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Do teachers need instructional analogies to teach mother-tongue (L1)? - Teachers' perceptions and representations of difficult topics in mother-tongue education. L1

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DO TEACHERS NEED INSTRUCTIONAL ANALOGIES
TO TEACH MOTHER-TONGUE (L1)? – TEACHERS’
PERCEPTIONS AND REPRESENTATIONS OF DIFFICULT
TOPICS IN MOTHER-TONGUE EDUCATION

ABSTRACT. The key elements in Shulman’s conception of pedagogical content knowledge are knowledge of representations of subject matter and understanding of students’ learning difficulties. The present study deals with teachers’ perceptions of areas of student difficulty related to their representations of difficult subject matter. The focus is the role of analogies in the representation repertoire of six experienced language teachers who were interviewed about aspects of subject-specific practical knowledge or pedagogical content knowledge: difficult topics in mother-tongue education, related learning problems, representations, use of analogies, need for appropriate analogies, and an instructional model. The main question addressed in this study is whether language teachers use forms of representation that are different from those used by science teachers, including analogies, because of the nature of their school subject. The results indicate that reading comprehension and writing proficiency are considered difficult topics, and there are various representations without analogies. In the teachers’ view, there is no need for analogies and an instructional model. It appears possible that language teaching does not lend itself to the use of instructional analogies.

KEY WORDS: academic discipline and school subject, analogies, difficult topics, knowledge base of teaching, mother-tongue teaching, pedagogical content knowledge

1. INTRODUCTION

Explaining difficult, new, or abstract subject matter to students often requires the use of special techniques, for instance, analogies. An analogy is the comparison of something familiar to something unfamiliar, in order to explain the unfamiliar concept. An analogy can help students transfer their existing knowledge to new knowledge. But analogies are also double-edged swords and can cause misconceptions. The analogy (a camera for the human eye or a computer for the brain) is a frequently applied tool within science education and has been intensively investigated as an aspect of science teachers’ practical knowledge (Glynn, 1989; Treagust, Harrison & Venville, 1998). Whether this also applies to other school subjects is something we do not know much about. In our own research on language teaching (Hulshof & Verloop, 2002), analogies there is not much evidence of analogies in

language teaching in classrooms and textbooks. If language teachers do use analogies, it is mostly unsystematically. There seems to be a difference in analogy-use across subject areas. Apparently there is a difference between school subjects with respect to the level of difficulty of concepts that need to be explained, and the experienced language teachers' practical knowledge that includes fewer analogies than that of teachers of physics or chemistry. The teaching of reading comprehension and literature does not offer content that is complex and difficult enough to need the sustained development of analogies (Grossman, 1990; Hulshof & Verloop, 2002).

Essential elements of language teaching, such as communicative skills and literary competence probably require different representations than electricity, magnetism, or atoms do. On the other hand, language teaching also includes rather abstract topics like grammar, argumentation, and literary analysis. These topics may not, however, be so abstract that it is necessary to use analogies. Magnusson, Krajcik & Borko (1999) have suggested three reasons science students find learning difficult: the level of abstraction, the planning strategies required to find solutions, and misconceptions. What is actually considered difficult content in mother-tongue education? The knowledge teachers must have about students in order to help them develop subject-specific knowledge should include knowledge of areas of student difficulty and related methods of instruction.

Shulman (1986) has introduced pedagogical content knowledge (PCK) as a specific category of teacher knowledge. The key elements in the conception of PCK are knowledge of representations of subject matter on the one hand, and understanding of specific learning difficulties and student conceptions, on the other hand. The more representations teachers have at their disposal within a certain domain, and the better they understand their students' learning processes in the same domain, the more effectively they can teach in this domain. According to Shulman (1986), all experienced teachers should have many powerful analogies in their representation repertoire. Other researchers have been concerned with this idea (Grossman, 1990), often without further elaboration when it concerns teachers' subject-specific practical knowledge. In the case of language teaching, we can place question marks just at this point because analogies are particularly useful for topics presenting some difficulty to the learner (Hulshof & Verloop, 2002; Newton & Newton, 1995). An analogy works best when the concept being taught is hard to grasp (Newton, 2000; Treagust et al., 1998). If the concept is simple, a straightforward explanation may be quicker and will not open the student to possible misconceptions from misapplication of the analogy. But what is simple or hard to grasp?

