

8. PRIMARY TEACHERS' ATTITUDES TOWARDS SCIENCE AND TECHNOLOGY

Results of a focus group study

INTRODUCTION

The study on primary teachers' attitudes towards science and technology has received considerable research attention over the last decades. However, if one looks at the extant literature in this domain, a major problem that becomes apparent is the lack of consistency in the conceptualization of what is meant by teacher attitudes. Attitude is a complex and multidimensional construct and a clear definition and thorough theoretical understanding are essential for research in this area. The present chapter is intended to shed more light on this construct and to present the results of a focus group study amongst pre- and in-service primary teachers that investigated both their personal attitudes towards science and technology and their attitudes towards teaching science and technology at primary school level.

Primary teachers' attitudes towards science have been investigated in a range of scientific studies world wide, but scientific progress in this field is slow due to several major theoretical and methodological issues (Bennett, Rollnick, Green, & White, 2001; Gardner, 1995; Kind, Jones, & Barmby, 2007; Osborne, Simon, & Collins, 2003). Most importantly, both in research and in educational change projects, the concept of an attitude towards science is often poorly articulated (Barmby, Kind, & Jones, 2008; Bennett et al., 2001; Coulson, 1992; Osborne et al., 2003; Pajares, 1992). Many studies do not, or incompletely, define the construct of attitude, do not explicate the different components of attitude that they measured, or do not make a distinction between attitudes towards science and related concepts, such as opinions or motivation. It is, therefore, difficult to determine what precisely was measured or investigated and, as a consequence, to determine if it actually is attitude that was investigated in these studies (Blalock et al., 2008). Furthermore, most researchers do not offer explanations for the choices they have made as to what components of attitude or attitude objects they selected to measure. These choices often seem to be based on pragmatic or convenience arguments.

The above-described lack of consistent definition and theoretical underpinning has led to a great variety of measurement instruments aimed at investigating teachers' attitudes towards science and technology. For example, some studies focused mainly on the affective components of attitude (e.g., Hartshorne, 2008; Ramey-Gassert, Shoyer, & Staver, 1996), while others focused exclusively on self-efficacy (e.g., Palmer, 2006; Wenner, 1993, 1995). In addition to (and probably also because of) the poor theoretical definition of what constitutes primary teachers' attitudes towards science and technology, many studies used measurement instruments that were poorly designed and that were not tested according to current methodological standards (Blalock et al., 2008; Coulson, 1992; Gardner, 1995; Reid, 2006). As a consequence, the results of the different studies cannot be compared nor replicated (Pardo & Calvo, 2002).

In an attempt to remedy these issues, the overall research project, of which the current chapter is part, is focused on disentangling the construct of primary teachers' attitudes towards science and technology. In a related review article (Van Aalderen-Smeets, Walma van der Molen, & Asma, in press) we aimed to explicate and structure the range of underlying components or dimensions of primary teachers' attitudes towards science and technology and we related these components to general psychological attitude theories. Based on this theoretical exercise, we developed a new measurement instrument: the Dimensions of Attitudes towards Science and Technology questionnaire (DAST). After construction of the first version of the DAST, we investigated its validity and reliability by means of a quantitative survey study and a qualitative in-depth focus group study, which is reported in this paper. Although the qualitative study was primarily intended to examine some important theoretical assumptions underlying the DAST, the results of the study proved to be essential for

further improvement of the survey instrument. As will be shown in the results and discussion sections of this chapter, interesting implications of teachers' beliefs and emotions were discerned that would not have been uncovered by means of a quantitative survey only. Before describing the method and results of our focus group study, we will first present the reader with an overview of the theoretical considerations that form the basis of the DAST and that were evaluated in the focus group study.

Theoretical Considerations

Attitude is not a single unitary concept, but a construct consisting of multiple subcomponents and attributes. The separate evaluations of each of these attributes contribute in varying degrees towards the overall attitude towards the object (Ajzen, 2001). Or, as Pajares (1992, p. 314) describes: "When clusters of beliefs are organized around an object or situation and predisposed to action, this holistic organization becomes an attitude". The overall psychological construct of attitude is often divided into three components: cognition, affect and behaviour (Eagly & Chaiken, 1993).

