# USING AN EXPERIMENTAL FRAMEWORK OF KEY ELEMENTS TO PARSE ONE-TO-ONE, TARGETED INTERVENTION TEACHING IN WHOLE-NUMBER ARITHMETIC

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*This report focuses on key elements of teaching occurring during intensive, one-to-one instruction with $3^{rd}$- and $4^{th}$-graders. The study involves six cases in all, each consisting of video records of up to eight lessons, each of 30-45 minutes' duration, resulting in the analysis of about 33 hours of video data. A resulting framework of four stages of analysis of one-to-one teaching is presented and the stage 'During solving a task' is elaborated according to students' responses: correct, partly correct, incorrect, and no response. Three subcategories pertaining to an incorrect response are described and two are exemplified via cases drawn from the data. The cases exemplify how the framework can be applied to analyse or inform intervention instruction and highlight its theoretical and practical importance.*

One-to-one tutoring, particularly by expert tutors is widely acknowledged as a powerful method for promoting students' learning gains (Bloom, 1984; Chi, Roy, & Hausmann, 2008; Cohen, Kulik, & Kulik, 1982). However, the reasons for the effectiveness of expert tutors are relatively unexplored. Thus it is worthwhile to research the instructional strategies of expert tutors during highly interactive one-to-one instruction.

## LITERATURE REVIEW AND THEORETICAL FRAMEWORK

Accordingly, this study focuses on the pedagogical skills that teachers use in one-to-one instruction when responding to particular situations, such as scaffolding and providing explanations (Chi, Siler, Jeong, Yamauchi, & Hausmann, 2001). In this study the one-to-one instruction is conducted by expert teachers who could conceivably be referred to as expert tutors. From here on in this paper we refer to them as teachers. In describing and illustrating key features of intervention instruction, Wright, Martland, Stafford and Stanger (2002) provided a set of 12 teacher behaviours—key elements of one-to-one teaching. These are micro-instructional strategies that teachers use during highly interactive one-to-one teaching. More recently, a set of eight additional key elements has been developed (Wright, 2010). Examples of key elements include *pre-formulating a task*, that is, statements and actions by the teacher, prior to presenting a task to a student, that have the purpose of orienting the student's thinking to the coming task; *post-task wait-time*, that is, the teacher's behaviour in providing sufficient time after posing a task for the student to think about and solve the task; and *within task setting change*, that is, a deliberate

action on the teacher's part in changing a setting during the period when the student is attempting to solve a task.

Ewing (2005) documented the characteristics of one-to-one teaching used by four Mathematics Recovery (MR) (Wright, 2003) teachers by analysing videotaped excerpts of their MR teaching sessions. These characteristics include scaffolding, double bind, illusion of competence, pre-formulating and reformulating questions, post question wait-time, vague or ambiguous questioning, questioning and prompting, and communication. Munter (2010) found that key elements such as 'post-task wait-time' and 'child checking' have a significant positive effect on students' learning. In considering teaching in general, as distinct from the teaching of arithmetic in particular, teacher behaviours such as scaffolding, post-task wait-time and child checking are well documented in research literature (e.g. Anghileri, 2006; Bliss, Askew, & Macrea, 1996; Grandi & Rowland, 2013; Hmelo-Silver, Duncan, & Clark, 2007; Van Es & Sherin, 2002).

This study focuses mainly on teaching whole-number arithmetic for the $3^{rd}$ and $4^{th}$ grade because most of the teacher behaviours mentioned earlier in the literature (Ewing, 2005; Munter, 2010; Wright et al., 2002) were developed by investigating MR intervention teaching of $1^{st}$ grade students. The arithmetic content for intervention students at $3^{rd}$ and $4^{th}$ grade differs significantly from that at $1^{st}$ grade. Thus a focus on $3^{rd}$ and $4^{th}$ grade students enables a review and extension of the existing framework. In this study, a key element of one-to-one teaching refers to the smallest unit of analysis of teaching with the following distinctive features. It is: (i) purposeful with the intention that it will lead to significant learning; (ii) ubiquitous in one-to-one teaching; and (iii) judged by experts to embody quality teaching.

**Research aims and research questions**

The study aims to: (i) illuminate the nature of observable teacher behaviours in the interactions between a teacher and a student; and (ii) develop a framework for analysing one-to-one teaching in whole-number arithmetic to $3^{rd}$ and $4^{th}$ graders. The study addresses the following research questions. **RQ1**: What are the key elements in one-to-one intervention teaching? **RQ2**: How can a framework of key elements be used to analyse one-to-one teaching?