It is, therefore, interesting and relevant to investigate language teachers' perceptions and representations, including the following components:

(1) students' understanding, for example, areas of student difficulty, and (2) representations for these specific topics, for example, representations such as analogies to make the unfamiliar-familiar. The present study deals with the relationship between (1) and (2) as an aspect of pedagogical content knowledge (Grossman, 1990; Magnusson et al., 1999; Shulman, 1986). The first component with subject matter considered to be difficult, was investigated with a population of teachers of biology, physics, and chemistry by Finley, Stewart & Yarrach (1982). No comparable study on language teaching exists. Because models of teaching with analogies (the second component) have recently become available in the field of science education research (Glynn, 1989; Treagust et al., 1998), it is relevant to ask language teachers about their need for an instructional strategy for teaching with analogies. So we can discuss some differences between science teaching and language teaching with respect to teachers' representational repertoire.

On the basis of the foregoing, five research questions were addressed:

1. What are (in experienced teachers' perceptions) difficult topics in language teaching?
2. What learning problems do students have with these topics (in experienced teachers' perceptions)?
3. What forms of representation do language teachers use to explain these topics?
4. Do language teachers use analogies to explain these topics?
5. Do language teachers need an instructional strategy for the use of analogies?

The more general structure behind these questions is based on a distribution of three concepts of teachers' cognitions and behaviour: *perception* (1 and 2), *use* (3 and 4), and *need* (5), and (4 and 5) are based on the assumption that teaching with analogies is broad enough to apply to content areas in general, including both language and science education (Glynn, Lawi & Doster, 1998).

To answer the questions, and discussing the last assumption, we conducted interviews with experienced teachers of Dutch (as mother-tongue). It is relevant to tell something first about mother-tongue education in The Netherlands, based on Gelderen, Couzijn & Hendrix (2000).

2. DUTCH SECONDARY EDUCATION AND MOTHER-TONGUE CURRICULUM

During the last 30 years, the Dutch secondary mother-tongue curriculum has gradually turned into a longitudinal course on language skills: mother-tongue education has become an efficient means to train communication skills of future students and employees.

In 1996, this 'instrumentalisation' of the subject resulted in the establishment of formal, detailed core objectives for national language skills examinations at the secondary level (ages 16–18). These core objectives are partly in line with those of the Basisvorming (basic curriculum, ages 12–15) with 90% of the focus on language arts and literary education. In the upper grades (ages 15–18) there is no formal domain for 'language awareness', 'linguistics' or 'language and culture'.

The choice for such a highly instrumental curriculum is related to a general mass-innovation of Dutch secondary education. In the paradigm of this innovation, the 'quality of education' is measured in terms of its direct, practical contribution to daily life, future study, or profession.

The 'language skills' domains of mother-tongue education (reading, writing, speaking/listening) are generally considered to be very important in a practical sense while the 'literary' and 'linguistic' domains are not and, consequently, have lost much of their content and study time. While 'literary history' and 'grammar' once dominated the curriculum, they lost this position in favour of text and argumentation analysis, summarizing skills, documented writing, oral presentations, group discussions, and – for the upper streams – classroom debates.

Language teaching is about skills and ways of thinking. Its focus is on knowing *how* rather than knowing *about*. There are clear differences between school subjects.

The decision to instrumentalise the mother-tongue curriculum, that is to consider the school subject 'Dutch' as a means to a practical end, has been met some critical responses.

