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# Multi-Method Triangulation in a Qualitative Study on Teachers' Practical Knowledge: An Attempt to Increase Internal Validity

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**Abstract.** This article describes multi-method triangulation as a means to enhance the internal validity in a qualitative study on language teachers' practical knowledge. Teachers' practical knowledge is viewed as a multi-dimensional concept, requiring multiple instruments for its exploration. In the triangulation procedure, data collected with three instruments were analysed and related to each other. Three steps of analysis, preceded by a pre-analysis step, were used to combine these data. The triangulation procedure culminated in a fairly comprehensive understanding of teachers' practical knowledge with respect to the teaching of reading comprehension to 16- to 18-year-old students. It was concluded that multi-method triangulation is a worthwhile procedure to enhance the internal validity in qualitative studies on a complex topic such as teachers' practical knowledge.

**Key words:** triangulation, qualitative research, research methodology, education, educational research

## 1. Triangulation in Qualitative Research

Now that qualitative research has established its own place in research on teaching (Silverman, 1997), the quest for more sophisticated procedures to secure objectivity in this type of research is increasing (e.g., Miles and Huberman, 1994). Two critical issues in regard to objectivity are reliability and validity. This article specifically deals with enhancing the *internal validity* of qualitative research. This is done in the context of a study about teachers' practical knowledge. In conceptualizing "internal validity", we follow Miles and Huberman (1994), who stated that internal validity has to do with questions such as "Do the findings of the study make sense?, Are they credible to the people we study and to our readers?, Do we have an authentic portrait of what we were looking at?" (p. 278). Pedhazur and Pedhazur-Schmelkin (1991) described internal validity, though in the context of (non)experimental research, as the *sine qua non* of meaningful research.

Gliner (1994) described *triangulation* as a method of highest priority in determining internal validity in qualitative research. Triangulation is a concept that originated in the discipline within the field of geography concerned with land sur-

veying. The term triangulation stands for the procedure that entails carrying out three measurements to determine the exact position of a point in the landscape. In social science research, the concept of triangulation is used metaphorically; it has various meanings and involves many corresponding procedures. Basically, triangulation in social science research refers to a process by which a researcher wants to verify a finding by showing that independent measures of it agree with or, at least, do not contradict it (Miles and Huberman, 1994). However, in practice, qualitative studies in the social sciences often involve picking triangulation sources that have different strengths, foci, and so forth, so that they can *complement* each other (e.g., Beijaard, 1990; Buitink, 1998). Especially in studies about complex phenomena – such as teachers' practical knowledge, which was the focus of our study – the systematic combination of various types of data is a crucial aspect (Cohen and Manion, 1994; Smaling, 1987). Miles and Huberman (1994) distinguished five kinds of triangulation in qualitative research:

- Triangulation by data source (data collected from different persons, or at different times, or from different places);
- Triangulation by method (observation, interviews, documents, etc.);
- Triangulation by researcher (comparable to interrater reliability in quantitative methods);
- Triangulation by theory (using different theories, for example, to explain results);
- Triangulation by data type (e.g., combining quantitative and qualitative data).

The type of triangulation chosen depends on the purpose of a study. Of course, more than one type of triangulation can be used in the same study. In this study, we focussed on triangulation by method by developing a strategy for combining the data collected with three different instruments.

Triangulation by method is more commonly known as methodological or multi-method triangulation. As methodological triangulation is also used to refer to the combination of qualitative and quantitative data ("triangulation by data type" in the list of Miles and Huberman; see, for example, Erzberger and Prein, 1997), we will use the term multi-method triangulation throughout this article. We follow Kopinak's definition of multi-method triangulation as entailing "gathering information pertaining to the same phenomenon through more than one method, primarily in order to determine if there is a convergence and hence, increased validity in research findings" (Kopinak, 1999: 171). Kopinak indicated that the use of more instruments would provide for more detailed and multi-layered information about the phenomenon under study.

In such a triangulation procedure, the way data are analysed is of major importance. Data analysis can be approached in various ways. Smaling (1987) described three approaches to the analysis of qualitative data, each of which can be applied to multi-method triangulation. The first is an intuitive approach: an individual researcher intuitively relates data from various instruments to each other. The quality of this approach depends on the quality of the researcher's intuition, and

it is often not possible to replicate the study. A second approach to triangulating qualitative data is a procedural approach: the focus is on documenting each step that is taken in the triangulation-by-method procedure in order to make it transparent and replicable. The third approach is the intersubjective approach in which a group of researchers tries to reach agreement about the steps to be taken in the triangulation-by-method procedure.

In this study, the focus is on the procedural approach. We wanted to explicate the various steps taken in the triangulation procedure, in order to allow for checks on our working method. We will describe and illustrate the procedure of triangulation that was followed in our study about teachers' practical knowledge (for a complete description of this study, see Meijer, 1999). In the next section, we will pay attention to the background of this study.

## 2. Teachers' Practical Knowledge

Research on teaching has, during the last two decades, increasingly focussed on the cognitions that underlie teachers' classroom practice rather than on their behaviour (e.g., Beijaard and Verloop, 1996; Calderhead, 1996; Carter, 1990; Shulman, 1986a). This change in focus was reinforced by developments in cognitive psychology that were based on the fundamental assumption that one's cognitions and actions influence each other and, likewise, that teachers' cognitions and their classroom behaviour mutually affect each other (cf. Clark and Peterson, 1986). So, in order to understand teaching, one cannot confine oneself to the investigation of teachers' behaviour, but should also involve teachers' cognitions (Beijaard and Verloop, 1996). In the present study, we refer to the cognitions that underlie teachers' actions as teachers' *practical knowledge*.

