressley & Ghatala, 1989). At this age, test-taking significantly increases "prediction" accuracy (Pressley & Ghatala, 1989).

Affect and Self-Concept Measures

Tutor Affect and Self-Concept Measure. Following the tutoring posttest, tutors' affect and concept of self-as-teacher were measured using a 7-point scale, with 7 indicating the high end of the scale. Tutors were asked to rate how frustrated they felt while tutoring, how much they enjoyed tutoring, how effective their tutoring was, how much they learned about tutoring, to what degree they became friends with their tutees, and how willing they would be to tutor in the future (see Appendix H).

Tutee Affect and Self-Concept Measure. Following the tutoring posttest, tutees' affect and concept of self-as-learner were measured using a 7-point Likert-type scale, with 7 indicating the highest rating. Tutees were asked to rate how frustrating they found the long-division problems, how enjoyable they found the problems, how positive they felt about their learning ability, how much they felt they learned, how positive their friendships were with their tutors, and how willing they would be to be tutored in the future (see Appendix L).

Procedure

In each of the two schools, all students who agreed to participate in the study were randomly assigned to one of the three experimental groups and to a tutoring mate (as described earlier).

Prior to any tutorial sessions, the pretest of long-division mathematics performance was administered to grade five tutees as a group. Grade seven and eight tutors were administered the mathematics estimation pretest measure, and the tutor criterion pretest of long-division performance. Immediately following these pretests, before any tutor training occurred, individual tutor-tutee dyads were audiotaped as they worked together for 15 minutes on two long-division problems.

Training sessions began one week after the pretest measures were taken. In the first training session, the experimenter met with each training group for 30 minutes. There were a minimum of three and a maximum of five students in each training group. Immediately following training of each group, individual tutor-tutee dyads were audiotaped as they worked together for 15 minutes on two long-division problems. During this tutoring session, tutors in the CS rule training group and the moderate support training group received feedback regarding their implementation of the training strategy. For example, if the tutor intervened at the wrong level, the trainer asked the tutor the previous level of intervention he/she used, the tutee response and whether the tutee then needed more or less support. Both moderate support tutors and CS trained tutors were very sensitive to experimenter feedback during the tutoring practice sessions, however. Due to this sensitivity, feedback was not given regarding every tutor error in strategy use. Rather, experimenter feedback was confined to one or two comments for each long-division question for both groups. A sample of 25% of the feedback sessions showed that tutors in the CS training group were given 1.67 feedback comments for each long-division problem and tutors in the moderate support control were given 1.84 comments per problem. The purpose of this feedback schedule was to ensure that the tutors would not become too discouraged or anxious. Tutors in the no training control condition received no feedback.

The second training session occurred one week after the first training session. In the second training session, the experimenter met with each training group for 15 minutes. Immediately following training of the last group, individual tutor-tutee dyads were audiotaped as they worked together for 15 minutes on two long-division problems. The basis for feedback was the same. Following the completion of all tutoring dyads, the tutors were given the affect and concept-of-self-as-teacher measure and the tutees were given the affect and concept-of-self-as-learner measure.

Three weeks after the second and last training-tutoring sessions were completed, tutoring posttests were administered. Tutees as a group were given a posttest of long-division mathematics performance. Grade seven and eight tutors were administered the mathematics estimation measure and the transfer of strategy measure. Immediately following these post-tests, individual tutor-tutee dyads were audiotaped as they worked together for 15 minutes on two long-division problems and two long-division word problems.

Training

Tutors assigned to the experimental group trained to use the CS rule were: (1) given a copy of Green's (1987) coding system for long-division and were taught to use the different intervention levels contingently, (2) given videotaped examples of good and bad tutoring as defined by the use of the contingent shift rule, and (3) given practice and feedback using the shift rule during training role play and training-tutoring sessions with grade five tutees (see Appendix M for training procedure).

Tutors assigned to the control group trained to consistently use moderate levels of support were: (1) given a copy of Green's (1987) coding system for long-division and were taught to consistently use levels three and four regardless of the tutee's response, (2) given videotaped examples of good and bad tutoring as defined by the use of moderate levels of support and using the same videotape as above, and (3) given practice and feedback using moderate levels of support during training role play and training-tutoring sessions with grade five tutees (see Appendix N for training procedure).

Tutors assigned to the no training control group were: (1) given a copy of Green's (1987) coding system, (2) given practice with long-division problems, and (3) given practice but no feedback while tutoring grade five tutees on the same problem sets as the other two training groups (see Appendix O for training procedure).

Results

All tutors met the criterion score on the long-division problems. Analysis of the tutor scores on the criterion measure demonstrated no significant differences between groups, $\underline{F}$ (2,21) = 1.58, MS_e = .74, $\underline{p} > .05$, ($\underline{M}$=3.80 for CS group, $\underline{M}$=4.00 for the moderate support group, $\underline{M}$=4.50 for the untrained control group) or between tutor grades, $\underline{F}$ (1,18) = 1.74, MS_e = .21, $\underline{p} > .05$, ($\underline{M}$=4.33 for grade seven tutors, $\underline{M}$=3.87 for grade eight tutors). Interrater reliability for coding the tutoring pretest and posttest transcripts according to tutor intervention level was $\underline{r}$ =.82 between two coders for a sample of 5 transcripts; for tutee success or failure the coefficient of agreement was $\underline{r}$ =.90.

Direct Training Outcomes

Tutor Use of the CS Rule. Use of the contingent shift rule was analyzed using a 3x2 (group x time) mixed analysis of variance (ANOVA). Analyses yielded no significant effects. Planned contrasts were used to test the specific hypothesis that tutors trained to use the CS rule would demonstrate a greater increase in rule use from tutoring pretest to posttest than would moderate support controls and untrained controls. The hypothesis was not confirmed. Mean percentage CS rule use by groups and times is shown in Table 1.

Table 1

Mean CS Rule Use as a Function of Group and Time

Time	Tutor Training Group CS Rule	Moderate	Untrained
Pretest			
M	23.50	23.50	27.00
SD	10.76	10.20	14.22
Posttest			
M	22.50	28.00	28.13
SD	13.16	15.96	17.54

Note that the use of the CS rule was examined over the three long-division components combined here. The use of the CS rule by component was coded but not analyzed because of insufficient component data.

The addition of tutor grade to the analysis produced a 3x2x2 ANOVA. This yielded a significant main effect of tutor grade which demonstrated that grade seven tutors used the contingent shift rule to a greater degree ($\underline{M}$=29.40) than grade eight tutors ($\underline{M}$=20.98), $\underline{F}$ (1,18) = 5.91, MS_e = 140.78, $\underline{p}$ < .01.

This analysis also yielded a significant interaction of tutor grade with group, F (2,18) = 6.13, $MS_e = 140.78$, $p < .01$. Simple main effect analyses of group revealed a significant effect for grade seven only, F (2,8) = 8.47, $MS_e = 82.96$, $p < .05$. Further analyses were not performed, as effects of tutor grade were not predicted nor of primary interest to this study. Scores for mean percentage CS rule use by group and tutor grade are presented in Table 2.

Table 2

Mean Percentage Use of the CS Rule as a Function of Group and Tutor Grade

	Tutor Training Group		
Tutor Grade	CS Rule	Moderate	Untrained
7			
M	19.33	29.38	39.50
SD	5.9	10.6	10.3
8			
M	25.20	22.13	15.63
SD	13.5	11.2	11.2

Tutor Use of Extreme Shifting. Previous studies have shown that children frequently make extreme or poorly-calibrated shifts in tutoring (e.g., Houston, 1987; Ellis & Rogoff, 1986). Therefore, analysis of extreme shifting (over more than two levels), but in the right direction according to contingent principles, was performed using a 3x2 (group x time) mixed analysis of variance. This resulted in no significant effects. A 2x3x2 (tutor grade x group x time) mixed analysis of variance yielded a main effect of tutor group, F (1,18) = 3.61, MS_e = 273.76, p < .05. Tutors in the moderate support group demonstrated the least amount of extreme shifting (M=26.13) followed by tutors in the CS training group (M=36.90) and untrained control group (M=41.44).

This analysis also yielded a significant interaction of group with time, F (2,18) = 3.61, MS_e = 353.45, p < .05. Simple main effects analyses revealed an effect of group on the posttest only, F (2,18) = 7.65, MS_e = 294.88, p < .01. Pairwise comparisons of the three training groups on the posttest were conducted by using Tukey's multiple-comparison procedure, based on a familywise Type 1 error rate of .05. The critical Tukey value was t(18) = 21.90. Pairwise comparisons revealed tutors in the CS training group used extreme shifting more frequently on the tutoring posttest (_M_=41.70) than tutors in the moderate support group (_M_=18.38), _t_(18) = 23.32, _p_ < .05. In addition, tutors in the untrained control group used extreme shifting more frequently on the tutoring posttest (_M_=51.00) than tutors in the moderate support group, _t_(18) = 32.62, _p_ < .05. Group use of extreme shifting in the correct direction by time is shown in Table 3.

Table 3

Mean Percentage Use of Extreme Shifting in the Correct Direction as a Function of Group and Time of Testing

	Tutor Training Group		
Time	CS Rule	Moderate	Untrained
Pretest			
M	32.10	33.88	31.88
SD	18.98	24.87	19.32
Posttest			
M	41.70	18.38	51.00
SD	18.12	14.69	24.80

The 2x3x2 (tutor grade x group x time) analysis yielded a significant interaction of tutor grade with group, F (2,18) = 6.03, MS_e = 273.76, $p < .01$. Simple main effects analyses of group revealed an effect at grade eight, F(2,10) = 12.33, MS_e = 209.19, $p < .01$, but not at grade seven. These unpredicted effects were not analyzed further.

Tutoring Patterns by Levels. To investigate any consequences of training for general patterns of tutoring, the eight levels of support were blocked into three broad groupings, consistent with the training program (i.e., moderate interventions were defined as Levels 3 and 4). Tutors' use of low (levels 0-2), moderate (levels 3 and 4) and high (levels 5-8) levels of support were analyzed by using a 3 x 2 multivariate analysis of variance (MANOVA), for the three groups and two times of testing. The MANOVA yielded a significant effect for group, *Rao R* (6,38) = 2.34, $p < .05$, a significant effect for time, *Rao R* (3,19) = 13.22, $p < .01$, and an interaction of group with time, *Rao R* (6,38) = 4.64, $p < .01$.

Tutors' use of levels of support was then analyzed for each group using one-way multivariate analyses of variance (MANOVAs) for the two times of testing. The MANOVAs yielded a significant effect of time on the levels of support for tutors in the CS group, *Rao R* (3,5) = 30.45, $p < .01$, and the moderate support control, *Rao R* (3,5) = 11.03, $p < .01$.