A renewed discussion can be observed about the 'proper' contents or subject matter of mother-tongue education. Many teachers feel unhappy about the recent innovation (learning to learn, independent learning, less whole-class instruction) in the 'study house', as a metaphor used for a new type of secondary school where pupils would work more or less independently, asking for guidance from the teacher as and when required. In fact, here we have an innovation from educational theory, not from educational practice, with all the predictable drawbacks. (See Bonset & Rijlaarsdam for a brief review of developments in the Dutch secondary mother-tongue curriculum (2004, pp. 35–38).)

3. METHOD

3.1. Interviews

Semi-structured interviews were conducted to elicit teachers' knowledge, beliefs, and practices. This is an instrument which can provide in-depth

information. All the teachers were asked the same question, which enhanced the comparability of the data. We conducted interviews with six experienced teachers of Dutch (as mother-tongue). The teachers ranged in teaching experience from 12 to 35 years the average being 21 years. The teachers were selected from a pool of secondary school teachers of Dutch who had been involved in teacher education for many years as student teacher mentors. Almost all subscribe to a pedagogic approach in which activity and independence are central. There are, of course, gradual different opinions about the relationship between theory and practice. Two were female; four were male. They teach at six different secondary schools. For the interviews, we developed a list of subjects for discussion, centered around five main questions corresponding with our research questions:

1. Which mother-tongue education topics require a great deal of attention and explanation when they are taught to students in the upper levels of secondary school? (focus: *perception*).
2. Why are these topics difficult for the students? (focus: *perception*).
3. What representations of subject matter (examples, illustrations, demonstrations, and/or analogies) do you use to explain these difficult concepts? (focus: *use, representation*).
4. If you use an analogy as a form of representation, is that just to review the explanation or do you elaborate the analogy, e.g., by also discussing the point where the analogy breaks down? (focus: *use, representation, analogy*).
5. Would you like to have more appropriate analogies (geared to the subject matter, and tested), including an adequate model to use in your lessons? See information about examples of analogies and the teaching-with-analogies model in Appendices A and B. (focus: *need*).

If the teachers, after answering and discussing the first three questions, had not mentioned analogies at all, the interviewer introduced this theme.

The teachers were familiar with the goals and the curricular content of the school subject Dutch language, including existing attainment targets and exit requirements. Moreover, descriptions of these goals were available for inspection during the interview.

The interviews were conducted at the teachers' own schools between December 1999 and February 2000. The integral interviews were recorded on tape and took an average time of one and a half hours.

3.2. *Analysis*

The text of the interviews was coded into manageable content categories on two levels (words, phrases) and then examined using content analysis (Carley, 1990). We quantified and analyzed the presence, meanings, and

relationships of certain words and concepts, then we made inferences about the messages within the text of the interviews. We focused on, and coded, the specific words and phrases that were indicative of the research questions: difficult topics in the Dutch curriculum, learning problems, learning behaviour, teaching methods, explanations, examples, stories, strategies, analogies, need for analogies.

Content analysis was not only used to analyze the presence of these words and phrases within the textual data, but also the implicit messages and meanings embedded within the text of the interviews while exploring these messages and meanings within the framework of the research questions, the focus was to look for synonyms and meaningful relationships too. Not all the teachers used the same terminology for the same concepts (for instance *example-analogy*). Some decisions of the researchers about choices in interpretation were subject of discussion.

The answers of the six teachers to the five questions were systematically analyzed by three different educational researchers. Every researcher had the same perspective on the subject. There was agreement about definitions of the categories and the results of the analysis (stability). Afterwards, there an authorization of the analysis and the way of representation by each of the interviewed teachers. The first two questions focused on perceptions regarding difficult topics and possible causes. The answers to questions three and four demonstrated representations in general, but sometimes exhibited specifically represent regarding analogies. The last question was an additional opinion about using analogies. The first question provided supposed *difficult topics* within the area of mother-tongue education; the ranking of topics by the teachers was not always clear. We recorded which topics were mentioned by the teachers and for how long they pursued the subject. The second question provided *reasons* for difficulty related to the level of difficulty. We were looking for reasons like abstraction, strategies in use, and misconceptions. The third question was marked by *teaching methods*; the last two questions were *opinions*. The qualitative content analysis took place by summarizing their remarks and conclusions, and illustrating them with well-chosen quotations. There was a correspondence of the categories to the conclusions (validity). In view of the small number of teachers interviewed, we did not collect quantitative data.