Many of the most recent studies of teachers' practical knowledge have focussed on its content, generating insights into the categories that constitute teachers' knowledge and beliefs (cf. Calderhead, 1996). Shulman (1975, 1986b, 1987) was one of the first to study the kinds of knowledge that teachers possess and that underlie their actions, and he described a number of domains and categories of teacher knowledge, which other researchers have used, expanded, and refined (e.g., Cochran, de Ruiter and King, 1993; Grossman, 1989, 1990; Gudmundsdottir, 1991; Peterson, Fennema, Carpenter, and Loef, 1989; Putnam and Borko, 1997; Van Driel, Verloop and De Vos, 1998). An important outcome of research into the content of teachers' practical knowledge is the development of the concept pedagogical content knowledge. Building on Shulman (1986b), Van Driel et al. (1998) described pedagogical content knowledge as referring to

> ... teachers' interpretations and transformations of subject-matter knowledge in the context of facilitating student learning. ... [It] encompasses understanding of common learning difficulties and preconceptions of students. (p. 673)

Van Driel et al. interpreted pedagogical content knowledge as a specific type of practical knowledge – or craft knowledge – in the sense that it refers to, and is investigated in relation to, a particular (subject matter) content. Pedagogical content knowledge is believed to be an essential domain in teaching because it explicitly pertains to the knowledge and skills that are "unique to the teaching profession" (Borko and Putnam, 1996).

When the conceptualizations of pedagogical content knowledge in several studies are compared, it becomes clear that there is a great deal of variation in definitions of pedagogical content knowledge. Van Driel et al. reviewed the studies of several scholars and matched the conceptualizations of pedagogical content knowledge in these studies, which resulted in a list of categories that can be distinguished within this type of practical knowledge. The categories van Driel et al. found in these studies included knowledge of (a) subject matter, (b) general pedagogy, (c) student learning and conceptions, (d) purposes, (e) curriculum and media, (f) representations and strategies, and (g) context (see Table I).

Although the understanding of the content of teachers' practical knowledge seems to be increasing, studies on this concept are primarily focussed on teachers' *knowledge and beliefs*. Calderhead (1996) found in his review that we have gained much insight into teachers' knowledge and beliefs, but that the relationship with the practice of teaching is still unclear. Morine-Dershimer (1992) came to a same conclusion and argued that this is probably caused by a lack of specific instruments that can provide insight into the cognitions that are actually inherent in teachers' actions (i.e., teachers' *interactive cognitions*).

Building on these notions, the purpose of our study was twofold: we investigated the content of teachers' practical knowledge and, simultaneously, we developed instruments and procedures for studying teachers' practical knowledge. We concentrated on a specific content area: teaching native and foreign language reading comprehension to 16- to 18-year-old students. We wanted to find out what teachers know and believe about teaching reading comprehension (i.e., teachers' knowledge and beliefs), and what goes on in their minds while they are teaching reading comprehension to 16- to 18-year-old students (i.e., teachers' interactive cognitions). It is our view that teachers' practical knowledge consists of knowledge and beliefs, on the one hand, and interactive cognitions, on the other (Meijer, 1999). We successively examined these two elements of teachers' practical knowledge, after which they were combined. Two questions were addressed in this study:

1. What is the content of teachers' practical knowledge?
2. How can teachers' practical knowledge best be explored and made explicit?

In the present article, the focus is on the second question – a methodological one. We will discuss in detail the procedure that was followed to combine the data on the elements of teachers' practical knowledge, aiming at synthesizing the results from three instruments into a comprehensive picture of teachers' practical knowledge.

*Table I.* Knowledge components in different conceptualizations of pedagogical content knowledge

| Scholars | Knowledge of: | | | | | | |
|---|---|---|---|---|---|---|---|
| | Subject matter | Representations and strategies | Student learning and conceptions | General pedagogy | Curriculum and media | Context | Purposes |
| Shulman (1987) | [a] | PCK | PCK | [a] | [a] | [a] | [a] |
| Grossman (1990) | [a] | PCK | PCK | [a] | PCK | [a] | PCK |
| Marks (1990) | PCK | PCK | PCK | [b] | PCK | [b] | [b] |
| Cochran et al. (1993) | PCKg | [b] | PCKg | PCKg | [b] | PCKg | [b] |
| Fernández-Balboa & Stiehl (1995) | PCK | PCK | PCK | [b] | [b] | PCK | PCK |

PCK: Pedagogical Content Knowledge; PCKg: Pedagogical Content Knowing.
[a]Distinct category in the knowledge base for teaching (i.e., not defined as a part of PCK).
[b]Not discussed explicitly.
From "Developing science teachers' pedagogical content knowledge", by J. H. Van Driel, N. Verloop, and W. De Vos, 1998, *Journal of Research in Science Teaching*, 35(6), p. 676. Copyright 1998 by John Wiley & Sons, Inc. Reprinted with permission of the author.

## 3. Participants and Instruments

Thirteen experienced teachers of four foreign languages (English, German, French, and Latin) and the mother tongue (Dutch) were involved in the study. Their practical knowledge with respect to the teaching of reading comprehension to 16- to 18-year-old students was examined in detail with three instruments which were based on existing methods for tapping and representing the content of teachers' practical knowledge (Kagan, 1990; Leinhardt, 1990):

1. A *semi-structured interview* to elicit teachers' ideas about various aspects of teaching reading comprehension;
2. A *concept mapping assignment*, in which teachers identified concepts that they viewed as important to teaching reading comprehension and then organized them into a schema. Subsequently, teachers gave verbal explanations of their concept maps;
3. A *stimulated recall interview*, in which teachers explicated what they were thinking in response to the videotape of a lesson they had just given.

The semi-structured interview and the concept-mapping assignment were both meant to capture teachers' knowledge and beliefs, whereas the stimulated recall interview was intended to examine teachers' interactive cognitions. Together, they were thought to provide a comprehensive picture of a teacher's practical knowledge concerning the teaching of reading comprehension to 16- to 18-year-old students.

## 4. The Triangulation Procedure: Analysis and Results

### 4.1. TRIANGULATION IN THIS STUDY

In this study, we conceived of triangulation as a process of combining and synthesizing data or results that are gathered using different instruments (cf. Smaling, 1987). We used instruments that each have their own focus and shed light upon different elements of what makes up teachers' practical knowledge. The underlying conceptual relationship between the data collected with the various instruments is discussed in the next section.

Triangulation in this study was not a matter of establishing whether analysis of the data from each of the three instruments would lead to the same results (Gliner, 1994) but, instead, the data from the instruments were combined to develop a comprehensive view of teachers' practical knowledge about teaching reading comprehension.