The cognitive component of attitude encompasses evaluative thoughts and beliefs a person has about the attitude object. In our case, this could be the belief that science is hard to understand, the belief that men are more interested in and better suited for a career in technology, or the belief that science is of essential economic value. These beliefs may range from a positive to a negative evaluation of attributes and everything in between.

The second component of attitude is affect. This component consists of feelings and moods a person experiences in relation to the attitude object. For instance, feelings of anxiety when confronted with science teaching or feeling a sense of insecurity when being asked questions about a technological problem. A positive attitude is characterized by the experience of positive physical reactions and emotions when confronted with the object, while a negative attitude is accompanied by negative affective reactions.

The third component of attitude is behaviour, which constitutes the behavioural response or action a person engages in when confronted with the attitude object. This response can be overt, in which case the person is actually acting out the behavioural response or action (e.g., teaching science and technology in class every Tuesday at 10 am). But the response may also be covert, in which case the person is intending to act out the behaviour or action but the action is not yet taking place. This covert response, labelled behavioural intention, is more frequently measured in surveys of primary teachers' attitudes towards science than the overt behaviour. Whether or not the intention to engage in certain behaviour is carried out is dependent on different circumstantial conditions at that time and place (Ajzen, 2001). The three components of attitude refer to the attitudinal responses a person has in relation to the attitude object (cognitive response, affective response, and behavioural response), but also to the different processes underlying the formation of an attitude.

Apart from the necessity of a distinction between different components or dimensions of attitude, it is important to distinguish between different objects of attitude. The attitude object is the entity or thing with respect to which an attitudinal evaluation is made; it is the object of evaluation. At first hand, this seems a simple description, but in many studies there is a lack of clarity on this subject. Many studies measure multiple objects of attitude (e.g., general attitude towards science, attitudes towards science in high school, or attitudes towards effective teaching of science) as if it were one attitude object, without even mentioning possible theoretical distinctions. In addition, different attitude objects are often blended to yield one overall score of attitude towards science. One common example of the blending of attitude objects is when questions on teachers' personal attitude towards science and questions on their professional attitude towards teaching science are intermixed.

In our view, personal attitude towards science and technology refers to the attitude a person has as a citizen, independent of that person's profession (in this case teaching at primary school level). Examples of this general attitude are: someone's beliefs about the historical or economic relevance of science for society or daily life and the general interest in or affect towards informing oneself about science and technology via different media. In contrast, a teacher's professional attitude towards the teaching of science and technology in primary school refers to the beliefs and feelings that he/she may have with respect to teaching these topics within the school context, such as beliefs about the appropriateness and importance of science and technology for

children at primary school level, or feelings of joy or anxiety towards teaching these topics.

To our knowledge, thus far only three studies attended to a possible distinction between primary teachers' personal and professional attitude towards science and technology (Atwater, Gardner, & Kight, 1991; Harty, Samuel, & Anderson, 1991; Koballa, 1986). Although these studies indicate that the two concepts should indeed be treated as distinct, albeit related, the measurement instruments that were used are problematic or were not reported in the articles. Further research, using both qualitative and quantitative methods, should therefore investigate how primary teachers consider these two objects of attitude and how the two might be related. To that end, the DAST is divided into two parts that each measures the different dimensions of attitude and related constructs. The first goal of the present focus group study was to validate this distinction and to explore how primary teachers perceive the two objects of attitude and possible relations between them.

A second goal of the focus group study was to find out which components of the tripartite model of attitude (affective, cognitive, and/or behavioural) primary teachers refer to when discussing their personal attitudes towards science and technology and their attitudes towards teaching science and technology. Furthermore, we explored how Bandura's concept of self-efficacy is related to the cognitive, affective, and behavioural components of attitude. Self-efficacy refers to the perceived capability, or confidence, a person has to perform a particular behaviour that may contain difficult and stressful elements (Bandura, 1997). A large number of studies that investigated attitudes of primary teachers towards teaching science and technology focused on the concept of self-efficacy (e.g., Coulson, 1992; Palmer, 2001, 2006; Ramey-Gassert et al., 1996; Skamp, 1991; Tosun, 2000; Wenner, 1993, 1995; Yates & Goodrum, 1990). In most of these studies, however, self-efficacy was not explicitly related to other dimensions of attitude. Although many primary teachers' indeed seem to feel insecure about their teaching of science and technology, it should be investigated how the concept of self-efficacy is related to primary teachers' beliefs, feelings, and behaviour towards (the teaching of) science and technology and whether other, perhaps previously neglected factors, might play a role.