Since the MANOVAs yielded significant time of testing effects for the support levels given by CS trained tutors and moderate support controls, one-way ANOVAs with time as the factor were used to test differences at each of the three levels of support for the groups. One-way ANOVAs revealed that tutors in the CS trained group provided high levels of support less frequently on the tutoring posttest (M=14.9) than on the tutoring pretest (M=24.1), F (1,7) = 8.98, MS_e = 38.1, $p < .05$. In addition, the moderate support controls provided moderate support more frequently on the tutoring posttest (M=37.4) than on the tutoring pretest (M=15.8), F (1,7) = 26.46, MS_e = 70.7, $p < .01$. They also provided high levels of support less frequently on the tutoring posttest (M=15.1) than on the tutoring pretest (M=31.0), F (1,7) = 17.62, MS_e = 57.2, $p < .01$. There were no differences over time for untrained controls' use of support levels. Mean percentage scores for each group's use of low, moderate and high levels of intervention on the tutoring pretest and posttest are presented in Table 4.

Table 4

Mean Percentage Use of Intervention Levels as a Function of Group and Time

	Tutor Training Group		
Level[a]	CS Rule	Moderate	Untrained
Low			
Pretest	63.5 (14.5)	53.5 (15.8)	66.0 (15.8)
Posttest	71.3 (11.0)	47.4 (16.1)	66.8 (21.7)
Moderate			
Pretest	12.1 (6.9)	15.8 (11.5)	11.8 (9.1)
Posttest	13.9 (8.4)	37.4 (13.0)	11.8 (11.1)
High			
Pretest	24.1 (12.0)	31.0 (9.1)	22.3 (11.1)
Posttest	14.9 (9.0)	15.1 (8.5)	21.6 (17.3)

Note. [a]Low = Levels (0-2); Mod = Levels (3-4); High = Levels (5-8).

Standard deviations are reported following mean scores in parentheses.

The move away from high support by CS trained tutors and moderate support tutors over time is in reality a move away from overscaffolding behaviour, as tutees in this study generally did not need assistance at high levels of support. As well, the increase in moderate support over time for moderate controls demonstrates a training effect. Tutors in the practice control group did not change their overscaffolding behaviour or their frequency of intervention at any of the three levels.

Tutee RSI Level. A 3x2 (group x time) analysis of tutee RSI level revealed no significant group differences or interaction. However, there was a nonsignificant trend towards a difference over time, $\underline{F}$ (1,20) = 3.65, $MS_e = 2.74$, $\underline{p} = .07$. Tutee RSI level was higher on the tutoring pretest ($\underline{M}$=2.56) than on the tutoring posttest ($\underline{M}$=1.62). This reflects generally lower tutee needs for support on the posttest, congruent with their increased rate of problem solution (see below).

Tutor Use of the RSI. Use of the RSI rule was analyzed using a 3x2 (group x time) mixed analysis of variance. Analyses yielded a main effect of group, $\underline{F}$ (2,20) = 4.26, $MS_e = 760.04$, $\underline{p} < .05$, which demonstrated that tutors in the moderate support group used the tutees' RSI level (M=29.81) less than those in the contingent shift group (M=54.93) and the untrained control group (M=54.56). Planned contrasts were used to test the specific hypothesis that tutors trained to use the CS rule would demonstrate a greater increase in RSI use from tutoring pretest to posttest than would moderate support controls and untrained controls. The hypothesis was not confirmed upon analysis, though the means were generally as predicted.

Thus far, the use of the RSI rule has been examined over the three long-division components. The use of the RSI by component was coded but not analyzed because of insufficient component data. More interventions per component and better representation of all support levels on each component would be needed before performing an analysis of the use of the RSI. Mean percentage scores for each group's use of the RSI on the tutoring pretest and posttest are presented in Table 5.

Table 5

Mean Percentage Use of the RSI as a Function of Group and Time

	Tutor Training Group		
Time	CS Rule	Moderate	Untrained
Pretest			
M	41.71	31.25	49.50
SD	31.32	27.47	30.37
Posttest			
M	68.14	28.38	59.63
SD	9.58	27.54	27.07

Tutee Math Performance. The analysis of tutees' long-division scores was performed using a 3x2 (group x time) mixed analysis of variance. The analysis did not yield the hypothesized interaction of group with time. Tutees taught by tutors trained to use the CS rule did not demonstrate a greater increase in long-division achievement from the long-division pretest to posttest (25.25%) than did tutees taught by moderate support controls (34.25%) or untrained controls (23.87%). There was only a significant main effect of time, F (1,21) = 43.69, MS_e = 212.14, $p < .001$, revealing that tutee scores on the long-division posttest were significantly higher (M=85.92%) than tutee scores on the long-division pretest (M=58.13%). This result is consistent with the nonsignificant trend (p=.07) toward less need for tutor support over time on these problems, reported earlier.

A 2x3x2 (tutor grade x group x time) analysis of variance yielded a significant three way interaction, F (2,18) = 3.66, $p < .05$, MS_e = 142.20. This interaction reflected the finding that the pretest to posttest long-division performance gain for tutees of grade eight tutors was a bit larger than the gain for tutees of grade seven tutors in the CS training group (3.07%), and in the moderate support group (4.00%), but much larger for tutees of grade eight tutors than for tutees of grade seven tutors in the untrained control group (43.25%). Further analysis of these unpredicted grade (or school) effects seemed unwarranted.

Generalization Outcomes

Tutoring Transfer. As part of the tutoring posttest, tutors instructed the tutees on two long-division word problems. The number of tutor interventions in the transfer task data was not sufficient to perform analyses (M=1.58, SD=1.38). Therefore, the specific hypothesis that tutors trained to use the CS rule would use scaffolding techniques more than would moderate support controls and untrained controls on a tutoring posttest of generalization could not be tested. Descriptively, tutors tended to intervene at low levels of support (M=1.84), with a fair success percentage (M=75%) across all groups.

Tutor Use of Strategy. Tutors were asked to describe what specific steps they would use to help a grade four student learn multiplication. A one-way analysis of variance was performed to examine if group differences were demonstrated on the measure. Scores for the use of contingent tutoring steps were not significantly different among tutors in the CS group (M=1.63), the moderate support group (M=1.23) and the untrained control group (M=1.23). Planned contrasts were used to test the hypothesis that tutors trained to use the CS rule would more frequently describe steps related to contingent tutoring than would moderate and untrained controls. The results were in the predicted direction but not significant. Group use of each contingent step is shown in Table 6.

Table 6

Tutor Transfer of Contingent Tutoring as a Function of Group and Strategies (percentage)

	Tutor Training Group		
	CS Rule	Moderate	Untrained
Strategy	(Percentage of Tutors Using Strategy)		
Breaking into Component Steps	50	50	63
Ordering Steps as to Support	25	13	25
Assessing the Learner's Response	50	25	25
Providing a CS Level	38	25	00

Tutor Estimation. Tutors were asked to estimate the number of questions which they answered correctly on a pretest and posttest of mathematics problems. Tutor estimation accuracy was analyzed using a 3x2 (group x time) mixed analysis of variance. A main effect of group, F (2,21) = 6.87, MS_e = 2.71, $p < .01$, demonstrated that the untrained controls estimated the closest to actual scores (M=.56), followed by the moderate support controls (M=1.94) and the CS training group (M=2.69). There were no other significant effects.

Planned contrasts were used to test the specific hypothesis that tutors trained to use the CS rule would demonstrate a greater increase in the accuracy of estimating their own mathematics achievement from prediction pretest to posttest than would moderate controls and untrained controls. The hypothesis was not confirmed upon analysis. The addition of tutor grade as a factor revealed no effects.

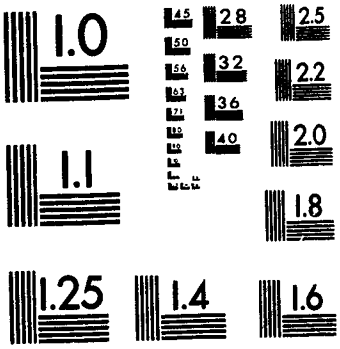
Affect and Self-Concept Outcomes

Tutor Affect and Self-Concept. Tutor affect (e.g., "how enjoyable was tutoring?") and concept of self-as-teacher (e.g., "how effective were you at tutoring?") were measured using a 7-point scale, from one - "not at all" to seven - "totally". A one-way analysis of variance revealed no group differences on the combined affect and concept of self-as-teacher questionnaire. Affect and teacher-concept were most positive for tutors in the CS training group (M=4.41), followed by tutors in the moderate support group (_M_=4.29) and then untrained controls (_M_=3.86).

The six items on the questionnaire were grouped _a priori_ into affect items and teacher-concept items, partially based on Savoy (1989). Items one ("how enjoyable was tutoring?"), two ("how frustrating was tutoring?"), five ("how much did you become friends with the tutee?") and six ("would you enjoy tutoring again?") were conceived as affect items, while items three ("how effective were you at tutoring long-division?") and four ("how effective are you at teaching usually?") were teacher-concept items.

Tutor Affect. Item correlations revealed that item one correlated most highly with items five (_r_=.42) and six (_r_=.69). Item five correlated most highly with items one (_r_=.42) and six (_r_=.48). Item six correlated most highly with items one (_r_=.69) and five (_r_=.48). Item correlations were thus generally in agreement with the _a priori_ grouping of affect items. Items one, five and six were included in an analysis of affect. Item two did not correlate well with any of the items and was thus excluded from the affect analyses.

2 of/de 2



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE MATERIAL 1010a
(ANSI and ISO TEST CHART No. 2)

Tutor affect was analyzed using a one-way analysis of variance for the three groups. The analysis yielded no significant differences in affect for the CS training group (M=3.98) versus the moderate support group (M=3.71) or the untrained controls (M=3.49). Planned contrasts were used to test the specific hypothesis that tutors trained to use the CS rule would demonstrate more positive affect regarding the tutoring experience than moderate support controls or untrained controls. The hypothesis was not supported. A 2x3 (tutor grade x group) analysis did not show effects.

Tutor Concept of Self-as-Teacher. Continuing the examination of item correlations, items three and four correlated most highly with each other (r=.26). This statistical correlation supported the a priori judgement that these two questions were related as aspects of the tutor teacher-concept. Obviously, however, the relation is not a strong one.

Tutor concept of self-as-teacher (items three and four) was analyzed using a one-way analysis of variance for the three groups. The analysis yielded a significant main effect of group, F (2, 21) = 4.75, MS_e = .82, p < .05. Planned contrasts were used to test the specific hypothesis that tutors trained to use the CS rule would demonstrate a more positive concept of self-as-teacher than would moderate support controls or untrained controls. Planned comparisons demonstrated that tutors in the CS training group had a better concept of self-as-teacher ($\underline{M}$=4.81) than tutors in the untrained control group ($\underline{M}$=3.5), $\underline{F}$ (1,21) = 8.42, MS_e = .82, $\underline{p}$ < .005. However, the difference between tutors in the CS training group and tutors in the moderate support group ($\underline{M}$=4.56) was not significant.