### 4.2. A THEORY ABOUT THE CONCEPTUAL RELATIONSHIPS AMONG THE DATA

The triangulation procedure employed in this study is based on our view of how teachers' knowledge and beliefs, on the one hand, and their interactive cognitions, on the other, are conceptually related. This can best be illustrated with the commonly accepted theory about the way people "use" their memory in their actions

(e.g., Baddeley, 1990), from which we derive two notions. First, knowledge and beliefs are stored in long-term memory. Long-term memory refers to a large body of information (e.g., knowledge, experiences) that more or less permanently exists in a person's mind (Anderson, 1980), but is also sometimes referred to as a "process" by which general information and knowledge of past experiences are stored in a "structured framework" (Taylor and Evans, 1985). A person's long-term memory has unlimited capacity, and its contents are organized and meaningful (Mayer, 1981).

A second notion inferred from this theory is that interactive cognitions are to be found in a person's *working memory*. Baddeley and Hitch (1974) introduced the concept "working memory", which they described as a distinct component of human memory. They considered this component as most important in complex (cognitive) activities, such as problem solving and reasoning (see also Baddeley, 1990; Cantor, Engle, and Hamilton, 1991; Hoosain and Salih, 1988; Taylor and Evans, 1985). Cantor et al. (1991) described working memory as

> . . . the currently active portion of long-term memory knowledge. . . . Working memory is, in essence, whatever information is activated above resting state for current cognitive activity. (p. 232) . . . it is the arena in which sophisticated processing occurs, and where there is on-line storage of information currently being manipulated. (p. 244)

According to Baddeley and Hitch, incoming information (in our case: of classroom events) activates parts, or elements, of a person's long-term memory. This activation occurs by selecting from long-term memory the corresponding or appropriate knowledge of facts and procedures. When this selected knowledge is "called up", it remains temporarily active and is used in a person's working memory.

It is not far-fetched to state that teaching involves cognitive activities that take place in teachers' working memory. Teaching involves dealing with complex situations that occur during classroom interaction. According to Baddeley and Hitch, complex situations are worked out by simplifying the situation, reducing the complexity by identifying elementary facts or procedures that have been experienced before and, therefore, can be easily dealt with because these are stored in long-term memory and are directly available. This implies that teachers deal with classroom situations by reducing them to knowledge of facts and procedures that are stored in their long-term memories. When confronted with classroom events, teachers activate appropriate and familiar elements from their long-term memory into their working memory and use these to establish a way to deal with the event (see Figure 1). Thus, teachers frame their interactive cognitions by utilizing their knowledge and beliefs to make sense of, and deal with, a particular (classroom) situation.

This view on teachers' cognitions led us to the following two inferences. First, teachers' knowledge and beliefs, on the one hand, and their interactive cognitions, on the other, differ in nature – teachers' knowledge and beliefs are relatively stable, while teachers' interactive cognitions are essentially dynamic (cf. Leinhardt, 1993). Second, we inferred from the theory described above that the two elements of

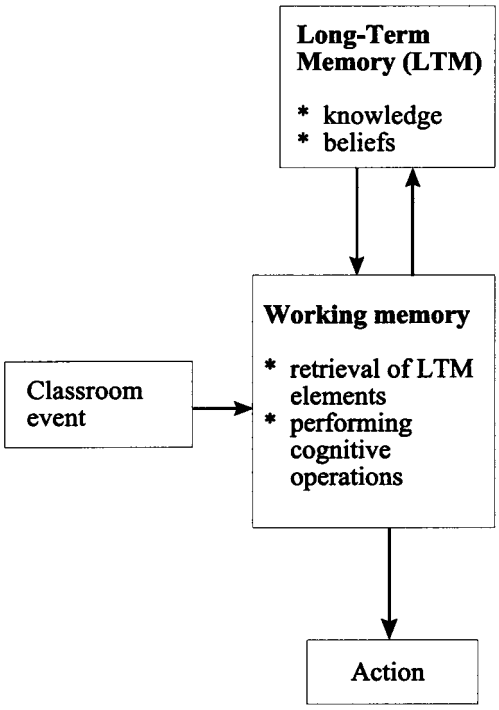


*Figure 1.* Simplified model of working memory in teaching.

teachers' practical knowledge are closely related in content because a teacher's working memory basically consists of elements from his or her long-term memory. Given this similarity in content, a consequence for the process of data analysis can be that the content of the two elements of teachers' practical knowledge might be analysed using the same categories. In this study, we developed these categories by first analysing the data collected about teachers' knowledge and beliefs (the first step in the triangulation procedure). Subsequently, these categories were used as a starting-point in the analysis of the data on teachers' interactive cognitions (the second step). Finally, the content of teachers' practical knowledge as a whole was examined. This last step completes the triangulation procedure.

### 4.3. THE TRIANGULATION PROCEDURE

Table II shows the triangulation procedure at a glance. In the next sections, the steps in the triangulation procedure are described, and the results of the steps are illustrated.

*Table II.* Overview of the triangulation procedure

| | Step | Element(s) of practical knowledge | Pre-analysis | | Steps in analysis | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Analysing the semi-structured interviews and the concept maps | Teachers' knowledge and beliefs | Preliminary definition and development of categories | 1A | Describing the content of each category of teachers' knowledge and beliefs | Descriptions of each category of teachers' knowledge and beliefs |
| | | | | 1B | Describing and interpreting teachers' knowledge and beliefs | Patterns in teachers' knowledge and beliefs |
| 2 | Analysing the stimulated recall interviews | Teachers' interactive cognitions | Enhancing the set of categories | 2A | Describing the content of each category of teachers' interactive cognitions | Descriptions of each category of teachers' interactive cognitions |
| | | | | 2B | Describing and interpreting teachers' interactive cognitions | Patterns in teachers' interactive cognitions |
| 3 | Combining results of the previous steps | Teachers' practical knowledge (knowledge, beliefs, and interactive cognitions) | Establishing the final set of categories | 3A | Describing the content of each category of teachers' practical knowledge | Descriptions of each category of teachers' practical knowledge |
| | | | | 3B | Describing and interpreting teachers' practical knowledge | Typology of teachers' practical knowledge |

#### 4.3.1. *The First Step: Analysing the Semi-structured Interviews and the Concept Maps*

The first step in our triangulation procedure (see Table II) consisted of studying teachers' long-term memory knowledge and beliefs about teaching reading comprehension to 16- to 18-year-old students (see also Meijer et al., 1999). The data collected with the semi-structured interview and the concept mapping assignment consisted of 13 transcripts of the interviews, 13 concept maps, and 13 transcripts of the explanations teachers gave of their concept maps. The analysis of data involved a preliminary definition of categories and two stages of actual data analysis. Once the categories were established and defined, they could be used for the two stages in the process of actual data analysis.