METHODS

Participants

Participants were in-service and pre-service primary teachers from the Netherlands. In total, 84 teachers participated in the study (12 male, 72 female; 38 in-service, 46 pre-service). The group of in-service teachers was mixed: some just started their careers as teachers, others were very experienced. On average, the teachers had 17 years of experience. The pre-service teachers were in their third year of study and had teaching experience through internships. In the relevant literature we found no indication that there is a difference between pre- and in-service teachers on their attitudes towards science and technology and teaching science and technology. Therefore, results of in-service and pre-service teachers were summed, with the exception of some instances where clarification of results made a distinction necessary.

The total group of in-service and pre-service teachers was divided into three groups, based on their level of training in teaching science and technology. The first group consisted of elaborately trained primary teachers who had participated in a training program on science and technology education. Within this group, the in-service teachers had previously participated in the national VTB-Pro program aimed at the professionalization of primary teachers into teaching science and technology. The pre-service teachers in this group had taken part in a minor on science and technology education as part of their study. The second group of teachers had previously received some training (between one and five lessons) on science and technology education. The third group consisted of teachers who received no prior training on teaching science and technology. Five focus group discussions were conducted for every level of training; which led to a total of fifteen focus group discussions. By dividing the teachers in groups based on their level of prior training, we were able to compare their insights about the objects and components of their attitudes towards science and technology and examine possible differences between the three groups.

Procedure and protocol

We decided to conduct focus group discussions to examine the attitudes of teachers towards (the teaching of) science and technology because this research method is well-suited for exploratory research. Focus groups may provide a natural setting in which people normally state and form their opinions and attitudes. Therefore, discussions took place at a familiar setting: either at the participating primary schools or at the participating colleges for teacher training.

We used a semi-structured protocol for every focus group discussion to make sure that differences between focus groups were minimized and that the same procedure was followed in every discussion. The protocol consisted of four parts: an introduction on focus groups and the topic of discussion, an explanation of what is understood by science and technology in the present study, questions on the attitudes teachers have towards science and technology, and concluding remarks on the most important aspects of the discussion. The questions on attitudes were focused on the difference between professional and personal attitude and the different components and concepts that may play a role in either the negative or positive attitudes that pre- or in-service teachers may experience towards (the teaching of) science and technology.

The discussions were guided by one or two of the authors. The first focus group discussion was conducted by two researchers to streamline the procedure and minimize the differences in interview styles. The group interviews lasted between half an hour and one hour.

Data-analysis

The focus group discussions were audio taped and notes were taken. Subsequently, a detailed report was made of each focus group discussion. For each focus group, all statements relating to science and technology were marked in the report. These statements were listed in a data file in order to obtain a comprehensive list of the relevant statements and issues from the total number of group discussions. This list was used to score the occurrences of statements for all discussions. When a statement occurred it was given the score '1', if it did not occur it was scored as '0'. Scores for the five focus groups within one level of training were summed. Remarks were subdivided between personal and professional attitude and categorized as relating to the different components of attitude that were mentioned in the introduction.

RESULTS

Below, we start our results section with a broad overview of teachers' own thoughts about a possible distinction and/or relation between personal and professional attitude that we observed in our study. Subsequently, we will examine teachers' remarks on professional and personal attitudes more closely, in order to find out which components and underlying attributes of attitude and related concepts were exactly referred to in the discussions. Overall, we found that teachers predominantly talked about their professional attitude and that relatively little information were provided on their personal attitude towards science and technology. Because of the relatively large amount of remarks on professional attitude, in our presentation of results, we provide separate overviews for positive and negative remarks, self-efficacy and other factors. Our presentation of teachers' accounts of their personal attitude will be kept simpler.

Professional versus personal attitude

One major goal of our study was to find out whether teachers perceive a distinction between their personal and professional attitude towards science and technology. In *every* focus group discussion, teachers claimed to experience a difference. Some teachers stated to have a positive attitude towards teaching science and technology, but a negative attitude towards science and technology in daily life. Furthermore, teachers said that they thought it was possible to have no personal interest in science and technology whatsoever, but to be aware of the importance of teaching it to primary school children. From these results, we infer that primary teachers' personal and professional attitudes towards science and technology should indeed be treated as separate constructs. In the remainder of the results section, we will show that responses to both attitude objects differ considerably for professional and personal attitude.