A 2x3 (tutor grade x group) analysis of variance yielded a main effect of tutor grade, $\underline{F}$ (1,18) = 5.27, MS_e = .51, $\underline{p}$ < .05, with grade seven tutors demonstrating a better concept of self-as-teacher ($\underline{M}$=4.71) than grade eight tutors ($\underline{M}$=4.03). Tutor grade interacted significantly with group, $\underline{F}$ (2, 18) = 5.49, MS_e = .51, $\underline{p}$ < .05. Simple main effects analyses of tutor group revealed a significant effect for grade seven only, $\underline{F}$ (2,8) = 10.91, MS_e = .62, $\underline{p}$ < .01. Table 7 shows concept of self-as-teacher scores by group and tutor grade.

Table 7

Mean Concept of Self-as-Teacher as a Function of Group and Tutor Grade (out of 7 possible)

Grade	CS Rule	Tutor Training Group Moderate	Untrained
7			
M	6.00	4.88	3.25
SD	1.0	.85	.50
8			
M	4.10	4.25	3.75
SD	.42	.87	.65

Tutee Affect and Self-Concept. Tutee affect (e.g., "how enjoyable were the division problems?") and concept of self-as-learner (e.g., "how much did you learn about long-division?") were measured using a 7- point scale, from one - "not at all" to seven - "totally". A one-way analysis of variance revealed a significant group difference on the combined affect and concept of self-as-learner questionnaire, F (2,21) = 4.66, MS_e = .70, $p <$ .05. Planned comparisons revealed that tutees in the CS group were more positive overall (*M*=5.24) than tutees in the untrained control group (*M*=3.99), *F* (1,21) = 8.94, MS_e = .70, *p* < .01, but not significantly different than tutees in the moderate support group (*M*=4.84).

The six items on the questionnaire were grouped *a priori* into affect items and learner-concept items. Items one ("how enjoyable were the division problems?"), two ("how frustrating were the division problems?"), five ("how much did you become friends with the tutor?") and six ("would you enjoy being tutored again?") were conceived as affect items, while items three ("how much did you learn about long-division?") and four ("how much of what you are taught are you usually able to learn?") were concept items.

Tutee Affect. Item correlations revealed that item one correlated most highly with items five (*r*=.65) and six (*r*=.55). Item five correlated most highly with items one (*r*=.65) and six (*r*=.58). Item six correlated most highly with items one (*r*=.55) and five (*r*=.58). Item correlations were thus generally in agreement with the *a priori* grouping of affect items. Items one, five and six were included in the analysis of affect, as for the analysis for tutors. Item two did not correlate well with any items and was again excluded from the analysis.

Tutee affect was analyzed using a one-way analysis of variance for the three groups. Planned contrasts yielded a significant difference in affect for the CS training group (*M*=5.16) from the untrained controls (*M*=3.41), *F* (1,21) = 3.09, MS_e = 2.00, *p* < .05, but no difference between the CS training group's affect and that of the moderate support group (*M*=4.43). A 2x3 (tutor grade x group) analysis did not show effects.

Tutee Concept of Self-as-Learner. Continuing the examination of item correlations, items three and four correlated most highly with each other (*r*=.68). This statistical correlation supported the *a priori* judgement that these two questions were related as aspects of the tutees' concepts of self-as-learner.

Tutee concept of self-as-learner (items three and four) was analyzed using a one-way analysis of variance for the three groups. The analysis did not yield a significant main effect. Tutees in the CS training group did not have a better concept of self-as-learner (*M*=5.13) than tutees in the moderate group (*M*=5.31) or in the untrained group (*M*=4.25). The planned comparison of tutees' self-concept in the CS training group with tutees' concepts in the untrained control group was not significant. There were no further effects.

Secondary Analyses of Measure Validity

Tutee Success Percentage. Tutee success in following tutor instructions on the tutoring pretest and posttest was analyzed, using a 3x2x3 (group x time x component) mixed analysis of variance. This revealed a significant effect of long-division component on tutee success, F (2,42) = 18.41, MS_e = 123.14, $p < .001$. Percentage of success on the components reflected the a priori expectations of component difficulty, with tutees experiencing the least success on estimation (M=75.08%), followed by multiplication (M=77.42%) and then subtraction (M=88.00%).

Number of Tutoring Interventions. The scaffolding notion implies that tutors overall would provide more support to more difficult task components (e.g., MacVicar et al., 1990; Saxe et al., 1987). The total number of interventions made by tutors overall was analyzed using a 3x2x3 (group x time x component) mixed analysis of variance. This revealed a significant main effect of time, F (1,21) = 8.70, MS_e = 176.41, $p < .01$, with tutors intervening more frequently on the tutoring pretest (M=15.01) than on the tutoring posttest (M=8.49). In addition there was a significant effect of component, F (2,42) = 24.97, MS_e = 81.89, $p < .001$. The number of interventions was greatest for the estimation component (*M*=17.52), followed by the multiplication component (*M*=13.06) and then the subtraction component (*M*=4.67). This analysis also yielded an interaction of component with time, *F* (2,36) = 6.36, MS_e = 38.85, *p* < .01. From tutoring pretest to posttest the number of interventions decreased 44% for estimation, 47% for multiplication, but only 30% for subtraction. Mean number of interventions per component are shown in Table 8.

Table 8

Mean Number of Interventions as a Function of Long-Division Component and Time of Testing

	Long-Division Component		
Time	Estimation	Multiplication	Subtraction
Pretest			
M	22.45	17.08	5.50
SD	15.36	11.97	5.29
Posttest			
M	12.58	9.04	3.83
SD	13.39	11.07	4.71

Tutor Average Intervention Level. Previous research with adult tutors in this paradigm has shown that tutors generally provide more support to the more difficult task components (e.g., MacVicar et al., 1990). Tutors' average level of intervention was analyzed using a 3x2x3 (group x time x component) analysis. This revealed a main effect of component, $F\ (2,42) = 49.40$, $MS_e = .52$, $p < .001$. The highest levels of support were given on the difficult estimation component (M=2.68), followed by the multiplication (M=2.14) and subtraction components (M=1.23). There was also a significant interaction of component with time, $F\ (2,42) = 4.85$, $MS_e = .45$, $p < .05$. The level of intervention from pretest to posttest decreased .37 for estimation, .69 for multiplication, and increased .16 for subtraction. See Table 9 for mean level of interventions by component and time.

Table 9

Mean Level of Interventions as a Function of Long-Division Component and Time of Testing (out of 8)

	Long-Division Component		
Time	Estimation	Multiplication	Subtraction
Pretest			
M	2.87	2.49	1.16
SD	1.00	.89	1.02
Posttest			
M	2.50	1.80	1.31
SD	1.05	.96	1.02

Relationship of Shift Patterns and RSI. Previous research has shown that adults' tutoring usage of the RSI is positively correlated with more appropriate CS patterns (e.g., Pratt et al., 1988, Wood & Middleton, 1975). More frequent tutor use of tutees' RSI level on the tutoring pretest correlated with tutors' pretest use of extreme shifting (ES) in the correct direction (r=.59) and tutors' use of the CS rule and ES combined (r =.58). However, the correlation between pretest RSI use and CS rule use alone was not significant.

More frequent tutor use of tutees' RSI level on the tutoring posttest correlated with tutor posttest use of extreme shifting (ES) in the correct direction (r=.59) and tutor use of the CS rule and ES combined (r =.50). Again, however, the correlation between posttest RSI use and CS rule use alone was not significant. Pretest and posttest correlations of shift patterns and use of the RSI are shown in Table 10.

Table 10

Correlations of RSI Use and Shifting Patterns at Tutoring Pretest and Posttest.

	CS	ES	CS+ES
RSI Prestest Use	-.21	.59*	.58*
RSI Posttest Use	-.08	.59*	.50*

* $p < .01$

Discussion

The purpose of the present study was to determine the consequences of training tutors to use different tutoring strategies to help younger students learn more about long-division skills. Overall, tutees showed improvement in their long-division performance after the tutoring sessions. Tutee improvement, however, was not dependent on the specific training group experiences of the tutor. Instead, all students, regardless of group, tended to show improved long-division skills after the tutoring experience. It appeared that contingently trained tutors found their strategy difficult to apply and did not, in fact, follow the contingency rule any more frequently at posttest than other tutors. Not surprisingly, then, there was no evidence of generalization of these skills by the contingently trained group to new problems, either.

There were, however, some benefits arising from training tutors to provide contingent support Contingently trained tutors felt more positive about themselves as teachers than did untrained tutors. In addition, learners taught by contingently trained tutors enjoyed the long-division problems more than tutees taught by tutors given practice only. Thus, this study shows some benefits resulting from specific tutor training in terms of tutor and learner feelings about learning. It may be that the difficulty children had in learning to tutor contingently can be remedied in future research, based on the information gained in this project. The discussion section first focuses on interpretations of the direct training, generalization and affect results. This is followed by discussions on the validity of the indices, interpretive observations, limitations of the study, and future research.

Direct Training Effects

Tutor Use of the CS Rule. Transcripts of the pretest and posttest tutoring sessions provided information regarding the tutoring process and use of the CS training strategy. Examination of the transcripts demonstrated that CS rule trained tutors did not learn to use more contingent strategies in selecting levels of support to provide scaffolded tutoring. More specifically, CS trained tutors did not show an increase in the provision of one or two levels more support after tutee failure, and one or two levels less support after tutee success. This was evidenced by the lack of a group by time interaction for use of the CS rule. That is, CS rule gain from tutoring pretest to posttest was not greater for the CS trained tutors than for the moderate support controls or untrained controls. In fact, there was little overall change in CS rule usage over time for any group.

This lack of a training effect could not be a result of group differences in pretest tutor long-division skills, because analysis of the tutors' long-division criterion measure demonstrated no pre-existing group differences. Nor was the training effect confounded by variations in tutee long-division ability. That is, there were no group differences in tutee RSI level as measured on the tutoring pretest.

One possible explanation for the lack of training effects concerns the child-tutors' difficulty in learning to scaffold instruction. It may be that child-tutors find that scaffolding instruction according to learner performance is inherently too difficult a task. This explanation, however, seems to be inconsistent with Palincsar's (1987) finding that child-tutors could be trained to scaffold reading comprehension dialogues when given a substantial amount of training. Furthermore, children have been shown to modify their instruction over time to be more sensitive to tutee needs (Ellis & Rogoff, 1982, 1986).

Considering child-tutors' demonstrated ability to learn to scaffold in other studies, it seems more likely that the child-tutors had difficulty in applying one or more aspects of the complex CS rule, rather than that the child-tutors found it difficult to learn to be responsive to learner needs. Observations of the tutoring and tutoring feedback sessions suggested that tutors were having difficulty making one or more of the decisions required in using the CS rule.

Specific rule training can reduce the ambiguity of general training (e.g., Ellson et al., 1968). However, in the present study, despite specific rule training, there was still a reasonable amount of ambiguity in applying the CS rule. Tutors manifested this ambiguity when attempting to decide: (1) the level of support they provided before a success or failure response, (2) if the tutee's response to an intervention was a success or a failure, and (3) the level of support that they should provide next, based on tutee response, the previous intervention level, and the limitation of the CS rule to move no more than two levels away from the previous level. This difficulty, however, does not seem to be beyond the child-tutors' ability to master, given more time. Lippitt and Lippitt (1968) were able to teach child-tutors difficult skills with extensive tutor training.