4.3.1.1. *The preliminary definition and development of categories.* The goal of the preliminary stage in the first step of the triangulation procedure was to establish categories that could be used both to describe the data and to serve as a basis for the analysis. The preliminary stage began with an intensive reading and study of all the teachers' data provided by the semi-structured interview and the concept mapping assignment. The outcome of this preliminary stage was a set of categories and a description of the data according to these categories.

The initial reading of the data indicated large dissimilarities between the teachers in knowledge and beliefs. To gain greater insight into the wide range of their knowledge and beliefs, and to emphasize all the typical matters as well as the extremes, we decided to closely examine the knowledge and beliefs of two teachers who appeared very distinct from each other. These data were compared to find indications of the ways in which the knowledge and beliefs of these two teachers differed, the reasons for the differences, how this related to the concept maps they created, and what constituted the differences in their knowledge and beliefs. At this point, we also reconsidered research that had been done on teachers' pedagogical content knowledge (as described in a previous section).

We wanted to find out whether the seven categories that had been identified in the studies reviewed by Van Driel et al. (see the left-hand column of Table III) could help us describe our teachers' knowledge and beliefs, and also could capture the differences in their knowledge and beliefs. These categories were used as the *starting categories* in our study. We read through the transcripts and compared the starting categories to our data in order to assess their validity (cf. Parker, 1985), reformulated them or generated new categories from the data, returned to the data to assess their validity, and went on doing so until the categories suited the data satisfactorily, which meant that no further categories could be formulated. We then described the categories and subsequently named the category in a way that best suited the description.

Thus, we developed a clearer picture of the essentials in the knowledge and beliefs of both teachers. We then repeated this process using data from a third teacher, then a fourth teacher, and so forth. The result of this procedure was a

*Table III.* Categories of teachers' knowledge and beliefs about teaching reading comprehension

| Starting categories | Categories in this study | Descriptions used in this study |
|---|---|---|
| Knowledge of subject matter | Subject matter knowledge | Knowledge of reading comprehension in the specific language subject, not directly related to teaching |
| Knowledge of general Pedagogy | Student knowledge | Knowledge about 16- to 18-year-old students in general, not directly related to reading comprehension |
| Knowledge of student learning and conceptions | Knowledge of student learning and understanding | Knowledge of the learning and understanding of 16- to 18-year-old students with respect to reading comprehension |
| Knowledge of purposes | Knowledge of purposes | Importance of, and goals for, teaching reading comprehension |
| Knowledge of curriculum and media | Curriculum knowledge | Texts and materials used in lessons on reading comprehension |
| Knowledge of representations and strategies | Knowledge of instructional techniques | Design, preparation, and structure of lessons in reading comprehension |
| Knowledge of context | [a] | |

[a]No equivalent.

six- item category system (see the middle column of Table III) with which the knowledge and beliefs of each individual teacher could be described. The relationship between our categories and the Van Driel et al. categories (i.e., the starting categories) becomes evident when comparing the left and middle columns of Table III.

The transcripts of the semi-structured interviews and the explanations the teachers gave of their concept maps were coded with the ATLAS/ti program (Muhr, 1994), which allowed us to describe each teacher's knowledge and beliefs in terms of each of the six categories.

4.3.1.2. *Stage A of the Step-One analysis: Describing the content of each category of teachers' knowledge and beliefs.* Stage 1A in the analysis consisted of a close examination of each category of teachers' knowledge and beliefs separately. The descriptions of the thirteen teachers' knowledge and beliefs concerning each category were compared and summarized, resulting in six separate descriptions of

the categories of teachers' knowledge and beliefs. The descriptions emphasize the similarities and differences within each of the six categories.

4.3.1.3. *Stage B of the Step-One analysis: Describing and interpreting teachers' knowledge and beliefs.* In stage 1B, we tried to find similarities and differences in the teachers' knowledge and beliefs. For this purpose, we identified and described *patterns* in teachers' knowledge and beliefs. The word "pattern" refers to groups of associated statements that give insight (a) into the way teachers' knowledge and beliefs are intertwined (in that they concern statements that refer to more than one category of teachers' knowledge and beliefs), and (b) into the similarities and differences in the knowledge and beliefs of the teachers. The patterns identified in the data fell into two clusters. One cluster concerns teachers' ways of combining subject matter knowledge and student knowledge into knowledge of student learning and understanding. The second cluster concerns teachers' reasons for curriculum selection.

### 4.3.2. *The Second Step: Analysing the Stimulated Recall Interviews*

The purpose of the second step in the triangulation procedure was to gain insight into teachers' working memory while teaching. The data for the Step-Two analysis consisted of 13 stimulated-recall-interview transcripts. The procedure we followed in analysing these data is described in this section. This procedure consisted of two main stages and a pre-analysis stage which concerned the enhancement of the set of categories.

4.3.2.1. *Enhancing the set of categories.* Based on the relationship between teachers' interactive cognitions and their knowledge and beliefs as described in a previous section, we started the study of teachers' interactive cognitions with the set of six categories that were identified in teachers' knowledge and beliefs (cf. middle column of Table III). However, as explained, we considered teachers' interactive cognitions to be of a different nature than teachers' knowledge and beliefs: teachers' knowledge and beliefs are relatively stable, while teachers' interactive cognitions are dynamic in essence (cf. Leinhardt, 1993). This meant that it had to be established whether, and to what extent, the six categories identified in teachers' knowledge and beliefs were applicable for analysing teachers' interactive cognitions. For this purpose, we first read through the stimulated-recall transcripts and compared the categories to these data in order to assess their validity, reformulated them or generated new categories from the data, returned to the data to assess their validity, and went on doing so until the categories suited the data satisfactorily. This meant that no further categories could be formulated (see the procedure followed in the first step).