When discussing a possible relation between personal and professional attitude, teachers were less unanimous. Some teachers who received no or only little prior

training in science and technology stated that the two do not influence each other. Examples of such responses are: 'If you have to teach it, you will' and 'in your own time you can do whatever you like, but not at school'. However, most of the less-trained teachers made contradictory statements that actually did reveal a perceived (causal) relation. Many teachers especially ventured the belief that personal attitude influences the way science and technology is taught. 'Teachers with a positive personal attitude teach in a more enthusiastic way' and 'teachers with a positive attitude show how things work in real life, not through pictures or videos.' Comparable comments, on the influence of personal attitude on professional attitude, were also made by other more elaborately trained teachers. Some statements were: 'If you are interested in something, you will teach that subject more frequently, and in a better and more extensive manner' and 'in free teaching hours, teachers will spend time on what they are interested in.' Some elaborately-trained teachers mentioned that to them, a positive personal attitude resulted in less fear of failure and a more constructive way of dealing with frustrations in teaching science and technology.

In addition to a perceived influence of personal attitude on professional attitude, teachers also reported that they experienced influences in the opposite direction. Teachers that had received elaborate prior training stated that their training, although mainly focused on professional attitude, indirectly influenced their personal attitude as well. They observed that the training had stimulated them to be more conscious about science and technology in their daily life. It should be noted, however, that such heightened interest and consciousness was mainly directed at the possibilities of everyday science and technology phenomena that they might use in their classes at primary school.

Professional attitude

The focus of the pre- and in-service teachers during our discussions was largely on their professional attitude. Table 1 lists the remarks made on the different attitude components that pertained to professional attitude, for teachers who received no, little, or elaborate prior training in science and technology.

Positive remarks Overall, teachers in the three training groups were about equally positive about teaching science and technology. Often, teachers stated that they enjoyed teaching science and technology and that they experienced enjoyment among their pupils as well (affective component). Furthermore, some teachers explicitly referred to the importance of gender equality and the stimulation of both boys and girls in science and technology (cognitive component). In addition, most teachers stated that science and technology are relevant to children and that they thought it was an important topic to teach at primary school level (cognitive component). However, it should be noted that teachers who had only little or no prior training in science and technology had difficulty explaining *why* science and technology at primary level are important. In contrast, the elaborately trained teachers were able to provide explanations. Their remarks were predominantly focused on the contribution of science and technology to children's 'personal knowledge', 'increased consciousness of their environment', 'safeguarding against consumer society' and 'increased vocabulary'.

Table 1. Number of remarks on professional attitude towards science and technology

<i>Attitude components</i>		
<i>No training</i>		
<i>Little training</i>		
	<i>Elaborate training</i>	
Positive cognitive factors	4	6
	5	
Positive affective factors	8	9
	8	
Total positive	12	15

	13
Negative cognitive factors	9
	11
	0
Context factors	21
	21
	5
Self-efficacy	1
	2
	0
Total negative	31
	34
	5

Negative remarks As listed in Table 1, the three training groups did differ considerably in their accounts of negative aspects. Elaborately-trained teachers made few negative remarks about teaching science and technology, while teachers who received no or little training made numerous negative remarks. As listed, responses predominantly pertained to negative cognitive factors and remarks about perceived contextual circumstances that might hinder the teaching of science and technology (such as perceived lack of materials or support from the school board).

Teachers who received no or only little prior training stated that they experienced a lack of knowledge about science and technology in general and about teaching science and technology in particular. As a consequence, they believed that science and technology were difficult to teach (cognitive component). In addition, the untrained pre-service teachers said that there was little attention for the topic in their teacher education. Although a fair number of teachers who received no or little prior training did state that science and technology are relevant and important to primary school children (see section on positive remarks), they also believed that mathematics, reading, and writing should have higher priority in primary education. Overall, although teachers responded positively to the importance of teaching science and technology, teachers that received no or only little prior training perceived a range of obstacles that, in their view, hinder implementation at primary school level. Because these beliefs are qualitatively different from other cognitive attitude components, we have labelled these beliefs under the heading 'context factors'.