**METHODOLOGY**

A qualitative research methodology is used to gain insight into the nature of observable teacher behaviours in teacher-student interactions in intensive, one-to-one teaching. Teacher behaviours are regarded as the central phenomena requiring exploration and understanding (Creswell, 2012). Considering that the nature of this investigation is to target phenomena (i.e., teacher behaviours), a phenomenological approach is adopted (Van Manen, 1990). Grounded theory method (Glaser & Strauss, 1967; Strauss & Corbin, 1994) is also used to discover patterns and theories through analysis of the teacher-student interactions in one-to-one teaching sessions.

The method used for this study is the collective case study (Stake, 2000). The participants consist of four teachers and six students. For two teachers, one student only was selected and for the other two teachers two students were selected. The four teachers were selected from a pool of approximately 50 teachers in the Mathematics Intervention Specialist Project (MISP) (Ellemor-Collins & Wright, 2011) and were regarded by MISP leaders as being particularly competent in intervention teaching. Thus 'purposeful sampling' strategies (Lincoln & Guba, 1985) constituted the basis for selecting the six case studies. The primary data source for this study consists of six sets of videotaped lessons involving one-to-one instruction in whole-number arithmetic. Each set consists of up to eight lessons, each of 30-45 minutes' duration, conducted over a period of 12 weeks resulting in approximately 33 hours of video for analysis. The video data provide a rich corpus of teaching and enables a significant investigation of key elements of one-to-one teaching. The authors systematically observed each teacher-student pair in a context of one-to-one intervention teaching in order to capture the nature of the teacher behaviours.

**Data analysis**

A standard method of analyzing teaching is to review repeatedly, the recording of teaching sessions and characterise each teaching moment in terms of the teacher's behaviours. Incorporating Van Manen's analytical method (1990), a methodological approach for analysing large sets of videorecordings (Cobb & Whitenack, 1996) and a model for analysis of video data (Powell, Francisco, & Maher, 2003) were adopted in this study. The videos were transcribed and then coded with respect to the key elements of one-to-one teaching by using the NVivo 10 software program. Thus this study involved a systematic study of the teacher behaviours in one-to-one intervention teaching described in the literature review and endeavoured to identify additional teacher behaviours considered to be significant.

**RESULTS**

**The extended list of key elements**

Table 1 lists two sets of key elements. Set A were described in research literature prior to the current study and are included in order to test their viability for future analyses of key elements. Set B arose during the analysis phase of the current study and therefore are likely to be useful for future analyses of key elements. Examples of the key elements in Set B include *recapitulating* which refers to a situation where the teacher summarises and states again a student's contribution during solving a task; *stating a goal* refers to a situation where the teacher summarises the recent progress and makes a statement about what needs to be practised more or what needs to be done next; *re-posing the task* refers to a situation where the teacher restates the task in order to help the student fully understand the task. It happens when the student generally shows that they cannot solve the task because they have lost track of some of the details of the task. The key elements in Set B complement the key elements in Set A and this results in a framework for analysing one-to-one teaching as follows.

| Set A | Set B |
|---|---|
| Scaffolding before | Recapitulating |
| Scaffolding during | Giving a meta-explanation |
| Introducing a setting | Confirming and highlighting a correct |
| Pre-formulating a task | response |
| Reformulating a task | Re-posing the task |
| Post-task wait-time | Rephrasing the task |
| Within-task setting change | Stating a goal |
| Screening, color-coding and flashing | Referring to a setting |
| Directing to check | Asking 'what do you notice?' |
| Affirming | Querying an incorrect response |
| Querying a correct response | |
| Explaining | |
| Changing a task format | |

Table 1: Extended list of key elements of one-to-one teaching.