We split up the category *student knowledge*, which was identified in teachers' knowledge and beliefs, into two categories that concerned thoughts about *students in general* and about *individual students.* We reformulated *purposes* into goals

*Table IV.* Overview of the categories identified in teachers' interactive cognitions and how they are related to categories identified in teachers' knowledge and beliefs

| Categories in teachers' knowledge and beliefs | Categories in teachers' interactive cognitions |
|---|---|
| Subject matter knowledge | Thoughts about subject matter |
| Student knowledge | Thoughts about individual students |
| | Thoughts about students in general |
| Knowledge of student learning and understanding | Thoughts about student learning and understanding |
| Knowledge of purposes | Thoughts about goals |
| Curriculum knowledge | Thoughts about the curriculum |
| Knowledge of instructional techniques | Thoughts about instructional techniques |
| [a] | Thoughts about the particular class |
| [a] | Thoughts about teacher-student interaction |
| [a] | Thoughts about process regulation |

[a]Absent.

because this was more closely related to our actual data. Teachers' interactive cognitions about this matter appeared to be only about goals, which is only one of the subcategories of *purposes.* We added categories that concerned thoughts about the *particular class*, *teacher-student interaction*, and *process regulation.* The result was a set of ten main categories, namely, thoughts about: (a) subject matter, (b) individual students, (c) students in general, (d) student learning and understanding, (e) goals, (f) the curriculum, (g) instructional techniques, (h) the particular class, (i) teacher-student interaction, and (j) process regulation. These categories are also listed in the right- hand column of Table IV. Correspondences between these ten categories and the six categories that were identified for teachers' knowledge and beliefs can be inferred from Table IV by comparing both columns. To complete this pre-analysis stage, the data were described according to the ten categories in the right-hand column of Table IV.

4.3.2.2. *Stage A of the Step-Two analysis: Describing the content of each category of teachers' interactive cognitions.* The first main stage (stage 2A) in the process of analysing teachers' interactive cognitions concerned an in-depth analysis of each of the ten main categories. To be able to describe the variety and range of the teachers' interactive cognitions in each of the ten main categories, each category was divided into subcategories. Using these subcategories gave more insight into the details of teachers' interactive cognitions in each category. With the use of the subcategories, the data could be described in more detail.

4.3.2.3. *Stage B of the Step-Two analysis: Describing and interpreting teachers' interactive cognitions.* Because we wanted to determine whether, and in what way,

the (sub)categories were related to each other, we first needed to describe the relationships between the (sub)categories for each teacher. Thus, the second main stage in the analysis procedure (stage 2B) consisted of a close examination of the relationship between the (sub)categories. We identified patterns in teachers' interactive cognitions, each of which indicated a relationship between two (sub)categories. These patterns describe the common features as well as the differences found in the teachers' interactive cognitions. The result of this second step was the description of two clusters of patterns (i.e., "teachers' approaches to students" and "teachers' approaches to the content of a lesson"), summarizing the most important similarities and differences in the teachers' interactive cognitions.

#### 4.3.3. *The Final Step: Combining Results of the Previous Steps*

The procedure to combine the results of the two previous steps, which were described above, consisted of two stages (see Table II). The purpose of this final step in the process of analysis was to synthesize the results of the analysis of the data provided by the three instruments used in the two previous steps in order to gain a deeper level of insight into teachers' practical knowledge. Previous to these stages, the final set of categories was established.

4.3.3.1. *Establishing the final set of categories.* Because the list of categories about teachers' interactive cognitions built on the list of categories in teachers' knowledge and beliefs, the former is a more extensive one. One of the categories of teachers' knowledge and beliefs was split up, and three other categories were added. We considered the categories that were added or used to split up a category when analysing teachers' interactive cognitions – thoughts about the particular class, about individual students, about teacher-student interaction, and about process regulation – as characteristic of these kinds of cognitions because these categories concern aspects of teaching that are directly related to the actual teaching situation. However, it cannot be concluded that teachers do not have any knowledge or beliefs about these categories. On the contrary, we think that teachers do indeed have knowledge and beliefs about these categories, but we did not ask about this in the semi-structured interview, and they probably are too (situation) specific to play a role in teachers' concept maps. For example, from the stimulated recall interview it became clear that teachers had numerous thoughts about (the capacities or behaviour of) individual students. In the semi-structured interview and the concept maps, only teachers' knowledge and beliefs about students in general became explicit because it would be highly impractical within the constraints of this study to ask teachers about their knowledge and beliefs about each individual student. Hence, thoughts or knowledge teachers have about a particular class, about individual students, about interacting with students, and about process regulation are not always included in studies about teacher cognitions; yet they appear to be important in describing teachers' interactive cognitions and, subsequently, in describing teachers' practical knowledge. As will become clear in the next sec-

tion, patterns in which these categories are involved appear to relate to patterns in teachers' knowledge and beliefs. These categories are therefore indispensable in the description and understanding of teachers' practical knowledge.

We concluded that the set of categories resulting from the examination of teachers' interactive cognitions was the most comprehensive and thus most adequate one for the description of teachers' practical knowledge. Consequently, the final set of categories involved teachers' practical knowledge about: (a) subject matter, (b) individual students, (c) students in general, (d) student learning and understanding, (e) goals, (f) the curriculum, (g) instructional techniques, (h) the particular class, (i) teacher-student interaction, and (j) process regulation (cf. right-hand column of Table IV).

4.3.3.2. *Stage A of the Final-Step analysis: Describing the content of each category of teachers' practical knowledge.* The purpose of stage A of the Final-Step analysis was to describe the content of each category of teachers' practical knowledge (i.e., teachers' knowledge, beliefs, and interactive cognitions in one). We first described each teacher's practical knowledge in terms of the ten categories. A comparison of these descriptions across teachers then resulted in a composite summary that described the content of each category of teachers' practical knowledge.

4.3.3.3. *Stage B of the Final-Step analysis: Describing and interpreting teachers' practical knowledge.* The purpose of stage B was to gain a comprehensive insight into teachers' practical knowledge. The question was whether the patterns found in both teachers' knowledge and beliefs and in their interactive cognitions were related to each other. We found that the patterns were not independent of one another but occurred in combination. For example, teachers who displayed the pattern in which their knowledge of student learning and understanding was primarily dominated by their subject matter knowledge often seemed to follow the pattern in which their subject matter knowledge influenced their curriculum knowledge (see Table V). The patterns were, of course, not always found in the same combination for each teacher and, furthermore, teachers did not always show a particular combination of patterns explicitly. Teachers regularly did not show a clear-cut example of a pattern, but they did seem to fit one more than others. Combining all patterns yielded considerable opportunities to describe combinations of patterns and to indicate the combinations that seemed to occur most often. By examining the combination of patterns for all 13 teachers, we distinguished three groups of related patterns. These are described in Table V.