Context factors From both the literature and our own practical experience, we knew that many primary teachers are inclined to mention contextual circumstances when they are questioned about their intention to teach science and technology. At the onset of our study, however, we did not anticipate that teachers' emphasis on context factors would be so prominent. In many of our focus group discussions, teachers mentioned that they did not succeed in implementing science and technology into their teaching on a structural basis due to lack of school support and insufficient school organization. In addition, teachers mentioned that they experienced other external obstacles, such as lack of materials, lack of time, and lack of money and a good method to teach science and technology. Also, many of them thought that teaching science and technology takes too much time to prepare.

Interestingly, however, our results showed a considerable difference between, on the one hand, pre- and in-service teachers that had received no or only little prior training in science and technology and on the other hand, teachers who were trained in a more elaborate way (see Table 1). Overall, teachers in the two former groups felt that teaching science and technology on a regular basis is too complex, due to the external obstacles mentioned above. The more elaborately trained teachers, however, seemed to have overcome such obstacles and expressed a very different perception. Some illustrative statements made by elaborately-trained teachers were: 'If they [teachers who perceive external obstacles in teaching science and technology] would understand the broadness of science and technology, they would know that teaching science can be done in a much simpler way, with less time investment and less expensive materials.' And: 'Many teachers are not prepared to teach science and technology and cannot see the possibilities; they only see the mess and the extra work'. Also, many of the well-trained teachers explained how they integrated science and technology

lessons into other subjects in class, which makes it less time-consuming and more related to compulsory math and reading lessons. They also stated that by using the right inquiry-learning didactics, teachers might invest less preparation time and leave a larger proportion of the lessons to pupils.

Self-efficacy As listed in Table 1, teachers did not disclose a lot of personal notes on their own feelings of insecurity or perceived lack of capability. Some teachers confessed that they felt insecure or were anxious about potential difficult questions by their pupils. But, overall, teachers did not refer to such ‘internal obstacles’, not even when they were questioned about it explicitly. In the focus groups with elaborately trained teachers, self efficacy was a topic of discussion, but these teachers referred to the low self-efficacy of their untrained colleagues (Table 1 only lists remarks that teachers made about their own beliefs and emotions, not about the perceived attitudes of others). According to well-trained teachers, low self-efficacy plays a large role in teachers’ reluctance to teach science and technology. In their view, however, low self-efficacy can be conquered if one learns to develop a different attitude. Examples of observations made by elaborately-trained teachers were: ‘Many teachers are afraid of failure, but one needs to learn that in science and technology education not everything has to succeed’, ‘Many teachers need structure and something to hold on to, while science and technology education needs space’, and ‘Teachers need to learn to deal with the chaos and mess that science and technology education can cause’. The elaborately-trained teachers disclosed that, prior to their training, they also experienced cold feet but that the training diminished their fear and reluctance. Interestingly, one teacher stated that after the training the bar was *less* high. ‘We understand now that we do not have to know everything about science and technology and that we can just start with what we already are familiar with.’

Personal attitude

As mentioned before, teachers expressed relatively few thoughts, beliefs, and feelings that related to science and technology in their personal lives. Table 2 lists the components of personal attitude that were discussed.

Table 2. Number of remarks on personal attitude towards science and technology

Attitude components

No training

Little training

Elaborate training

Positive cognitive factors

1
0
0

Positive affective factors

9
4
9

Total positive

10
4
9

Negative cognitive factors

7
5
0

Negative affective factors

0
3
0

Total negative

7
8
0

No opinion

2
0

As listed, almost all positive comments on personal attitude towards science and technology were on affective factors. Irrespective of type of prior training, in all groups some teachers mentioned that they enjoyed watching or reading about science and technology and found it fun and interesting. It should be noted, however, that in many of these positive remarks, teachers referred to technical applications that directly affected their personal life, such as enjoyment in working out the functions of their mobile phone. Elaborately-trained teachers stated that their increased focus on science and technology had made them wonder about the world around them.

Negative remarks were predominantly focused on cognitive factors, such as difficulty and, to a smaller extent, gender differences. Teachers who had received little or no prior training mentioned that in their personal lives they were not interested in science and technology and some even said they thought it was boring. Furthermore, these teachers mentioned to experience a lack of knowledge and some of them believed that men are more interested in science and technology than women are. In addition to these specific beliefs, several teachers also stated that they simply had a negative attitude towards science and technology in their personal life and that they felt so little affinity with the topic that they felt unable to form an opinion about our questions on personal attitude. For the same reason, they disclosed that they had difficulty answering the survey questions on personal attitude that we pilot-tested among them.