4. RESULTS

The headings correspond with the five research questions: *perception* (sections 4.1 and 4.2: difficult subjects and related learning problems), *use/representations*

(section 4.3: forms of representation, use of analogies), and *need* (section 4.4: need for analogies and an instructional model).

4.1. *Difficult Subjects*

The teachers differed in their perceptions with respect to areas of student difficulty, reflecting their view of the subject area. We did not explicitly ask for their beliefs about their view of the subject area. Some common difficult topics emerged spontaneously, mostly focusing on strategies, not on concepts. The influence of exit qualifications and the examination program for Dutch, which focuses on (reading and writing) skills and application, is a very important factor here.

Reading comprehension (especially summarizing texts, distinguishing fallacies, evaluating argument, learning strategies) is considered difficult by four of the six teachers. Two of these teachers believe that reading comprehension develops gradually, while the other teachers believe that some students are not able to learn it in any way:

It is very difficult to see (and to understand) structures in texts. Not only in texts to summarize, but also in theoretical texts in textbooks.

For two other teachers (who are teaching at more traditional schools), grammar and orthography are important when difficult topics for students are at stake.

General subject-specific skills, related to the innovation of secondary education, like learning to learn and learning and applying of strategies, are also mentioned by these teachers as obstacles for students. Cross-curricular skills and subject-specific skills are sometimes hard to separate:

Well, I think they have a lot of trouble with several skills, especially reading comprehension, acquiring and applying the reading strategies, and realizing the intention of these learning activities. Reading comprehension focuses on separating main points and subordinate points in texts. That is still a big problem in summarizing a text.

Some teachers introduce the typical restricted ‘school learning’ aspect of subject matter and don’t know how to present the subject matter in a non-school learning (more naturalistic) manner:

It has to do with the fact that certain parts of the subject matter are considered ‘extraterrestrial’ by the students. Students consider argumentation to be nothing more than a curriculum object, while they use arguments every day, at home, and everywhere. But students don’t connect these things.

Lack of reference and ‘knowledge of the world’ is mentioned by two teachers. One of them says:

To distinguish facts and opinions is a very difficult subject. I think because there is a relationship with reading comprehension. Reading papers allows a starting point. Some students don’t read at all.

Changes in modern secondary education (the new approach to learning at upper secondary level, which now focuses on individualization, learning to learn, skills, teacher as coach) has had a great influence, especially when the teacher works at a more traditional school:

Many of these points are closely bound up with the principle of learning to learn. That is one of the most difficult things in education. Students are often not used to it and are not taught to develop it.

Classified from more to less difficult, the five most frequently mentioned topics, in fact parts of the whole curriculum, were: reading comprehension (especially summary, argumentation theory), writing proficiency (especially argument, text revision), literature (especially analysis, poetry), grammar (especially sentence analysis), and orthography. It is a mixture of skills, strategies, metalinguistic knowledge, and application of explicit rules. According to the teachers, the combination of the language-as-communication paradigm and the learning-to-learn paradigm has contributed to the complexity and difficultness of mother-tongue teaching, c.q. learning (see for the paradigms: Bonset & Rijlaarsdam, 2004).

4.2. *Related Learning Problems*

The teachers generally have some idea about what students consider difficult, but they don't clearly indicate why students have trouble with these subjects. Experienced teachers' practical knowledge with respect to student characteristics is very personal and intuitive. The teachers mentioned a number of factors which have a negative influence on learning difficult topics: planning of strategies, the funny reasoning of children, lack of motivation, strong curricular character of the subject matter, lack of background knowledge as a frame of reference, level of abstraction, system separation, non-utilized 'extraterrestrial' prior knowledge. They believe there is a need for structure, and an affiliation to students' everyday lives.