Within the first group of patterns, three of the four patterns emphasize subject matter knowledge. In addition, there seems to be a lack of attention for the students: there is only a general approach to them. We marked this group of patterns as one with a *focus on subject matter* (see the right-hand column of Table V).

Within the second group of related patterns, two patterns are directly related to student knowledge. Furthermore, from the fact that the patterns "knowledge of

*Table V.* Relationships between patterns, the elements of teachers' practical knowledge in which the patterns are found, and foci of related patterns

| | Related patterns | Found in teachers' | Focus |
|---|---|---|---|
| First group of related patterns | Strong influence of subject matter knowledge on knowledge of student learning and understanding | Knowledge and beliefs | *Focus on subject matter* |
| | Knowledge of curriculum is related to subject matter knowledge | | |
| | A general approach to students | Interactive cognitions | |
| | A subject-matter approach to the content of a lesson | | |
| Second group of related patterns | Strong influence of student knowledge on knowledge of student learning and understanding | Knowledge and beliefs | *Focus on students* |
| | Knowledge of curriculum is related to student knowledge | | |
| | An individual-student approach to students | Interactive cognitions | |
| | A curriculum approach to the content of a lesson | | |
| Third group of related patterns | Balance between subject matter knowledge and knowledge of students in their influence on knowledge of student learning and understanding | Knowledge and beliefs | *Focus on student learning and understanding* |
| | Knowledge of curriculum is related to knowledge of student learning and understanding | | |
| | A particular-class approach to students | Interactive cognitions | |
| | Combining subject matter and curriculum in the content of a lesson | | |

curriculum is related to student knowledge" and "a curriculum approach to the content of a lesson" are both in this group of patterns, it can be inferred that the latter shows an indirect link to student knowledge. We labelled this group of patterns as one with a *focus on students*.

In the third group of related patterns, the relationships seem less clear. In one pattern, there is a balance between subject matter knowledge and student knowledge; in another, there is a balance between subject matter and curriculum; and in a third, there is a focus on student learning and understanding. Furthermore, there is a particular-class approach to students. When this group of patterns is compared with the first two, it is particularly striking that there does not seem to be a dominant focus on either subject matter or students, or a lack of attention for either. However, another difference is the attention given to student learning and understanding, which is the focus of curriculum knowledge and, through this,

is related to the content of a lesson. We therefore decided to label this group of patterns as one with a *focus on student learning and understanding*.

Based on these labelled groups of patterns, a *typology* of practical knowledge was developed. We used the descriptions of the patterns to describe teachers' practical knowledge according to the ten main categories for each of the labelled groups. These three types, each focussing on either subject matter, students, or student learning and understanding, are described in Appendix I. Because the descriptions are based on the pattern descriptions, they are *not* descriptions of teachers, but descriptions of *generalized types* of practical knowledge with regard to the teaching of reading comprehension to 16- to 18-year-old students. However, clear examples of the types of practical knowledge could be found in our group of teachers (see Meijer, 1999).

## 5. Conclusion and Discussion

One of the purposes of our study was the development of procedures that can lead to the enhancement of the internal validity in qualitative research. For this purpose, we developed an analysis procedure that was based on triangulating data which were provided by three instruments (i.e., multi-method triangulation). This triangulation procedure can be summarized as follows (see also Table II):

1. We initiated our triangulation procedure by articulating how the elements of teachers' practical knowledge are conceptually related to each other. For this purpose, we used the theory of human memory described in a previous section. Following this theory, we considered it plausible that teachers' knowledge and beliefs, on the one hand, and teachers' interactive cognitions, on the other, although different in nature, are closely related in their content. Based on this notion, a three-step procedure for triangulation was developed.
2. We began the process of analysis by looking closely at the data on teachers' long-term memory elements (i.e., their knowledge and beliefs) provided by the structured open interviews and the concept mapping task. We first paid specific attention to the data of two teachers who appeared to be extremes, and involved research that had been done on teachers' practical knowledge, by using categories from others' research to classify the content of teachers' practical knowledge. After analysing all the data on teachers' knowledge and beliefs, we defined a set of six categories and a description of teachers' knowledge and beliefs.
3. The set of six categories resulting from the analysis of teachers' long-term memory elements was used as a starting-point for analysing teachers' working memory while they are teaching (i.e., their interactive cognitions). The results of this analysis were a refined and extended set of categories, as well as a description of teachers' interactive cognitions.
4. We combined the results of these two steps in order to gain insight into the larger issue of teachers' practical knowledge. We established a set of categories

with which we described the content of teachers' practical knowledge. Based on patterns that were identified in teachers' knowledge and beliefs as well as in their interactive cognitions – which captured the wide variation in the teachers' practical knowledge – we developed a typology consisting of three types of practical knowledge.

From the results of our study, we can conclude that the procedure of triangulation that was used to combine the data provided by the semi-structured interview, the concept mapping task, and the stimulated recall interview, was a fruitful procedure because it increased our insight into the content of teachers' practical knowledge. First, we were able to establish a set of categories of practical knowledge, which was based on the sets that were identified in teachers' knowledge and beliefs, and in their interactive cognitions. Second, and most important, we were able to combine the patterns that had been identified in teachers' knowledge and beliefs and in teachers' interactive cognitions, on the basis of which we were able to develop a *typology* of teachers' practical knowledge and to describe three types of practical knowledge in detail. So, the triangulation procedure resulted, in particular, in more insight into how the categories of teachers' practical knowledge were related to each other.

There are two final remarks we would like to make here. The first concerns the involvement of insights from other research. In the investigation of teachers' practical knowledge, it is important to let the data speak for itself as much as possible. Yet, there are insights available about teachers' practical knowledge which can be legitimately used in further investigations about this concept. In our study, we used insights generated from research on the content of teachers' practical knowledge as a starting-point for our analysis. However, in order to do justice to the teachers' practical knowledge (i.e., the knowledge *of* teachers), we think that the use of insights from other research is only legitimate when this is done on condition that the insights can be reformulated or revised in order to make them fit the data (cf. Parker, 1985).