As was found for professional attitude, differences between groups of teachers with different levels of prior training were observed only with respect to negative remarks. On average, teachers from all groups were about equally positive about science and technology in daily life. However, teachers with little or no prior training in science and technology also held negative personal beliefs, whereas teachers that were more elaborately trained did not mention any negative aspects.

DISCUSSION

The results of the present study confirmed our assumption that primary teachers perceive a difference between their professional and personal attitude. When asked explicitly, the majority of the (pre-service) primary teachers in our sample stated to experience a difference between the two attitude objects. In addition, they reported that in their view the two constructs could develop independently. Most notably, when probed about the different underlying components and sub-attributes of their attitudes, teachers predominantly talked about their professional attitudes towards teaching science and technology and reported having very little feelings for or beliefs about these topics in their daily life. Furthermore, some teachers clearly had a more positive attitude towards teaching science and technology than towards science and technology in their personal life. Apparently, the two attitude constructs can develop to a different extent and in different directions. In our view, teachers' distinctive approach towards their personal and professional attitude towards science and technology underscores the importance of treating personal and professional attitude as two separate objects of attitude in future qualitative and quantitative studies.

Apart from investigating a possible distinction between teachers' personal and professional attitude towards science and technology, a second goal of our study was to find out which components and sub-attributes of the tripartite model of attitude (affective, cognitive, and/or behavioural), and the related concept of self-efficacy primary teachers refer to when discussing their attitudes towards science and technology. What are the aspects of attitude they spontaneously come up with in an informal conversational setting? The results of our study showed that respondents focused mainly on the cognitive and affective components of attitude. No remarks that could be categorized as relating to the behavioural component of attitude were made. Furthermore, teachers hardly commented on their self-efficacy. Instead, the less-trained teachers referred largely to external obstacles in their teaching environment. In the remainder of this discussion, the results that relate to the tripartite model of attitude are discussed in more detail. Subsequently, we will examine the theoretical implications of the results for self-efficacy and context factors.

Reconsidering the tripartite model

Initially, we set out to investigate teachers' attitudes as consisting of cognitive, affective and behavioural components. During our focus group discussions, however, teachers only mentioned their beliefs and feelings and did not come up with behavioural attitudinal aspects. This may suggest that the pre- and in-service teachers

in our sample do not view their behaviour and behavioural intention as part of their underlying attitude. This finding corresponds with the way attitude is considered in the influential Theory of Planned Behaviour (TPB) (Ajzen, 1991). According to the TPB, attitude (together with subjective norm and perceived behavioural control) determines behavioural intention, which is the immediate motivational factor for behaviour itself. According to this theory, attitude consists of a cognitive, or evaluative, component and an affective component. Behavioural intention is viewed as a direct outcome of these two attitude dimensions and not as a component of attitude itself.

The sub-attributes of cognition and affect that we found in our present focus group study are highly similar to the attitude attributes that we put forward based on our theoretical examination of previous literature in this domain (see Van Aalderen-Smeets et al., in press). Most importantly, the teachers in our sample did not refer to any unexpected aspects of attitude that deviated from the attributes that we found in our large scale literature review. Furthermore, many of the attributes found in the literature were also spontaneously mentioned by the teachers during our focus group discussions. This implies that the attributes of the cognitive and affective components that we hypothesized based on our examination of the literature are indeed corroborated by the discussions that we had with the pre- and in-service teachers on their attitudes towards science and technology. The cognitive aspects of professional attitude that were discussed are: relevance of science and technology for pupils, gender differences in enjoyment of or achievement in science and technology, and difficulty of teaching science and technology. The cognitive remarks that related to personal attitude were scarce and focused mainly on difficulty. The affective responses for both professional and personal attitude were focused on enjoyment or dislike of (teaching) science and technology.