Thus, a related explanation concerns the amount and effectiveness of the tutor training given here. It may be that more than two training sessions and two tutoring feedback practices with the CS rule are needed before child-tutors can demonstrate competence in their use of the CS rule. The number of training sessions used was similar to that of Robins (1989), whose training study resulted in effective CS training of adults on a story-telling task. Nevertheless, children may require more practice to master such complex tutoring rules than do adults. The child-tutors' need for more practice with the CS rule is supported by the finding that child-tutors have been shown to learn to scaffold following more extensive training (e.g., Palincsar, 1987). Tutors in Palincsar's study were given 10 training sessions and 12 practice sessions of 35 minutes each.

Alternatively, if the time devoted to tutor training was sufficient, it may be that the training was not as effective as planned because of the tutees' generally high level of performance on the long-division task (pretest RSI was 2.56, suggesting that on average, low support interventions were needed). Thus, the implication of this relatively low RSI pretest score was that some tutees did much of the work without any tutor intervention. This, in turn, meant that these tutors had less opportunity to practice the use of the CS rule at higher levels of support (where their intervention would be needed when the tutee faltered), and thus there was little room for practicing some aspects of tutoring contingently.

Noting the previous arguments, it seems reasonable to suggest that if tutors were given more tutoring practice and were tutoring students who were functioning at a lower level of independence than those of the present study, the tutors might learn to make the decisions involved in applying the CS rule and thereby learn to tutor contingently in this mathematics area.

The effects of tutor grade on the use of the CS rule were unexpected and unclear. There was no reason to expect that grade seven tutors would use the CS rule more frequently than grade eight tutors or that tutor grade would interact with group for the use of the CS rule. The small number of subjects in each grade by treatment cell makes it unproductive to attempt to account for these unanticipated effects. Further research on tutor grade with a larger sample size within groups would be necessary to draw useful conclusions about any potential differences in effects of tutor grade. Furthermore, tutor grade level was confounded with the factor of school in the present design.

Tutor Use of Extreme Shifting. An analysis of tutors' use of extreme shifting in the correct direction was performed, so that if partial training effects occurred they would not be omitted. It was reasoned that tutors given CS rule training could learn to provide contingent patterns of shifts, without learning to stay within two support levels of the previous level of intervention. The findings in this analysis indicated that extreme shifting was comparable between groups on the tutoring pretest, but significantly different between groups on the posttest. Moderate support controls demonstrated less extreme shifting on the posttest than tutors in the CS trained group and the untrained group. This is consistent with the demonstrated increase in moderate support use by this moderate group after training (see Table 4), which should lead to less extreme shifting. However, the use of extreme shifting on the posttest did not differ for CS rule trained tutors and untrained tutors. Therefore, the idea of partial training effects for the CS group was not supported.

There was a tutor grade by group interaction which demonstrated that grade eight tutors' use of extreme shifting was more variable between groups than that of grade seven tutors. These differences suggest that the training-tutoring experience is somehow different for grade seven and grade eight tutors. However, it may be that the results are spurious because of the small sample size in each grade by group cell. Again, this may be a school difference, due to the grade by school confound in this study.

Tutoring Patterns By Levels. Although there were no specific training effects in use of the CS rule, there were some related effects of training evidenced. Tutors in the moderate control group used the moderate level of support more frequently on the tutoring posttest than on the pretest. In addition, tutors in the CS rule trained group moved away from high levels of support on the posttest to lower level interventions. Moderate controls also moved away from high level support on the posttest but toward the moderate level of support. The moderate controls' shift from high to moderate support is reasonably explained as the effect of the moderate support training. This particular group did show clear evidence of a training effect on a simple, noncontingent rule (see Table 4). The CS trained tutors' shifts from high to low support over training indicate that these tutors may have learned not to give more support than the tutee needs, that is, not to overscaffold. This explanation is further supported by the fact that untrained controls did not change the frequency of interventions at any of the three levels from pretest to posttest. It seems reasonable to suggest then that there were some nonspecific effects of CS training. Possibly the CS training group had acquired part of the contingency rule (avoiding overscaffolding after success), but not the more difficult matching component (avoiding underscaffolding after failure).

Tutee RSI Level. Tutee RSI levels demonstrated that tutees were already performing the long-division task reasonably independently before tutoring occurred. The average pretest tutee RSI level was between level 2 ("general hint") and level 3 ("label operation"), indicating that simply specifying the correct operation was sufficient for success over 66% of the time. Although tutees' RSI level was low on the pretest (2.56 on a 9-point scale), it was still possible for tutoring to lower tutees' need for support. This was suggested by a non-significant trend towards lower tutee RSI levels on the posttest (M=1.62).

Tutor Use of the RSI. It was hypothesized that the CS trained group would use the tutees' RSI level to a greater extent than the control tutors because greater use of the CS rule would lead to greater use of the RSI. Not surprisingly, the lack of a training effect for the use of the CS rule was paralleled by a lack of such an effect for tutor use of the RSI. The tutoring transcripts demonstrated that the tutoring pretest to posttest gain in the use of the RSI was not significantly greater for the CS trained tutors than for the moderate support controls or untrained controls, though the average gain scores were somewhat larger for the CS group than for the other two.

Moreover, child tutors' use of the RSI did appear to be quite reasonable overall. Typical scaffolding patterns were evident in the children's tutoring, in that the more difficult components (especially estimation) received significantly more support at both times of testing than did less difficult tasks (subtraction). The difficult components also received more interventions in total. As well, overall use of the RSI level was quite high (46%), in comparison to Houston's (1987) observational study (19.9%) of younger child-tutors, Pratt et al.'s (1988) observational study of parent tutoring on a range of tasks (29.8%) and MacVicar et al.'s (1990) observations of parents tutoring on the long-division task (19.8%).

A reasonable explanation for the high RSI use in this study was that tutees frequently needed little or no assistance. Therefore, in these situations, tutors giving little or no assistance to tutees would be considered to be tutoring in the RSI. Overall, nearly 50% of the time in this study, tutors simply did not intervene at all prior to a tutee's problem attempt. However, lack of tutor assistance may obviously be a result of factors other than a sensitivity to learner needs. For example, in comparison to adult tutors, child-tutors have been reported to be less skilled at providing verbal instruction (Ellis & Rogoff, 1982), and therefore may be sitting idle in these instances because of immature verbal skills or uncertainty about how to frame interventions. Similarly, tutors may not have provided assistance because they could not easily utilize non-verbal instruction on the long-division task. So, the hesitancy of child-tutors in using verbal instruction, coupled with a task which is not well suited to non-verbal instruction, may have falsely elevated our measure of tutors' sensitivity to learner needs because these tutees in general simply required little assistance.

Alternatively, the higher tutor RSI scores in the present study may have a simpler explanation. It may be that it is much easier to recognize when a learner needs no assistance at all than it is to know what specific level of assistance the learner needs. If so, the reasonably competent tutees of the present study would make the task of being sensitive to learner needs easier, since all the tutor needs to do is keep quiet, therefore raising tutors' apparent use of the RSI.

Tutee Math Performance. The lack of differential training effects was demonstrated on the tutee achievement measure as well. That is, there were no tutoring group differences in tutees' long-division gain scores. Tutees' long-division pretest performance, as measured on a parallel version of Savoy's (1989) pretest, was high (58.1%), in comparison to the pretest scores of Savoy's tutees (11.7%). This difference may be attributable to the later testing date in the grade fives' school year for the present study, compared with Savoy's assessments made much earlier in the school year. Of course, school or teacher differences, or other factors, may be involved in such cross-experiment comparisons as well.

Tutees' long-division posttest performance (85.9%) in this study, as measured on a parallel version of

Savoy's (1989) posttest, was significantly higher than their pretest performance, suggesting that tutoring resulted in substantial learning gains overall across all three training groups. Although the pretest and posttest assessment instruments were not counterbalanced in this study, the number of digits in the divisors and dividends was parallel across the two forms. Furthermore, Savoy's (1989) tutees showed no gains from these long-division pretests to posttests when they were given no or ineffective tutoring, but large gain scores when they were given contingent support tutoring. That some tutee groups did not improve on the posttest, yet others did improve, suggests that the pretest-posttest difference was not attributable to differential test difficulty, but to learning in the Savoy (1989) study. This argument is further supported by the counterbalancing of pretest and posttest mathematics measures in the Savoy (1989) study. Therefore, having used long-division tests parallel to Savoy's (1989), it seems reasonable that the gain in long-division performance for tutees in the present study was also a real effect. Although outside factors (e.g., classroom learning) may have brought about this apparent learning, direct tutoring in the peer dyads on long-division remains a plausible explanation for these improvements from pre- to posttest. However, this apparent learning effect was equivalent for the contingent, moderate support and practice control groups in this study, inconsistent with the hypothesis of greater gains for the contingently-taught group.

Generalization Effects

Tutoring Transfer. Tutors' skill in transferring scaffolding techniques in tutoring to a closely related task (long-division word problems) could not be determined in this study. The average number of tutoring interventions on the transfer task (1.58) did not provide sufficient data to examine tutors' use of contingent shifting or tutors' use of the RSI, since both of these indices require a series of interventions for analysis. It can be deduced by the overall tutee success percentage (75%), at low levels of average tutoring support (M=1.84), that the fifth-graders' need for assistance on this closely related long-division transfer task was low. It appears that tutors cverall scaffolded their tutoring on this transfer measure appropriately, by providing low levels of support when that was all that was needed for fairly high tutee success. It may also be, as in the case of high RSI use, that the tutors are simply not very good at intervening and that this was in their favour in this transfer situation, where tutees happened to need little assistance.

Although the hypothesized group differences concerning the transfer of CS rule use and RSI use could not be tested, one could reasonably assume that, if these were measured, no group differences would have been found, as group differences in scaffolding strategies were not found on the direct training task.

Tutor Use of Strategy. Tutors' ability to transfer scaffolding strategies at a conceptual level was measured by asking them to write about the way they would teach a grade four student the task of multiplication. Although the results were not significant, there was some tendency for CS trained tutors to mention more scaffolding strategies than did moderate support controls and untrained controls, in their descriptions of how they would teach multiplication. This trend may suggest that tutors had begun to learn the CS rule conceptually, even though they had a difficult time applying it in their actual teaching. Nevertheless, the lack of significant group differences indicates that these principles were not yet mastered by the CS group. The lack of group differences might also suggest that the CS tutors did not believe they were trained to use an an effective tutoring strategy and therefore did not list scaffolding strategies to a greater degree than tutors in the control groups. More plausibly, as indicated by the quality of the tutors' answers, the tutors experienced difficulty expressing what they would actually do in the tutoring situation.