Sometimes the teachers just don't know how students learn, in this case even a very experienced teacher:

It is a puzzle to me why students have so much trouble with grammar and orthography. I don't think the rules are complicated.

I am surprised at the learning behaviour of children. Then I offer them the textbook, saying again and again (...).

He thinks about it and says:

If you want to learn something, you can learn it quickly. It is a matter of motivation. Most children are not motivated for school work.

Sometimes the teachers do know how students learn. One of the younger teachers answers:

Learning orthography has to do with mental system separation, as it does in the case of learning strategies.

The students' lack of background knowledge is mentioned several times:

Learning to distinguish facts and opinions seems to be very difficult. I think it is because it is linked up with students' reading comprehension. If they are used to reading texts or a paper and have an extended vocabulary or more general education than other students, it is really an advantage. But it is very difficult to reduce an existing disadvantage. Besides, some students never read at all.

There is no systematic relationship between forms of representation and the learning process of the individual student. Most instructional strategies are determined very situative and justified on the basis of the teacher's personal experience, c.q., practical knowledge. The age of the students also determines the representation repertoire. The use of analogies is generally considered to be dependent on age. The only teacher that uses analogies frequently has a clear opinion about this question:

In the first stage of secondary education, an analogy like liquorice and toffees for sorts of verbs is no longer useful, because the students think it is childish. In the second stage of secondary education such analogies are again possible because students think they are funny and helpful. This will be the connection with the following section about the forms of representation.

4.3. *Forms of Representation, Use of Analogies*

Although various forms of representation are used, analogies do not play a prominent role. Only after the interviewer mentioned this possibility using Appendix A did two teachers remember some analogies in the sense of mnemonic devices, and not in the sense of scaffolds (Rosenshine & Meister, 1992). Apparently there is no prepared use of analogies.

After focusing on the analogy as a form of representation, one of the teachers says he uses many analogies for explanation, however, not according to a particular system, as elaboration and reflection are absent (cf. the phases in Glynn's TWA model, see Appendix B):

There is a grammatical difference between parsing and analyzing. If I say 'He is walking down the street', 'He' is simultaneously called a personal pronoun and the subject. In this case I say that you have many makes of car and you have many colours. If a car is blue it doesn't mean it is a Ford. They have to consider the question carefully to see what exactly the question is. Do you want to know whether it is a part of a sentence or a part of speech?

After eliciting a reply, two of the teachers do not see the difference between examples and analogies. Analogies are sometimes used in a broad sense to teach difficult concepts:

You start with clear examples and then you gradually carry the discussion to a higher level.

Strategies are mostly determined by exit requirements and the elaboration used in textbooks. There is not a lot diversity. One teacher intentionally applies transfer of strategies:

Strategies for reading informative texts are also applicable to reading literature: prediction of content on the basis of fragments.

One characteristic of these teachers is the search for an attractive introduction to the lesson and gearing instruction to students' everyday lives. Showing the students how to do it, speaking aloud, and thinking aloud are considered as important by most of the teachers as factual knowledge and examples, like the readers' letter in teaching argumentation and other students working on video tape.

Most of the teachers mention subject-specific representations, applied to teaching particular topics. Because of the new exit requirements, the teachers are using more cross-curricular representations. Consequently, their own contribution to methods of teaching has decreased. Only one teacher is spontaneously using analogies, mostly to illustrate, without instructional intentions.

4.4. *Need for Analogies and an Instructional Model*

There is no need for extra analogies or a model for using analogies systematically, though four of the teachers emphasize the importance of analogies for student teachers:

I think there is some sense in it for student teachers.

Because they are rather afraid of theory, all the teachers more or less prefer learning in and from practice. One teacher (very experienced, a 'man of practice' as he likes to say) expresses it as follows:

How do you explain it to students? We [= experienced teachers] are always saying it's a question of trial and error.

There's no need for comparisons to explain things better, I'd rather do it in my own manner.