Reconsidering self-efficacy and perceived influence of context factors

For self-efficacy the results were somewhat different than we expected. To our surprise, the teachers in our sample hardly mentioned their own feelings of insecurity or low confidence in teaching science and technology. This contrasts with several previous studies that did find that many teachers display low self-efficacy in this domain (e.g., Tosun, 2000; Yates & Goodrum, 1990). One possible explanation may be related to the research method that we used: it might be that teachers felt reluctant to disclose their uncertainties in front of colleagues or classmates during our focus group discussions.

However, an alternative explanation may be sought in the fact that many previous studies did not measure self-efficacy in combination with other components of attitude or related concepts. As a consequence, in previous studies teachers have been unable to display their beliefs and emotions on related constructs and aspects of attitude and were forced to focus exclusively on their (lack of) self-efficacy. Because self-efficacy has been measured as the only indicator of teachers' attitude towards science in quite a number of studies (and in some ways has even been equated with attitude), it could be argued that its role has perhaps been somewhat overestimated. Thus, even if teachers felt that their attitude towards science and technology depended on other aspects as well, they were unable to express this in the closed survey items that were focused primarily on self-efficacy.

In contrast, during our focus group discussions, teachers were able to talk freely about their attitude and related concepts and were not restrained by a limited survey. Interestingly, even when asked explicitly about their personal self-efficacy, many teachers reported that they did not experience low self-efficacy per se and were quite confident about teaching science and technology. In our view, this implies that in order to genuinely find out which aspects of attitude may hinder teachers to teach science and technology, it is important to examine self-efficacy in relation with other components and attributes of attitude.

Our results show that the teachers in our sample did not necessarily perceive self-efficacy as the main reason for their reluctance to teach science and technology. Rather than disclosing internal obstacles, such as insecurities about teaching science and technology or fear of difficult questions by pupils, the teachers in our study referred to external obstacles, such as lack of suitable materials, lack of a structured science and technology teaching-method, and lack of preparation time. This implies that context factors may play a large role in teacher attitudes towards science and technology. However, this aspect has thus far been hardly examined in conjunction with other attitudinal aspects in empirical studies on teacher attitudes towards science and technology (Van Aalderen-Smeets, in press) and its influence on actual teaching behaviour thus remains largely unclear. In the present study, we observed that the less-

trained teachers focused on external obstacles to quite a large extent, while the elaborately trained teachers held very different perceptions on the importance of structured materials and methods. This interesting difference is reflected on in more detail below, where we will show that teachers' differential perceptions of internal and external factors that may hinder (or foster) their teaching of science and technology could be integrated in a new theoretical framework of teachers' attitudes towards science and technology.

Implications for further research

The results of the present study have led to two implications for our overall research project and further research in this area. First, the results of the present focus group study contributed to our understanding of the underlying dimensional structure of primary teachers' attitudes towards science and technology, which is reflected in our formulation of a new theoretical framework. Second, it provided valuable insights for the development of an integrated attitude survey instrument that we would not have gained if we would have tested the instrument by means of paper-and-pencil methods only. These implications are clarified below.

Theoretical framework for attitude

Our large-scale review of the literature and the present focus group study instigated us to formulate a new theoretical framework for primary teachers' attitudes towards science and technology, which consists of three components and seven underlying attributes (see Figure 1). In our view, the proposed framework is suitable for describing both the professional and personal attitude of primary teachers towards science and technology. As can be seen in Figure 1, the framework integrates previous theoretical considerations as formulated in the Theory of Planned Behaviour, findings from previous studies on teachers' attitudes towards science and technology, and our present findings that relate to teachers' perceptions of self-efficacy and their perceived dependency on contextual factors. In our new framework, the cognitive and affective component of the original tripartite model remain and consist of sub-attributes that were found both in the present study and in previous studies (although in previous studies these attributes were not investigated in conjunction). However, the original tripartite model was revised in two ways: based on the results of our focus group study and in line with the Theory of Planned Behaviour, we excluded the behavioural component as part of the underlying construct of attitude and added a new third component that we labeled 'Perceived Control'.

Note: The same framework is suggested for both personal and professional attitude towards science and technology

Figure 1. New framework for primary teachers' attitudes towards (teaching) science and technology

Results from our focus group study showed that teachers made no comments on behaviour or behavioural intention as part of their attitudes towards (teaching) science and technology. Based on these results and on our re-evaluation of the extant literature on the psychological concept of attitude, we agree with Ajzen (1991) that behaviour and behavioural intention are conceptually different from attitudes and that this component should not be part of the construct of attitude itself. Instead, attitudes should be viewed as antecedents of behavioural intention, which among other things determines actual behaviour. Therefore, in our new framework, behaviour and behavioural intention are included as outcomes of attitude and not as part of the theoretical construct of attitude itself.