Tutor Estimation. As CS trained tutors did not learn to use the CS rule effectively, it would not be expected that they would have gained the skills that would be learned through using the CS rule (e.g., the ability to detect one's own errors). It was therefore not surprising that a greater gain in metacognitive awareness was not demonstrated by CS trained tutors than by moderate support and untrained control tutors on a task requiring metacognitive awareness (i.e., a task that required the tutor to estimate his/her performance scores on the general mathematics pretest and posttest). In fact, the untrained control group demonstrated significantly more accurate postdictions of their performance overall, across both times of testing, than the other groups. Thus, this was the single significant pretest difference apparent across groups in the present study. Training differences did not interact with these group differences at post-test, however.

A possible explanation for the overall greater estimation accuracy of the untrained control group may be related to the tutor scores on the long-division criterion measure. Although there was no statistical difference between groups, the untrained group had the highest average score on the criterion measure (Untrained, *M*=4.50; Moderate, *M*=4.00; CS, *M*=3.80). It may be that tutors in the untrained group were higher achievers than tutors in the other groups. If so, the untrained group's superior estimation accuracy would be consistent with Owings, Petersen, Bransford, Morris, and Stein's (1980) findings.

Owings et al. (1980) found that academically more successful fifth graders were more able to distinguish the difficulty of sentences studied for a memory test (a test of metacognitive awareness according to Palincsar & Brown, 1987) than less successful fifth graders. Similarly, the present study's finding of greater estimation accuracy (metacognitive awareness) and indications of better criterion performance by untrained tutors may suggest that untrained tutors estimated test performance more accurately because they were higher achievers on average than other tutors. Regardless, this is a puzzling finding which is difficult to interpret.

Affect and Self-Concept Effects

Tutor Affect. Tutors in the CS training group did not demonstrate more positive affect than tutors in the moderate support or untrained control group. More specifically, summary tutor ratings of how enjoyable tutoring was, how much they became friends with the tutee, and how much they would enjoy tutoring again, did not differ according to the tutor's training group.

Overall, tutor affect reflected a "somewhat" to "moderate" level of enjoyment of the tutoring experience. This moderate overall rating, and the lack of group differences, may reflect that none of the experimental conditions was exempt from presenting some difficulties for the tutor. The untrained controls were given neither a specific tutoring strategy to employ, nor feedback. The moderate support controls were instructed to employ a moderate level of support regardless of the tutee's response. Finally, the CS trained tutors were required to learn and apply a complex strategy. The moderate affect rating overall is consistent with peer tutoring research, which has shown that tutoring is not always a positive experience for tutors (Cloward, 1967; Cohen et al., 1982). On the other hand, it was clearly not a negative experience for most of the students involved.

Tutor Concept of Self-as-Teacher. Tutor ratings of how effective they were at tutoring long-division, and how effective they were at teaching usually, differed according to the tutors' training group. Tutors in the CS training group demonstrated a more positive concept of self-as-teacher than tutors in the untrained control group. This self-concept difference, however, was not evidenced between the CS trained tutors and the moderate support controls. This result suggests that specific strategy training and feedback or training itself builds more teaching confidence than mere teaching practice. Although Robins (1989) found that CS trained mothers did not feel more effective as tutors than did untrained mothers, it may have been, as she suggested, that more training sessions were needed to demonstrate this pattern. The present study employed two tutoring and feedback sessions, beyond the two strategy training sessions employed in Robins' (1989) study. Alternatively, peers who are untrained may generally feel less confident as teachers than do untrained mothers instructing their own children. In this case, specific training effects on confidence levels would be expected for peers, but not necessarily for the adults.

The difference in tutors' concept of self-as-teacher cannot be explained by differences in tutee success, because tutees taught by CS-trained tutors did not experience a different degree of success (83.1%) than tutees taught by the moderate support controls (81.4%) or the untrained controls (80.5%). In addition, as tutors in the CS training group were not applying the CS rule to a greater degree than tutors in the control groups, the influence of a factor(s) other than use of the CS rule must be operating on tutors' concept of self-as-teacher.

A possible explanation for the tutor concept of self-as-teacher effects may be related to the observations on scaffolding noted previously. In the present study, on the tutoring posttest, CS trained tutors provided high levels of support (level 5 and over, considering an RSI of 1.62) on 14.3% of their interventions, in contrast to untrained controls (21%). Moderate support tutors provided high levels on 17.9% of their interventions. It may be, then, that a higher degree of "over-scaffolding" by untrained controls, compared with that by CS trained tutors, led to tutee dissatisfaction and thus to less positive judgements of tutoring ability by the untrained control tutors.

Alternatively, it may be that tutors in the CS trained group felt better about themselves as teachers than untrained controls because they were employing a teaching strategy which they judged to be a good strategy--one that considers the learner's needs and builds independence. They may also have reasoned that if they were being trained to use this strategy, it was an effective teaching method. In contrast, untrained controls may have felt that they had no real strategy or that the strategy they adopted was not particularly good because they themselves developed it and were unsure of its benefits.

One other possible reason that tutors in the CS group were more positive about their teaching than tutors in the untrained control group could be that the experimenter was not blind to the hypotheses and may have communicated more enthusiasm to the training group than to the untrained control group. That the results of an experiment may unintentionally be influenced by the experimenter is a research problem which has been much discussed (Kintz, Delprate, Mettee, Persons, & Schappe, 1965; Rosenthal, 1964) and should be noted in this study as a possible explanation for the teacher-concept effect. Beyond the efforts of the experimenter to be consistent in the treatment of the participants (e.g., prepared scripts), the effects of the experimenter bias are difficult to control without using an experimenter who is blind to the hypotheses.

Based on the follow-up analyses by tutor grade level, it seems that this group difference in teaching concept was only present for the grade seven tutors. Perhaps the grade eight tutors in the CS training group judged their teaching ability against their adherence to the CS rule to a greater extent than did the grade seven tutors and therefore did not feel better about themselves as teachers. As stated previously, however, the small number of subjects in each cell for these group by grade analyses makes it risky to interpret these effects.

Tutee Affect. Tutee affect ratings were generally significantly more positive for tutees trained by CS trained tutors than for those taught by untrained controls, but not different from those taught by moderate support controls. As there were no group differences in tutee success rate or tutee RSI level, this result suggests that tutees enjoyed the tutoring experience to a greater degree when the tutor had been given teaching instruction and feedback, as opposed to mere teaching practice. However, this reasoning does not sufficiently explain the finding regarding tutees' enjoyment of the division problems.

As in the case of tutor concept of self-as-teacher, a possible explanation for the tutee affect findings may be related to overscaffolding. As we are already dealing with relatively competent learners in this study, it is more likely that overscaffolding would influence tutee enjoyment rather than the concept of self-as-learner. It is reasonable that tutee enjoyment would be lessened by tutor overscaffolding because interventions would be interfering in a task step in which the tutee has proven competence. This continued interference may have been a source of frustration to the tutees, which may in turn have decreased their enjoyment. Therefore this affect finding is reasonable when one remembers that on the tutoring posttest, high levels of support were most frequent for untrained controls, followed by moderate controls and then CS trained tutors.

As suggested for the teacher-concept effect for tutors, it may be in this case as well that experimenter bias may have played a role in the tutee affect finding. That is, perhaps the experimenter's expectancy that tutees in the CS group would enjoy the tutoring sessions more than moderate support and untrained controls brought about this result.

Alternatively, it may be that tutees trained by CS tutors were aware from the feedback sessions that tutors were attempting to be sensitive to their needs and that this attempt on the tutors' part made the long-division task more enjoyable for the tutees. In contrast, it may be that tutees trained by moderate support controls realized from feedback sessions that their tutors were not allowed to be systematically sensitive to their needs and therefore found the long-division task less enjoyable. Finally, tutees taught by untrained controls might have realized from the practice sessions that tutors were getting no instruction from the researcher/trainer and were allowed to carry on even when it was apparent to the tutees that the tutoring was not effective. This, in turn, would take away from the enjoyment of the long-division problems.

Tutee Concept of Self-as-Learner. Generally, tutees' ratings of how much they learned about long-division, and how much of what they are taught they are usually able to learn, were in the "quite a bit" range and did not differ according to the training group of the tutors.

Validity of Study Indices

Tutees' overall performance on the pretest and posttest tutoring interventions reflected a high degree of success (80.5%). This success level suggests that the tutees did not find the task too difficult and that the tutors could generally provide a support level at which the tutee could succeed. Tutee success levels on the separate components suggested that the components of the long-division task were of differential difficulty. Tutees experienced the least success on the estimation component, followed by multiplication and then subtraction, as expected.

Tutors' ability to employ scaffolding on the long-division was demonstrated in ways which were consistent with findings of parental scaffolding patterns in MacVicar et al. (1990) and Saxe et al. (1987). Peer tutor scaffolding was evident in the differential treatment of the long-division components, and the adjustments made in tutoring over time.

Tutors intervened most frequently on the least familiar and apparently most difficult long-division component (estimation), and provided fewer interventions on multiplication and subtraction. As well, the average level of support was greatest for the estimation component, with less support being provided for the multiplication and subtraction components (as found by MacVicar et al., 1990, for adults). In addition, tutors made changes in the number and level of their interventions as tutees' performance improved. Specifically, they reduced the number of interventions and support levels for the estimation and multiplication components of the task. As the number of interventions and support on the subtraction component were at a low level on the pretest, it was not surprising that tutors did not decrease the number of interventions or support for the subtraction component on the posttest.

Although use of the RSI was not correlated with use of the CS rule, it was moderately positively correlated with extreme shifting in the correct direction and the combination of "extreme shifting plus use of the CS rule". Previous studies that found RSI rule use was correlated with CS rule use included correct directional shifts larger than two levels as a measure of CS rule use (MacVicar et al., 1990). Considering the present correlational finding of RSI use with extreme shifting in the correct direction and the conservative definition of CS rule use, it appears that a more "liberal" definition of CS rule use in the present study over wider shifts supports the typical finding of a positive correlation of CS rule use with use of the RSI.

Interpretive Observations

It was apparent during the first training session that tutors learning the CS rule were having great difficulty applying it. They seemed to understand and appreciate the rule, but had difficulty on one or more aspects of applying the rule. Tutors frequently provided support without first determining the level of that support according to Green's coding sheet. This act left them floundering when their next decision was to be made partly on the basis of the decision they had just made.

In contrast, moderate support controls appeared to know how to apply the moderate support strategy but did not always comply with it. Reasonably enough, the tutors did not like intervening at moderate support levels when it was apparent that the tutee did not need so much assistance. During training sessions, untrained controls (practice controls) asked for instructions as to what they should do when they were tutoring, and generally seemed unsatisfied that they were not given instructions.

Although tutee performance on long-division problems was good prior to tutoring, tutees did seem to benefit from working on difficult and intimidating-looking problems. It appeared that over the course of the study they were learning to apply a familiar concept to a set of problems more difficult than those they had previously worked on.