Teaching is very personal, contextually determined. There is no need for theory in this case.

The model (see Appendix B) used as an example of an instructional strategy during the interview and also used as a catalyst, sometimes triggered specific examples of analogies, from which appeared the tacit knowledge and the nonsystematic use of analogies (I = interviewer, T = teacher):

I: The model concerns the metaphorical analogy (when it concerns two different domains in the comparison), like a camera for the human eye.

T: To explain grammar, I use a drawing. I draw a circle. Beforehand I have said that when you have command of the grammar of a certain language, you have insight into structures, which makes it much easier to learn another language. Then I give the example of an auto

mechanic. Because he knows how cars work in general, he is able to repair not only type X but also type Y. Well, it is the same story with languages. Then I mark the centre of the circle. The kernel is the combination of subject and predicate. This kernel is connected with the objects in the sentence. These are additions to the kernel of the sentence, and closely connected with it. The adjuncts are the exterior rind. They are extra additions. Then students often say: Oh, I have never seen it that way.

The analogy is sometimes interpreted as a form of transfer:

I: Maybe it is good to ... these are some examples of analogies from science education (see Appendix A). You have already mentioned some comparable analogies. Do you use analogies of this type in your teaching practice?

T: Yes, I have something I did in a third year class: explaining the pure grammar. Then you refer to the structure of other sentences and that this sentence is just a little bit more difficult. What I see as a clear analogy, which I often point out when we discuss the structure of a text, is that when they are busy with writing proficiency, they should think, oh, I meet the same things during reading comprehension and the other way round.

From the interview with the same teacher:

I: Would you need, supposing they existed, more appropriate comparisons, examples, and forms of demonstrations with respect to a concept in the textbook?

T: Honestly, I don't. Mostly because I like it to invent an example that is appropriate to the situation in the real world or the school. That has an easy appeal. I have no trouble with it.

I: Would you like to have a model to incorporate analogies and examples into your lessons?

T: Well, I am actually not such a theory-man. Over the years I have developed some ideas about what works and what doesn't in the classroom in particular situations.

In answering the question about the representations of supposed difficult topics, only one teacher spontaneously mentioned some analogies. After triggering specific questions that focused on the use of analogies, all the teachers made it clear that they have analogies available as a sort of tacit knowledge. They became aware of the fact that they were using analogies sometimes after the issue was raised.

5. DISCUSSION AND CONCLUSIONS

There are several kinds of subject-specific practical knowledge or PCK. This study dealt with practical knowledge with respect to the representation of difficult subjects in teaching language in secondary education. Using analogies is an aspect of subject-specific practical knowledge since Shulman (1986), a part of teachers' representation repertoire. This also applies to language teaching, if we interpret analogy broadly (as the connection of subject matter with out-of-school reality). It is still an uphill battle. The elaboration of analogies in lessons and textbooks for language teaching breaks down,

though the interviews revealed that teachers have tacit knowledge about analogies. To what extent are teachers conscious of analogies?

Recent research suggests that analogies are explanatory tools used by teachers and textbook authors in all content areas. However, there are clear differences between school subjects. Teachers of Dutch language and literature are mostly teaching by means of strategies and examples. Mother-tongue education deals with an interpretative kind of knowledge. The distinction between school knowledge and daily life is a problem for students in language and literature. Sometimes they reject language skills didactics as 'schoolish', implicitly referring to their daily use of language skills. Teachers seem to experience this by presenting subject matter in a non-school learning manner.