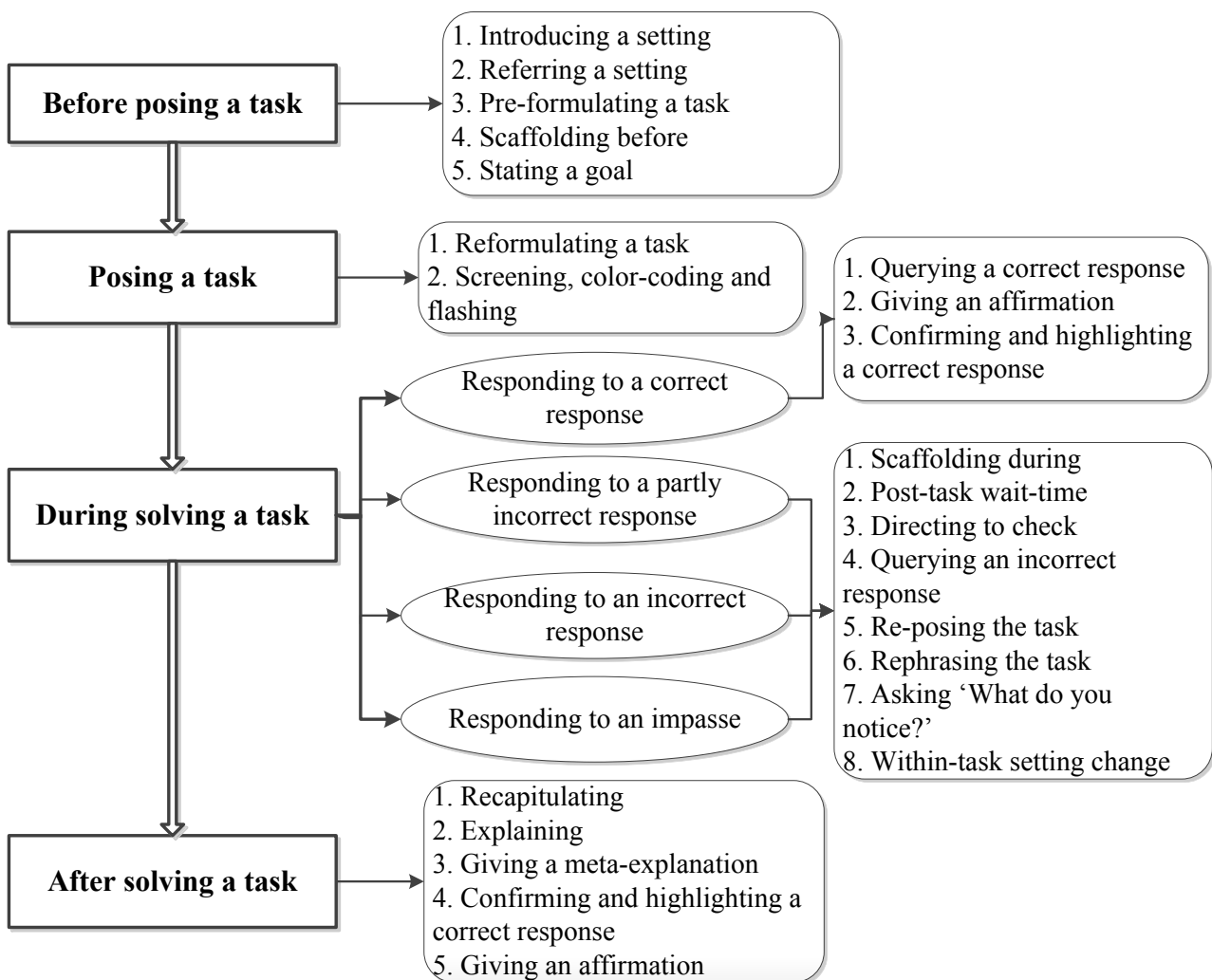**Key elements of one-to-one teaching: a reformulation**



Figure 1: An Experimental Framework for analysing one-to-one teaching.

In teacher-student interactions, the teacher might monitor and respond to the student's response. This is sometimes called a 'teacher move' or 'tutor move' (e.g. Chi et al., 2001; Lu, Eugenio, Kershaw, Ohlsson, & Corrigan-Halpern, 2007). Figure 1 sets out the Experimental Framework that resulted from analysis of the teacher-student interactions in the data. There are four stages of the teacher dealing with a task: A–Before posing a task; B–Posing a task; C–During solving a task; and D–After solving a task. Collectively, these constitute the first or highest level of analysis. As well, the stage of C–During solving a task, is construed as four categories of teacher responses: C1–Responding to a correct response; C2–Responding to a partly correct response; C3–Responding to an incorrect response; and C4–Responding to an impasse. For each category, there are specific key elements that teachers usually use to respond to the student's response.