A few grade seven and eight tutors expressed some anxiety that they knew less than the tutees or that the tutees were smarter. Although all tutors met the criterion measure, it may be that lower achievers understood the concept of long-division but were prone to make more mistakes or to exhibit slower solution processes. If these tutors were paired with high achieving tutees the tutor anxiety may have reflected actual experience.

The social context of the tutoring session for these often unacquainted dyads was sometimes awkward. Tutors rarely initiated conversation not related to the tutoring task, and looked to the experimenter to initiate the tutor-tutee introductions. Tutoring sessions could likely have been more enjoyable if all tutors had been trained to establish more of a social relationship with the tutees.

Limitations of the Study

The present study investigated whether child-tutors could be trained to employ the CS rule. Although child-tutors did not learn to employ the complete CS rule more frequently, their ability to eventually acquire this strategy cannot be discounted. It may be that tutoring practice and feedback sessions would have been effective in teaching the tutors the CS rule if tutees' needs for task assistance were greater and/or if more training sessions were employed.

The tutees' relatively high pretest performance, and consequent low RSI level, indicated that their skill levels were rather high for use of this particular training task. Due to unforeseen delays, the study was conducted toward the end of the school year. Tutoring which occurred earlier in the school year, prior to so much school practice at long-division in Grade 5, would give tutors more opportunity and practice using the higher levels of intervention and support, and a greater sense of their superiority at the task. In addition, this earlier testing would provide the tutees with more room to benefit from and enjoy the tutoring.

The study was also limited by the fairly brief training schedule. The CS strategy proved to be a very difficult one for tutors to learn over two training and two feedback sessions. In order to fully determine whether child-tutors could learn to implement the CS rule, and determine the benefits that arise from its implementation, it would be necessary to extend the training sessions.

The skill level of the tutees and the brevity of the training provide strong reasons for not interpreting the lack of training effects in this study to mean that junior high tutors could not under any circumstances learn to use the CS rule. In addition, the lack of a training effect does not allow one to address many aspects of the sufficiency of Vygotskian (1978) theory for explaining and predicting the components that lead to peer tutoring benefits. Nevertheless, the <u>general</u> ideas of scaffolding described by Wood et al. (1976) and others, and based in Vygotskian principles, were quite consistently supported by the overall patterns observed across groups.

A further limitation of this study was the confound between tutor grade and school (i.e., grade seven tutors were used at one school and grade eight tutors at another school). The outcome of the confound was that when tutor grade effects occurred, it was not possible to determine whether they were a product of tutor grade or tutor school (or classroom). As tutor grade effects were not of primary interest to the study, and were not expected on the basis of the literature review effects due to this factor may have been artificial. Accordingly, interpretation of these tutor grade/school effects was not stressed. Other limitations of the study to be mentioned briefly were the sample size, the population and the lack of an experimenter who was unaware of the hypotheses. Firstly, there were some trends, towards CS trained tutors showing greater conceptual knowledge of the steps involved in the CS rule and toward greater use of the RSI, which may reasonably be viewed as not effectively tested here due to lower power. Increased sample size would be necessary to determine the reality of these effects. Secondly, the findings are limited in the population to which they can be generalized. The sample can be broadly described as including middle-class, English speaking grade five tutees and grade seven and eight tutors using same and opposite gender tutor-tutee pairings. Finally, the lack of a "blind" experimenter who was unaware of the hypotheses prevents one from conclusively stating that outcomes that occurred as hypothesized did so for reasons hypothesized (i.e., training). However, it would be difficult with this training experiment to have a truly unaware experimenter, or an experimenter who could have a constant influence on all participants. It may be then that the lack of a "blind" experimenter and associated experimenter outcome expectancies could explain findings that were hypothesized, specifically the affect results for the present study.

Future Research

The present study demonstrated a benefit to tutors' concepts of self-as-teacher and tutees' feeling about tutoring when tutors were given training as opposed to mere practice tutoring. As well, all tutees demonstrated achievement gains, at least arguably as a result of peer tutoring. Although achievement benefits were not greater for tutees taught by tutors trained in a strategy based on Wood's instantiation of Vygotsky's (1978) theoretical work, the predicted benefits of the CS rule could not be adequately tested due to lack of direct training effects in the CS tutoring group.

The most obvious research question that should be investigated as a result of this study is whether a longer training schedule would allow the child-tutors to learn to apply the CS rule, and, if so, if the resulting benefits would be as predicted in this study. The reason for believing that extending the training could bring about training effects is related to the difficulty of learning the CS rule, and child-tutors' demonstrated tutoring abilities.

The task of learning and applying the CS rule is one with which child-tutors had great difficulty. The finding that child-tutors did learn quite rapidly to give moderate support according to Green's levels of support, indicates that child-tutors may be able to learn to apply the full spectrum of Green's support levels provided they are given more training than in the present study. A longer, more in-depth training would allow one to determine how difficult the rule is to learn and whether it can be learned and applied by child-tutors. The benefits of tutoring with the CS rule have been demonstrated in past research (e.g., Robins, 1989; Savoy, 1989) and provide a further argument for suggesting that extended tutor training would be a worthwhile research endeavour.

Alternatively, further research might address procedural questions. The present study could be replicated with a more careful examination of training procedures. In regard to training procedure, one suggestion would be to give feedback to the tutor regarding his/her tutoring, but not during the tutoring practice sessions. Rather, this feedback would be more appropriately given without the tutee present. This feedback could occur immediately and individually, following the tutoring practice, with the tutor receiving feedback from a playback of the tape from the practice tutoring session. This suggestion is in accord with Cohen's (1986) observation that "the necessary structuring of the tutoring encounter should be implemented unobtrusively and with minimal interference, so as not to detract from either the tutor's sense of control or the free and relaxed atmosphere between the peers" (p. 183). In addition, all tutors should be taught both the importance of making friends with the tutee and the social skills with which to do so. This social training would help relieve the anxiety related to test-taking.

Research could be carried out on the efficacy of a variety of training methods to teach tutors the CS rule. One method of training might employ Palincsar's idea of having the trainer model the scaffolding strategy in his/her training of the tutors. Another method might include training in metacognitive awareness along with CS rule training. Investigating the efficacy of different methods for teaching the CS rule is a worthwhile empirical study, considering the gains shown in previous studies from CS rule use.

Finally, different tasks could be compared for tutors′ success in learning to apply the CS rule. From the present study, it is suggested that the tasks be ones which the tutor has fully mastered. This tutor superiority would allow the tutor to focus on application of the difficult CS strategy and not be distracted by the demands of the task. In addition, the task should be one in which the tutor can easily evaluate the tutee′s response as a success or failure and easily evaluate his/her own level of intervention.

In summary, peer tutoring of all types in this long-division context was shown to be associated with apparent gains in tutee achievement, but the components which led to these benefits were unclear. It is necessary to perform further research in the peer tutoring area to ascertain tutors′ skills in providing good instruction as defined by Vygotsky and instantiated by Wood.

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APPENDIX A

EXAMPLES OF LEVELS OF SUPPORT

	Dividend	Multiplication	Subtraction
0	No help	No help	No help
1	Prompt ("try this one")	Prompt	Prompt
2	Hint ("how many times?")	Hint ("what's next?")	Hint ("what do you do with those numbers?")
3	Tell the math step to use ("Divide 27 into 43")	Tell the math step to use ("Multiply them")	Tell the math step to use ("Subtract them")
4	Specify which numbers to use ("How many times will 2 go into 4")	Specify which numbers to use ("Multiply 41 times 6")	Specify which numbers to use ("Subtract 182 from 356")
5	Specific hint ("That looks like too many times")	Specific hint ("That is too big")	Specific hint ("I don't think you did that right")
6	Give step answer <u>or</u> tell where a number is to be printed ("I would try 2" "Put the number up above")	Give step answer <u>or</u> tell where a number is to be printed ("4 times 2 is 8", "Put the answer under here")	Give step answer <u>or</u> tell where a number is to be printed ("8 minus 3 is 5", "Put it down here")
7	Give step answer <u>and</u> tell where a number is to be printed ("That will be 4, put it above here")	Give step answer <u>and</u> tell where a number is to be printed ("6 times 6 is 36, and it goes here")	Give step answer <u>and</u> tell where a number is to be printed ("It's a 3; put it under the 6")
8	Tutor does it	Tutor does it	Tutor does it

APPENDIX B

PRETEST OF TUTORS′ LONG-DIVISION SKILL

Please complete these division problems and show remainders with an "R".

1. 875 divided by 21
2. 1966 divided by 32
3. 4681 divided by 62
4. 1739 divided by 19
5. 29634 divided by 55

APPENDIX C

TUTORS' TRANSFER OF STRATEGY USE

If you were to teach a grade four student how to do multiplication describe what you would do. Please write down in steps what you would do.

APPENDIX D

TUTORS' ESTIMATION MATHEMATICS PRETEST
Del Grande et al., (1980)

Add:

$$\begin{array}{r} 1.79 \\ .65 \\ 3.95 \\ \hline \end{array}$$

Subtract:

$$\begin{array}{r} 94 \\ 45.68 \\ \hline \end{array}$$

Calculate:

$$\frac{21 - 7 + 5 \times 3}{4 + 2} =$$

Solve for x:

$$\frac{24}{30} = \frac{x}{10} \qquad x = \underline{\qquad\qquad}$$

Multiply:

$$\begin{array}{r} 7.34 \\ 1.6 \\ \hline \end{array}$$

Tell which is greater:

$$\frac{3}{7} \text{ or } \frac{2}{7} \qquad \underline{\qquad\qquad}$$

Add:

$$\frac{3}{8} + 4\frac{4}{9} =$$

Reduce to the simplest term:

$$\frac{12}{15} =$$

Divide:

$$2\frac{2}{5} - 1\frac{1}{10} =$$

Write as percent:

$$\frac{15}{25} =$$

Divide:

$$57 \overline{)\,8.932}$$

Find the Average:

22, 34, 17, 26, 21

Ans. ____________

APPENDIX E

TUTORS' ESTIMATION MATHEMATICS POSTTEST

Add:

$$\begin{array}{r} .96 \\ 2.85 \\ 4.76 \\ \hline \end{array}$$

Subtract:

$$\begin{array}{r} 20.2 \\ 18.65 \\ \hline \end{array}$$

Calculate:

$$\frac{36 - (9 + 3)}{14 - (9 + 5)} =$$

Solve for x:

$$\frac{10}{12} = \frac{5}{X} \qquad x = \underline{\hspace{3cm}}$$

Multiply:

$$\begin{array}{r} 8.65 \\ 5.3 \\ \hline \end{array}$$

Tell which is greater:

$$\frac{1}{8} \text{ or } \frac{1}{7} \qquad \underline{\hspace{3cm}}$$

Add:

$$\frac{2}{5} + 4\frac{1}{4} =$$

Reduce to the simplest term:

$$\frac{18}{20} =$$

Divide:

$$2\frac{1}{4} - 1\frac{1}{8} =$$

Write as percent:

$$\frac{16}{25} =$$

Divide:

$$29\overline{)34.67}$$

Find the Average:

32, 35, 43, 28, 22

Ans. ____________

APPENDIX F

TUTORS' TRANSFER OF TRAINING

1. Your mother tells you that there are 1879 hours until Christmas. You want to find out how many days this is, and you remember there are 24 hours in each day. How many days are left until Christmas?