While science teachers teach through analogies, language teachers teach through examples, strategies and stories. Stories are analogous to analogies for literature teachers. Referring to the foregoing, we can raise the following (not yet elaborated) discussion questions regarding school subjects, academic disciplines, types of analogies, and research tools:

- Is the subject-specific practical knowledge of language teachers (especially focused on strategies, procedures, planning with steps) and teachers of physics or biology (especially focused on concepts) different with respect to content? Does that explain the difference in using analogies? Or does strategy instruction (reading and writing strategies, analyzing literary texts) require a different kind of analogy? Cf. Curtis (1988) and Iding (1997).
- Is the previous point connected with the nature of the academic disciplines and corresponding opinions on, and the content of, school subjects? Is biology in secondary education an academic subject and English a hands-on subject? Cf. Grossman & Stodolsky (1995). Does subject matter create distinctive operational contexts for teachers? Cf. Stodolsky & Grossman (1995).
- How are different types of analogies used for different purposes, even if teachers don't realise they are doing so? This is probably an interesting empirical issue for follow-up research.
- Is it possible to study academic subjects using research tools and theoretical frames that are not adapted to the different subjects? Does research on L1 require other tools than research on science teaching?

With respect to some conclusions, it is necessary to include some restrictions here regarding generalisations, because the research dealt only with six teachers.

All the teachers had perceptions of difficult content in mother-tongue education. They differed in their perceptions with respect to areas of student difficulty and did not analyze the problem of difficult content by mentioning categories or causes. They mentioned direct examples from practice, without much reflection. Reading comprehension, writing proficiency, literature, and

grammar were the most frequently mentioned difficult topics. Their practical knowledge with respect to student characteristics was very personal, intuitive, and situative. With respect to language education, first of all the students' own planning of strategies is relevant as a degree of difficulty. More reasons were found here than distinguished by Magnusson et al. (1999).

Although various forms of representation were used, analogies did not play a prominent part. Strategies and examples were often mentioned. There was a mix of cross-curricular strategies (broadly applicable) and topic-specific strategies (much narrower in scope).

There is no need for a model like 'Teaching-with-analogies' (as distinct from the need of science teachers for such a model). During the interview, the model (see Appendix B) sometimes triggered examples of analogies. Teachers who themselves had few analogies available, nevertheless considered such a model beneficial for student teachers. Theory is useful . . . for others.

In preparing a lesson in which an analogy will be used, the teacher has to consider some points: the degree of difficulty of the topics, the degree of novelty, prior knowledge of students, familiarity with the analogy. Cf. Treagust et al. (1998). We did not find this: practice is determined by intuitions and ad hoc solutions. Some solutions are well-known aspects of PCK, for instance, the connection to the students' common experiences and the real-world experiential knowledge that students need to comprehend new content. We found that the key elements in the conception of PCK, the relationship between areas of student difficulty, and representations, were less obvious; the number of analogies used was disappointing. An interesting conclusion could be that teachers do not need analogies to teach mother-tongue.

If the difference between science education and language education is a matter of using analogies versus using stories, strategies, and examples, there are important implications for teacher education in these disciplines. What about the course content regarding components of PCK that are not used by experienced teachers? That is certainly an issue for further research.

APPENDIX A

Analogies

Analogies provide an explicit comparison between one area of knowledge and another area of knowledge that is completely outside the first (Ortony, 1979).

Examples of analogies (not language teaching):

Water flowing through pipelines for the electric circuit.
Marbles for gas molecules.
Lock and key model for function of DNA.
A computer for the brain.
A camera for the human eye.

A factory for a cell.
 A small town for a factory.
 Baking bread for photosynthesis.
 The heart is like a pump.

APPENDIX B

The Teaching-with-Analogies (TWA) model

Glynn (1989, 1996) describes a strategy to use analogies in connection with the prior knowledge of students to facilitate the learning of new concepts. His TWA model consists of six operations. The order in which the six operations are carried out can vary. It is usually important, however, to perform all the operations.

1. Introduce the target concept to be learned.
2. Review the analog concept.
3. Identify relevant features of target and analog.
4. Map similar features.
5. Indicate where the analog breaks down.
6. Draw conclusions.

In this model, ideas from a familiar concept (the analog) are transferred to an unfamiliar one (the target). If the analog concept and the target share some similar features, an analogy can be drawn between them. The process of comparing the features is called mapping.

Analog and target are often examples of a superordinate concept.

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