Second, we used a theory about human memory to indicate the relationships in our data. Subsequently, this was the basis for our analysis. The fact that our data were linked gave cues about the way the data might be analysed. The theory about the relationships in the data allowed us to use the same categories as a point of departure for analysing all the data and formed the basis for the triangulation procedure. In studies where such a theory is not available, it may not be possible to follow the same procedure.

There are many ideas about the criteria that qualitative studies should meet in order to enhance their internal validity. We think that procedures for establishing internal validity should be developed within the context of the specific features of qualitative research (see also Miles and Huberman, 1994). In this article, we have described a triangulation procedure that, in the specific context of our study, appeared to be fruitful.

## Appendix I

*Types of practical knowledge in teaching reading comprehension*

| Practical knowledge about: | Type A: Focus on subject matter | Type B: Focus on students | Type C: Focus on student learning and understanding |
|---|---|---|---|
| Subject matter | Explicit ideas and detailed knowledge about the skills and way of working that are involved in reading comprehension. The definition of reading comprehension is often related to the skills and knowledge students need for the final exams. | Reading comprehension is often defined in terms of general student knowledge, as is knowledge about necessary skills and way of working. Subject matter is seen as of minor importance; teacher's knowledge of a subject should play a minor part in education. | Explicit knowledge about skills and possible ways of working in reading comprehension. |
| Individual students | Knowledge of individual students (if any) is mostly about their behaviour in the classroom, often related to misbehaviour. Teacher is often wrong about what to expect from individual students. | Detailed and in-depth knowledge about characteristics and capacities of each individual student. | Teacher knows basic characteristics and capacities of each student, especially about each student's possible contribution to a lesson. |
| Students in general | Little explicit knowledge about students in general, and/or negative attitudes towards them (they are not motivated, etc.). | Basic concern for children; detailed knowledge of these students' background, environment, and characteristics. | Explicit knowledge about the characteristics, background, and environment of (16- to 18-year-old) students in general. |

| Practical knowledge about: | Type A: Focus on subject matter | Type B: Focus on students | Type C: Focus on student learning and understanding |
|---|---|---|---|
| Student learning and understanding | Teaching reading comprehension is seen as the training of skills. Little knowledge about how students work or about what difficulties they perceive. | Explicit knowledge of how to motivate students, always trying to make students feel comfortable. Knowledge of differences between students or difficulties they perceive in terms of general student knowledge. | Explicit knowledge of how students work and what constitutes differences between them, based on detailed knowledge of both subject matter and students. |
| Goals | Teaching reading comprehension is seen as important because of the emphasis on it in the final exams. The primary goal of teaching reading comprehension is to prepare students for the exams and therefore teachers have to consider the training of skills that are necessary for the final exams. | Teaching reading comprehension is considered important because it allows students to deal with society. The goal of teaching reading comprehension is to make students discerning or even philosophical readers and thinkers. In the final exams, no attention is paid to this goal of teaching reading comprehension. | Teaching reading comprehension is considered as the foundation of all subjects in school and important for further education and real life. Attempts to strike the right balance between the subject matter that has to be taught (for the exams and further education) and the students' motivation and interests; steering a middle course between academic (subject matter) goals and students' needs (broad pedagogical goals). |
| Curriculum | Texts from earlier exams are used in lessons because this best prepares students for the exams. Reasons for selecting texts are based on subject matter knowledge. | Teacher's own texts are used or students decide. Texts are not necessarily or directly related to final exams. Text selection is used as a motivational strategy, based on general student knowledge. | Selection of texts is related to (academic as well as broad pedagogical) goals that have to be reached in a lesson in reading comprehension. |

| Practical knowledge about: | Type A: Focus on subject matter | Type B: Focus on students | Type C: Focus on student learning and understanding |
|---|---|---|---|
| Instructional techniques | Students often work on their own or there is a lecture. Preparing lessons is not necessary if the text is known to the teacher. Extra attention for weaker students takes the form of additional homework assignments. | No lesson preparation: lessons are designed around reactions, questions and moods of students, time of the day, etc. There are a lot of discussions or group work. Always making sure that every student keeps up. | Lessons are prepared and designed according to lesson goals; always aiming at variation to account for differences between students' preferences and learning styles. |
| Particular class | Knowledge of the particular class is about the class' background in general or related to what students have learned in earlier lessons. | The class is seen as a group of individual students. Knowledge of a class is primarily about the characteristics of a class in general, but the teacher is also sensitive to changes in the atmosphere during a lesson. | Detailed knowledge of the class, about its background knowledge as well as about its general characteristics. Teacher is sensitive to the class atmosphere. |
| Teacher-student interaction | Interaction between teacher and student is often difficult, stemming from negative teacher attitudes towards students in general and from misinterpretations of their capacities. | Interaction between teacher and students is intimate and based on basic care for children in general. Interaction can be different for every student. | Teacher interacts with the whole class and with individual students when necessary or appropriate. |
| Process regulation | Teacher regulates time and order, mainly related to the lesson content that is planned to be dealt with in the lesson. | Hardly any regulation of time, content, or order. The lesson is regulated by (questions and remarks of) students. | Teacher is very concerned about managing the content of a lesson as well as the learning process of the students. |

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## References

Anderson, J. R. (1980). *Cognitive Psychology and Its Implications.* San Francisco: Freeman.

Baddeley, A. (1990). *Human Memory. Theory and Practice.* Hillsdale, NJ: Lawrence Erlbaum.

Baddeley, A. D. & Hitch, G. (1974). Working memory. *The Psychology of Learning and Motivation* 8: 47–89.

Beijaard, D. (1990). *Teaching as Acting.* Doctoral dissertation. Wageningen, The Netherlands: Wageningen Agricultural University.

Beijaard, D. & Verloop, N. (1996). Assessing teachers' practical knowledge. *Studies in Educational Evaluation* 22(3): 275–286.

Borko, H. & Putnam, R. T. (1996). Learning to teach. In: D. C. Berliner & R. C. Calfee (eds.), *Handbook of Educational Psychology.* New York: Macmillan, pp. 673–708.

Buitink, J. (1998). *In-functie opleiden en in-functie leren van aanstaande leraren* [Teaching and learning in initial in-service teacher education]. Doctoral dissertation. Groningen, The Netherlands: Rijksuniversiteit Groningen.