2. You have 18,239 marbles and your mother asks you to divide them up evenly among all of the children in your neighborhood. There is a total of 28 children in the neighborhood. How many marbles will each child receive?

APPENDIX G

EXAMPLES OF LEVELS OF SUPPORT FOR THE TRANSFER MEASURE

(AN ADAPTATION OF GREEN'S 1987 CODING SYSTEM)

0	No directive
1	General verbal ("try this one")
2	General hints ("what's next?")
3	Ask which operation ("Divide, Multiply, or Subtract?")
4	Label operation ("Divide")
5	Hint to breakdown sentence into numbers ("Which number is being divided into a smaller number?" or "what do you have to divide that number by?")
6	Give step answer or recording ("The number being divided into sections is 1879, Put it down here", or "the number you are dividing by is 24, Put it here")
7	Give answer and recording ("Write down 1879 divided by 24, put 1879 number here and 24 here")
8	Tutor demonstrates

APPENDIX H

TUTORS' AFFECT AND CONCEPT OF SELF-AS-TEACHER

Please read the following questions and circle the number which best suits your answer.

1. HOW ENJOYABLE WAS TUTORING?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very	totally

2. HOW FRUSTRATING WAS TUTORING?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very	totally

3. HOW EFFECTIVE WERE YOU AT TUTORING LONG-DIVISION?

1	2	3	4	5	6	7
none	very little	little	medium amount	quite a bit	very much	totally

4. HOW EFFECTIVE ARE YOU AT TEACHING USUALLY?

1	2	3	4	5	6	7
none	very little	little	medium amount	quite a bit	very much	totally

5. HOW MUCH DID YOU BECOME FRIENDS WITH THE TUTEE?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very much	totally

6. WOULD YOU ENJOY TUTORING AGAIN?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very much	totally

APPENDIX I

TUTEES' MATHEMATICS PRETEST

1. 29/2 =
2. 75/3 =
3. 86/2 =
4. 57/4 =
5. 399/17 =
6. 9162/29 =
7. 7680/233 =
8. 86745/379 =

APPENDIX J

CODING SCHEME FOR LONG-DIVISION

Example Problem:

```
     _21_
   27)493
     44
       53
       27
       26 R
```

Step 1. Estimation

In the above example, the child did not successfully estimate how many 27's there are in 49, therefore, no point is awarded.

Step 2. Multiplication

The child did not successfully multiply 27 by 2, therefore, no point is awarded.

Step 3. Subtraction

The child successfully subtracts 44 from 49 to derive the difference 5, therefore, one point is awarded.

Step 4. Bringing down the digit

The child successfully brings down the 3, therefore, one point is awarded.

Step 5. Estimation

The child successfully estimates how many 27's there are in 53, therefore, one point is awarded.

Step 6. Multiplication

The child successfully multiplies 27 by 1 to derive the product 27, therefore, one point is awarded.

Step 7. Subtraction

The child successfully subtracts 27 from 53 to derive the difference 26, therefore one point is awarded.

Step 8. Remainder

The child successfully recognizes that 26 is the remainder, therefore, one point is awarded.

The child has successfully solved six of the eight steps correctly. The child's percentage correct for this problem, therefore, is seventy-five.

APPENDIX K

TUTEES' MATHEMATICS POSTTEST

1. 475/19 =

2. 3295/59 =

3. 9879/323 =

4. 37987/711 =

APPENDIX L

TUTEES' AFFECT AND CONCEPT OF SELF-AS-LEARNER

Please read the following questions and circle the number which best suits your answer.

1. HOW ENJOYABLE WERE THE DIVISION PROBLEMS?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very	totally

2. HOW FRUSTRATING WERE THE DIVISION PROBLEMS?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very	totally

3. HOW MUCH DID YOU LEARN ABOUT LONG-DIVISION?

1	2	3	4	5	6	7
none	very little	little	medium amount	quite a bit	very much	totally

4. HOW MUCH OF WHAT YOU ARE TAUGHT ARE YOU USUALLY ABLE TO LEARN?

1	2	3	4	5	6	7
none	very little	little	medium amount	quite a bit	very much	totally

5. HOW MUCH DID YOU BECOME FRIENDS WITH THE TUTOR?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very much	totally

6. WOULD YOU ENJOY BEING TUTORED AGAIN?

1	2	3	4	5	6	7
not at all	a little bit	some-what	moderate	quite a bit	very much	totally

APPENDIX M

TRAINING SCRIPT FOR TUTORS TAUGHT THE CS RULE

Training Session 1

General Instructions

Thank you very much for agreeing to participate in this study. The first thing I would like to do today, is explain two reasons why I am conducting this study. One reason for conducting this study is so that I can examine how older students communicate with their younger peers when they are helping them to learn how to do long-division problems. A second reason for conducting this study is so that I can examine what type of teaching tips will help older students teach their younger peers better.

Now, I'd like to briefly explain what we will be doing over the next two weeks. We are meeting today and one day next week to talk about good teaching. Following each of these meetings, you will be given 15 minutes to practice teaching a grade 5 student how to do long-division. Your teaching goal will be to teach this Grade 5 student how to do long-division problems well enough so that he or she can solve long-division problems on his or her own. While you are teaching, I will help you by giving you some feedback about your teaching. You are free to discuss this study with your parents, but please do not discuss this study with your fellow students until the study is finished.

Are there any questions? Who can tell me one reason for this study? Who can tell me the other reason for this study? Who can tell me what will happen over the next two weeks? Who can tell me what your teaching goal will be?

Specific Instructions

Here is a list of some possible ways to help the student you are tutoring in long-division (give them Green's levels of interventions for long-division). These are arranged from the least helpful (at the top) to the most helpful (at the bottom). For the tutoring sessions in which your goal is to help a grade five student learn long-division I would like you to use a teaching strategy to help you meet your goal. This is the strategy: offer the student only as much help as he or she needs -- this means if the student is able to correctly do what you suggested that you should offer a little less help. As well, if the student is having problems doing as you suggested, offer him or her a little more help. What are the two parts to the strategy? [The students will then be asked to repeat the rule in abbreviated form: student success - support less; student failure - support more.]

Script for Videotape

We are now going to watch a videotape of an older student (Christine) tutoring a younger student (Shannon) in long-division. I will go through the videotape with you and point out examples of where Christine successfully or unsuccessfully follows the rule of offering a little more help when Shannon is having difficulty doing some part of a long-division problem and of offering a little less help when Shannon is able to do some part of a long-division problem alone. (In the videotape the tutor and tutee work on a chalkboard in order that trainees watching the videotape can see what is being written.)

EXAMPLE 1 (bad downshift - offering too much help after problem)

Christine: "Try this question" (writes it on the board) -"75 divided by 6" (Level 1 - prompt)

Shannon: "I don't know what to do." (Failure)

Christine: "I will show you how" (writes out the answer and talks about what she is doing) - "6 goes into 7 once - put a 1 up here - put a 6 under the 7 and subtract - you are left with 1 - then bring down the 5 and put it beside the 1 -that gives you 15 -six goes into 15 twice - put a 2 up here and 12 under the 15 and subtract - you are left with 3 and because 6 will not go into 3 your answer is 12 remainder 3" (Level 8 - tutor does it).

Stop Videotape: Christine began by telling Shannon to "try this question". What level of help is this according to your handout? (A: Level 1). Is Level 1 a little help or a lot? (A: a little). Did Shannon succeed when Christine gave her help at level one? (A: no). According to our rule what should Christine do when Shannon has trouble? (A: give a little more help). What did Christine do? (A: gave a lot more help). So did Christine use the rule successfully or unsuccessfully (A: unsuccessfully).

EXAMPLE 2 (script continues - good upshift offering less help after success)

Shannon: "I would feel better if you gave me a chance to do the question with your help rather than doing the question for me".

Christine: "O.K. divide these numbers" (points to the numbers written on the board) (Level 3 - Tell the math step).

Shannon: "Six goes into seven once and the one goes here." (Success)

Christine: "Good. What's next?" (Level 2 - Hint)

Stop Videotape: Christine began by telling Shannon to "divide these numbers". What level of help is this according to your handout? (A: Level 3). Did Shannon succeed when Christine gave her help at level three? (A: yes). According to our rule what should Christine do when Shannon succeeds? (A: give a little less help). Christine said "what's next?" to Shannon. Was that giving a little less help than when she said "divide these numbers"? Yes. So did Christine use the rule successfully or unsuccessfully (A: successfully).

EXAMPLE 3 (script continues - good downshift - offering a little more help after failure)

Shannon: "You put the six under the seven, subtract and I am left with one - then I bring down the 5 and have 15 - then I subtract 6 from 15" (last statement a failure).

Christine: "Divide these numbers" (points at 15 and 6) (level 3 - tell the math step)

Shannon: "Six divided by 15 equals..." (failure)

Christine: "How many times will 6 go into 15?" (level 4 - specify numbers to use for math step)

Stop Videotape: Christine began by telling Shannon to "divide these numbers". What level of help is this according to your handout? (A: Level 3). Did Shannon succeed when Christine gave her help at level three? (A: no, said 6 divided by 15 instead of 15 divided by 6). According to our rule what should Christine do when Shannon has problems? (A: give a little more help). Christine then said "how many times will 6 go into 15?" was that giving a little more help than when she said "divide these numbers"? So did Christine use the rule successfully or unsuccessfully (A: successfully).

EXAMPLE 4 (script continues - bad upshift - offering less help after problems)

Remember Christine last comment, "How many times will 6 go into 15?" (level 4 -specify numbers to use for math step). We will start the tape where Shannon answers how many times 6 goes into 15.

Shannon: "Six goes into 15 four times". (failure)

Christine: "Divide" (level 3 - tell the math step)

Stop Videotape: Christine began by asking Shannon "how many times will 6 go into 15"? What level of help is this according to your handout? (A: Level 4). Did Shannon succeed when Christine gave her help at level four? (A: no, said 4 times rather than 2). According to our rule what should Christine do when Shannon has problems? (A: give a little more help). Christine then said "divide", was that giving a little more help than when she said "how many times will 6 go into 15"? So did Christine use the rule successfully or unsuccessfully (A: unsuccessfully).

EXAMPLE 5 (script continues - good downshift -offering more help after problems)

Remember: Shannon has failed at level 4 "how many times will 6 go into 15" and has now been told to "divide" (level 3)

Shannon: "Six goes into 15 three times" (failure)

Christine: "That looks like too many" (Level 5 - specific hint)

Shannon: "Six times three is too many... I'll try six times two - 12 -that is right - just like before, 2 goes here and 12 here subtracted from 15 equals three - then, how many times can 6 go into three -none, so the answer is 12 remainder three. (success).