This report will focus on Category C3. This refers to a teacher's moves in response to an incorrect response on the part of the student, particularly in situations where the student is not using any strategy or seems unable to respond. This results in actions by the teacher relevant to the task and typically has the purpose of helping the student to solve the task. The situation is described as follows. The teacher initially poses a task. The student responds incorrectly. Three cases corresponding to C3 are:

> **Case C31**: The teacher then responds by directly correcting the student's response. This typically applies to answer-focused tasks where the teacher focuses on getting the student's answer but the nature of the task is such that it cannot not be elaborated in terms of a strategy.

> **Case C32**: The teacher assists the student indirectly by asking or allowing the student to check their last response. Student checking in this way typically involves a resort to an easier or simpler strategy.

> **Case C33**: The teacher provides assistance which results in a less-challenging task. In this situation, the teacher typically uses one or more key elements such as scaffolding during, post-task wait-time, querying an incorrect response, rephrasing the task, re-posing the task, and within-task setting change. This typically applies to strategy-focused tasks (Munter, 2010) where the teacher is interested in a particular strategy that the student used to solve the task. Examples for C31 and C33 follow.

**Example C31**. Amilia-Karral: Ten pluses

| | |
|---|---|
| A: | (Opens a workbook on table) What we are going to do in your book is to practice doing some of these (indicates the ten pluses) and some writing. What's ten plus four? (Points at the sum 10+4) |
| K: | Ten plus four is fourteen. |
| A: | Can you write that down? |
| K: | (Writes down the answer in the workbook – 41) |

A:      Okay. (Gets the pen from Karral) When we write fourteen, we write a one first, not a four first (corrects the writing in the workbook).

K:      Oh!

**Example C33**. Amilia-Mia: Jumping forward to a decuple

A:      Okay. (Opens workbook on table) I'm going to tell you a number and I want you to tell me what the next ten is and how many to get there. (Writes in workbook: 48→; 63→; 27→; so on) Does that make sense?

M:      Yep.

A:      Like we were doing yesterday. (Keeps filling page with examples). Okay. (Finishes writing and hands the workbook to Mia). 48. What's the next ten?

M:      Fifty. (Immediately)

A:      Gorgeous! How many to get there?

M:      Um. Eight. (Looks at Amilia)

A:      Forty-eight. Think about what forty-eight would look like. How many more will make fifty?

M:      (After 7 seconds) Wouldn't it be... forty-nine? No… nine? (Looks at Amilia)

A:      Let's have a look. (Takes out some ten-frames)

M:      Oh. It is seven. (Going to writes down the answer in workbook)

A:      No. Stop. Stop. There's my eight (Places out an 8-dot ten-frame). There's my forty (Places out four 10-dot ten-frames)

M:      Oh. Two. (Immediately)

A:      Two more. (Nods)

M:      (Writes down the answer in workbook)

## DISCUSSION

The framework of key elements enables micro-analyses of highly-interactive one-to-one instruction. The two cases exemplify how the framework can be applied to analyse or inform intervention instruction. Example C33 illustrates that a teacher can use many key elements effectively in responding to each particular situation and each particular response from the student. Before posing the task, the teacher uses the key element of 'pre-formulating a task' in order to orient the student's thinking to the coming task. When the student responds incorrectly to the task, the teacher first uses 'rephrasing the task' by expressing the task in an alternative way to make the meaning clearer to the student, and then allows the student time to think about the task by using 'post-task wait-time'. The student again gives an incorrect response. The teacher then changes the setting from a formal written task to one using ten frames, by using 'within-task setting change', to help the student solve the task. The student comes up

with the right answer and the teacher then uses the key element 'confirming and highlighting a correct response'.

## CONCLUSION AND RECOMMENDATIONS

The key elements are of practical importance because they are frequently observed in one-to-one intervention teaching. They are of theoretical importance because understanding them better can lead to more effective ways to characterize the range of instructional methods teachers use. Thus the framework enables a deeper understanding of the teacher-student interactions in particular learning domains. As well, the framework is likely to be applicable across the range of student attainment and also to small group and whole class instruction.

Further research could focus on three questions: (i) to what extent are different key elements prevalent for different teachers, that is, do some key elements occur more frequently for some teachers than others? (ii) to what extent can particular teachers be characterised in terms of the teacher behaviours, that is, to what extent can different teaching styles be determined? and (iii) to what extent are some key elements used more in particular learning domains?

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