Calderhead, J. (1996). Teachers: Beliefs and knowledge. In: D. C. Berliner & R. C. Calfee (eds), *Handbook of Educational Psychology.* New York: Macmillan, pp. 709–725.

Cantor, J., Engle, R. W. & Hamilton, G. (1991). Short-term memory, working memory, and verbal abilities: How do they relate? *Intelligence* 15: 229–246.

Carter, K. (1990). Teachers' knowledge and learning to teach. In: W. R. Houston (ed.), *Handbook of Research on Teacher Education.* New York: Macmillan, pp. 291–310.

Clark, C. M. & Peterson, P. L. (1986). Teachers' thought processes. In: M. C. Wittrock (ed.), *Handbook of Research on Teaching* (3rd ed). New York: Macmillan, pp. 255–296.

Cochran, K. F., De Ruiter, J. A. & King, R. A. (1993). Pedagogical content knowing: An integrative model for teacher preparation. *Journal of Teacher Education* 44(4): 263–272.

Cohen, L. & Manion, L. (1994). *Research Methods in Education* (4th ed.). London: Routledge.

Erzberger, C. & Prein, G. (1997). Triangulation: Validity and empirically-based hypothesis construction. *Quality & Quantity* 31(2): 141–154.

Fernández-Balboa, J. M. & Stiehl, J. (1995). The generic nature of pedagogical content knowledge among college professors. *Teaching and Teacher Education* 11(3): 293–306.

Gliner, J. A. (1994). Reviewing qualitative research: Proposed criteria for fairness and rigor. *The Occupational Therapy Journal of Research* 14(2): 78–90.

Grossman, P. (1989). A study in contrast: Sources of pedagogical content knowledge for secondary English. *Journal of Teacher Education* 40(5): 24–31.

Grossman, P. L. (1990). *The Making of a Teacher: Teacher Knowledge and Teacher Education.* New York: Teachers College Press.

Gudmundsdottir, S. (1991). Ways of seeing are ways of knowing. The pedagogical content knowledge of an expert English teacher. *Journal of Curriculum Studies* 25(5): 409–421.

Hoosain, R. & Salih, F. (1988). Language differences, working memory, and mathematical ability. In: M. M. Gruneberg, P. E. Morris & R. N. Sykes (eds), *Practical Aspects of Memory: Current Research and Issues: Vol. 2. Clinical and Educational Implications.* Chichester: John Wiley & Sons, pp. 512–517.

Kagan, D. M. (1990). Ways of evaluating teacher cognition: Inferences concerning the Goldilocks Principle. *Review of Educational Research* 60(3): 419–69.

Kopinak, J. . (1999). The use of triangulation in a study of refugee well-being. *Quality  Quantity* 33(2): 169–183.

Leinhardt, G. (1990). Capturing craft knowledge in teaching. *Educational Researcher* 19(2): 18–25.

Leinhardt, G. (1993). On teaching. In: R. Glaser (ed.), *Advances in Instructional Psychology.* Hillsdale, NJ: Lawrence Erlbaum, pp. 1–54.

Marks, R. (1990). Pedagogical content knowledge: From a mathematical case to a modified conception. *Journal of Teacher Education* 41(3): 3–11.

Mayer, R. E. (1981). *The Promise of Cognitive Psychology.* San Francisco: Freeman.
Meijer, P. C. (1999). *Teachers' Practical Knowledge. Teaching Reading Comprehension in Secondary Education.* Doctoral dissertation. Leiden, The Netherlands: Leiden University.
Meijer, P. C., Verloop, N. & Beijaard, D. (1999). Exploring language teachers' practical knowledge about teaching reading comprehension. *Teaching and Teacher Education* 15(1): 59–84.
Miles, M. B. & Huberman, A. M. (1994). *Qualitative Data Analysis.* Thousand Oaks, CA: Sage.
Morine-Dershimer, G. (1992). *Patterns of Interactive Thinking Associated with Alternative Perspectives on Teacher Planning.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.
Muhr, T. (1994). *ATLAS/ti. Computer Aided Text Interpretation and Theory Building, 1.1E.* Berlin, Germany.
Parker, W. C. (1985). *Teachers' Interactive Decisions and Behaviour Utilization During Instruction.* Paper presented at the annual meeting of the American Educational Research Association, Chicago.
Pedhazur, E. J. & Pedhazur-Schmelkin, L. (1991). *Measurement, Design, and Analysis: An Integrated Approach.* Hillsdale, NJ: Lawrence Erlbaum.
Peterson, P. L., Fennema, E., Carpenter, T. P. & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. *Cognition and Instruction* 6(1): 1–40.
Putnam, R. T. & Borko, H. (1997). Teacher learning: Implications of new views of cognition. In: B. J. Biddle, T. L. Good & I. F. Goodson (eds), *International Handbook of Teachers and Teaching* (Vol. 2). Dordrecht, The Netherlands: Kluwer Academic Publishers, pp. 1223–1296.
Shulman, L. S. & Elstein, A. S. (1975). Studies on problem solving, judgment, and decision making: Implications for educational research. In: F. N. Kerlinger (ed.), *Review of Research in Education* (Vol. 3). Itasca, Illinois: Peacock.
Shulman, L. S. (1986a). Paradigms and research programs in the study of teaching: A contemporary perspective. In M. C. Wittrock (ed.), *Handbook of Research on Teaching* (3rd ed.). New York: Macmillan, pp. 3–36.
Shulman, L. S. (1986b). Those who understand: Knowledge growth in teaching. *Educational Researcher* 15(2): 4–14.
Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review* 57(1): 1–22.
Silverman, D. (1997). *Qualitative Research: Theory, Method and Practice.* London: Sage.
Smaling, A. (1987). *Methodologische objectiviteit en kwalitatief onderzoek* [Methodological objectivity and qualitative research]. Doctoral dissertation. Lisse, The Netherlands: Swets & Zeitlinger.
Taylor, J. C. & Evans, G. (1985). The architecture of human information processing: Empirical evidence. *Instructional Science* 13: 347–359.
Van Driel, J. H., Verloop, N. & De Vos, W. (1998). Developing science teachers' pedagogical content knowledge. *Journal of Research in Science Teaching* 35(6): 673–695.