Stop Videotape: Christine began by telling Shannon "divide" What level of help is this according to your handout? (A:

Level 3). Did Shannon succeed when Christine gave her help at level three (A: no). According to our rule what should Christine do when Shannon has problems? (A: give a little more help). Christine then said "that looks like too many". Was that giving the right amount of help needed? Yes. So did Christine use the rule successfully or unsuccessfully (A: successfully).

Training Session 2

At the beginning of this session, we will review teaching goal and the contingency rule. If the examples from the videotape were not all viewed in session one, they will finish being viewed and discussed in session two. Session two will involve more practice recognizing the correct and incorrect use of the shift pattern. Tutors will be asked to role play the part of teacher and learner. The learner will be instructed to give some incorrect responses to the tutor, just as a grade 5 student is likely to do. The experimenter and the observing students will give feedback to the student who is playing the part of the tutor regarding his/her use of the CS rule.

APPENDIX N

TRAINING SCRIPT FOR TUTORS TAUGHT TO USE MODERATE SUPPORT

Training Session 1

<u>General Instructions</u>

The general instructions for the moderate support training group will the same as that for the CS rule experimental group.

<u>Specific Instructions</u>

Here is a list of some possible ways to help the student you are tutoring in long-division (give them Green's levels of interventions for long-division). These are arranged from the least helpful (at the top) to the most helpful (at the bottom). For the tutoring sessions in which your goal is to help a grade five student learn long-division I would like you to use a teaching strategy to help you meet your goal. This is the strategy: consistently offer the student help which is at a medium level according to your handout (i.e., level 3 and 4)--this means that you should try not to give the tutee alot of help (e.g., level 6 -telling the answer) and try not to give the tutee too little help (e.g., level 2 -"what's next?"). What is the strategy? The students will then be asked to repeat the rule in abbreviated form: level 3 and 4 - medium support.

<u>Script for Videotape</u>

We are now going to watch a videotape of an older student (Christine) tutoring a younger student (Shannon) in long-division. I will go through the videotape with you and point out examples of where Christine successfully or unsuccessfully follows the rule of always offering help that is at a medium level - level 3 or 4. (This group will see the same videotape as the experimental group. The tutoring will be interpreted as successful or nonsuccessful according to Christine's use of support at level 3 or 4).

EXAMPLE 1 (2 incorrect levels -- offering too little help followed by offering too much help)

Christine: "Try this question" (writes it on the board) -"75 divided by 6" (Level 1 - prompt)

Shannon: "I don't know what to do." (Failure)

Christine: "I will show you how" (writes out the answer and talks about what she is doing) - "6 goes into 7 once - put a 1 up here - put a 6 under the 7 and subtract - you are left with 1 - then bring down the 5 and put it beside the 1 -that gives you 15 -six goes into 15 twice - put a 2 up here and 12 under the 15 and subtract - you are left with 3 and because 6 will not go into 3 your answer is 12 remainder 3" (Level 8 - tutor does it).

Stop Videotape: Christine began by telling Shannon to "try this question". What level of help is this according to your handout? (A: Level 1). Is Level 1 a little help or a lot? (A: a little). Did Christine use our rule correctly? (A: no). According to our rule what should Christine have done? (A: given help at level 3 or 4). For example? After Shannon said she didn't know what to do, Christine showed her how to do the question. What level of help is this according to your handout? (A: Level 8). Is Level 8 a little help or a lot? (A: alot). Did Christine use our rule correctly? (A: no). According to our rule what should Christine have done? (A: given help at level 3 or 4). For example?

EXAMPLE 2 (1 correct level - offering medium help followed by 1 incorrect level - offering too little help)

Shannon: "I would feel better if you gave me a chance to do the question with your help rather than doing the question for me".

Christine: "O.K. divide these numbers" (points to the numbers written on the board) (Level 3 - Tell the math step).

Shannon: "Six goes into seven once and the one goes here" (Success)

Christine: "Good. What's next?" (Level 2 - Hint)

Stop Videotape: Christine began by telling Shannon to "divide these numbers". What level of help is this according your handout? (A: Level 3). Is Level 3 a little help or a lot? (A: neither, it is medium help). Did Christine use our rule correctly? (A: yes). Following Shannon's reply that six goes into seven once, Christine said "what's next?" to Shannon. What level of help is this according to your handout? (A: Level 2). Is Level 2 a little help or a lot? (A: a little).

Did Christine use our rule correctly? (A: no). According to our rule what should Christine have done? (A: given help at level 3 or 4). For example?

EXAMPLE 3 (2 correct levels - offering help at level 3 followed by help at level 4)

Shannon: "You put the six under the seven, subtract and I am left with one - then I bring down the 5 and have 15 - then I subtract 6 from 15" (last statement a failure).

Christine: "Divide these numbers" (points at 15 and 6) (level 3 - tell the math step) Shannon: "Six divided by 15 equals..." (failure)

Christine: "How many times will 6 go into 15?" (level 4 - specify numbers to use for math step)

Stop Videotape: Christine began by telling Shannon to "divide these numbers". What level of help is this according to your handout? (A: Level 3). Is Level 3 a little help or a lot? (A: neither, it is medium help). Did Christine use our rule correctly? (A: yes). Christine then said "how many times will 6 go into 15?". What level of help is this according to your handout? (A: Level 4). Is Level 4 a little help or a lot? (A: neither, it is medium help). Did Christine use our rule correctly? (A: yes).

EXAMPLE 4 (1 correct level - offering help at level 3)

Remember Christine last comment, "How many times will 6 go into 15?" (level 4 -specify numbers to use for math step). We will start the tape where Shannon answers how many times 6 goes into 15.

Shannon: "Six goes into 15 four times". (failure)

Christine: "Divide" (level 3 - tell the math step)

Stop Videotape: Christine said "divide". What level of help is this according to your handout? (A: Level 3). Is Level 3 little help or a lot? (A: neither, it is medium help). Did Christine use our rule correctly? (A: yes).

EXAMPLE 5 (1 incorrect level - offering help at level 5)

Remember: Shannon has failed at level 4 "how many times will

6 go into 15" and has now been told to "divide" (level 3)

Shannon: "Six goes into 15 three times" (failure)

Christine: "That looks like too many" (Level 5 - specific hint)

Shannon: "Six times three is too many... I'll try six times two - 12 -that is right - just like before, 2 goes here and 12 here subtracted from 15 equals three - then, how many times can 6 go into three -none, so the answer is 12 remainder three. (success). Stop Videotape: Christine said "that looks like too many". What level of help is this according to your handout? (A: Level 5). Is Level 5 a little help or a lot? (A: alot). Did Christine use our rule correctly? (A: no). According to our rule what should Christine have done? (A: given help at level 3 or 4). For example?

Training Session 2

At the beginning of this session, we will review the teaching goal and the levels rule. If the examples from the videotape were not all viewed in session one, they will finish being viewed and discussed in session two. Session two will involve more practice recognizing the correct and incorrect use of levels. Tutors will be asked to role play the part of teacher and learner. The learner will be instructed to give some incorrect responses to the tutor, just as a grade 5 student is likely to do. The experimenter and the observing students will give feedback to the student who is playing the part of the tutor regarding his/her use of the levels.

APPENDIX O

TRAINING SCRIPT FOR UNTRAINED TUTORS

Training Session 1

General Instructions

Thank you very much for agreeing to participate in this study. The first thing I would like to do today, is explain two reasons why I am conducting this study. One reason for conducting this study is so that I can examine how older students communicate with their younger peers when they are helping them to learn how to do long-division problems. A second reason for conducting this study is so that I can examine what type of teaching tips will help older students teach their younger peers better.

Now, I'd like to briefly explain what we will be doing over the next two weeks. We are meeting today and one day next week to practice long-division performance. Following each of these meetings, you will be given 15 minutes to practice teaching a grade 5 student how to do long-division. Your teaching goal will be to teach this Grade 5 student how to do long-division problems well enough so that he or she can solve long-division problems on his or her own. You are free to discuss this study with your parents, but please do not discuss this study with your fellow students until the study is finished.

Are there any questions? Who can tell me one reason for this study? Who can tell me the other reason for this study? Who can tell me what will happen over the next two weeks? Who can tell me what your teaching goal will be?

Specific Instructions

Here is a list of some possible ways to help the student you are tutoring in long-division (give them Green's levels of interventions for long-division). These are arranged from the least helpful (at the top) to the most helpful (at the bottom). For the tutoring sessions in which your goal is to help a grade five student learn long-division I would like you to practice your long-division performance.

Training Session 2

At the beginning of this session, we will review the teaching goal and do a few long-division problems independently. Tutors will be asked to role play the part of teacher and learner. The learner will be instructed to give some incorrect responses to the tutor, just as a grade 5 student is likely to do. The observing students will be asked to observe but not to make comments.

APPENDIX P

FEEDBACK LETTER

Dear Parent/Guardian:

I would like to thank the students who so eagerly participated in the long-division peer tutoring project, and the parents who gave their consent. The project entitled, "The Effectiveness of Training Peer Tutors to Scaffold Instruction" was conducted in May, 1990 by Judy MacVicar, a graduate student at Wilfrid Laurier University, under the supervision of Dr. M. Pratt.

This study involved seventh- and eighth-grade tutors and fifth-grade learners, working in tutor-learner pairs. The purpose of the study was to determine the consequences of training tutors to use different tutoring strategies, to help younger students learn more about long-division skills. Tutors were assigned to one of three training conditions: (1) contingent training, (2) moderate support training, (3) practice. The contingently trained tutors were taught to follow a rule to give more support if the tutees failed and less support if the tutee succeeded. The tutors trained to provide moderate support were taught to consistently provide predetermined medium levels of support. The tutors assigned to the practice condition were not taught to use a specific tutoring strategy but were given the same amount of tutoring practice time as the trained tutors.

Overall, tutees showed improvement in their long-division performance after the tutoring sessions. Tutee improvement, however, was not dependent on the training group of the tutor. Instead, all students, regardless of group, tended to show improved long-division skills after the tutoring experience. It appeared that contingently trained tutors found their strategy difficult to apply and did not, in fact, follow the contingency rule any more than other tutors.

There were, however, some benefits arising from training tutors to provide contingent support. Contingently trained tutors felt more positive about themselves as teachers. In addition, learners taught by contingently trained tutors enjoyed the long-division problems more than tutees taught by tutors trained to give moderate support or tutors given practice only.

This study demonstrates the effectiveness of peer tutoring in general, for tutee learning. As well it shows some benefits resulting from specific tutor training in terms of tutor and learner feelings about learning. We think that the difficulty children had in learning to tutor contingently can be remedied in future research, based on the information gained in this project. When tutors learn to tutor contingently, we expect even greater achievement benefits for tutees.

Again, I thank all who participated in this project. If you would like further information please contact me at (416)-525-2284 or Dr. M. Pratt at 884-1970 (ext. 2824).

Sincerely,

Judy MacVicar

Michael W. Pratt
Professor