Instead of behaviour and behavioural intention as a third component of attitude, we propose a new third component, of which self-efficacy is part. Our review of the literature showed that many researchers have studied self-efficacy as a main attitudinal predictor of the teaching of science and technology at primary school level (Van Aalderen-Smeets et al., in press). Although the pre- and in-service teachers in the present study did not disclose a lack of self-efficacy, we agree that self-efficacy should be included in a complete framework of primary teachers' attitudes towards science and technology. However, if we want to form a complete picture of the role that different aspects of attitude might play, self-efficacy should not be investigated in isolation but in conjunction with other components and attributes. Theoretically, we suggest that self-efficacy is neither part of the affective nor the cognitive component of attitude, because self-efficacy is qualitatively different from both. In our view, self-efficacy consists of both cognitive and affective aspects that are focussed on people's internal beliefs about and feelings of being in control to execute particular behaviour or not.

The results of the present study have shown that apart from internal beliefs and feelings that adhere to self-efficacy, an additional aspect that seems to be closely related to teachers' sense of 'being in control' concerns the beliefs and feelings that teachers have about external, or contextual factors. In our view, teachers' perceived dependency on context factors (such as their belief that they can only teach science and technology when their school takes care of the right materials and enough preparation time) cannot be left out of a complete theoretical framework of primary teachers' attitudes towards science and technology. On the contrary, we believe that together with self-efficacy (which reflects teachers' internal perception of control) it should be included in a dimension that we call 'Perceived Control'. It should be noted that we deliberately refer in this label to teachers' *perception* of being in control. Similar to the cognitive and affective dimensions of attitude that are necessarily subjective, this new component reflects someone's subjective beliefs and feelings about internal and external obstacles, not the factual presence of such obstacles.

Ajzen (2002) proposed that perceived external, contextual obstacles should be viewed as a part of self-efficacy. However, the results of the present study suggest that teachers' dependency on context factors may differ from their self-efficacy. Overall, the teachers in the present study felt to have sufficient self-efficacy, but a large group still perceived low control in teaching science and technology because they felt that they could not teach science and technology without the right materials or methods provided to them. Measuring both aspects as one attitudinal attribute would make it impossible to deduct these clearly different aspects and would hinder a distinction between different combinations of the attributes. In our view, theoretically teachers could be (a) low on self-efficacy and highly dependent on context factors, (b) high on self-efficacy, but still highly dependent on context factors, or (c) high on self-efficacy and not dependent on context factors. These three categories reflect increasing levels of confidence or a sense of being in control. A fourth possibility, in which teachers would be low on self-efficacy and not dependent on context factors at the same time, seems less realistic. Because both constructs are clearly related but in theory do not always need to point in the same direction, unlike Ajzen (2002), we included them as separate sub-attributes of the dimension that we labeled perceived control.

Integrated attitude instrument

Our revised framework for primary teachers' attitudes towards science and technology provided us with valuable insights for the development of a new and integrated attitude instrument, the Dimensions of Attitude towards Science and Technology questionnaire (DAST). The DAST is an instrument that consists of two separate questionnaires: one that measures the professional attitude of teachers and another that measures their personal attitude. Unlike most previous studies, in which attitude items on different attitude objects were intermixed (see Van Aalderen-Smeets et al., in press), we believe that measuring professional and personal attitude separately leads to a more reliable and valid investigation of teacher attitudes. For both questionnaires, sub-scales were included that were directly derived from the seven underlying attributes of the new theoretical framework.

Although some previous survey instruments measured certain aspects of teachers' attitudes, self-efficacy, or dependency on context factors, thus far no attitude instrument was developed that measures the total construct of primary teachers' attitudes towards science and technology, including our newly proposed component of perceived control. The STEBI, developed by Enoch and Riggs (1990), is a much-used instrument measuring self-efficacy. It combines the measurement of self-efficacy with items on teacher outcome expectancy, but does not include the measurement of teachers' perceived dependency on context factors or other components of attitude. Lumpe, Haney, and Czerniak (2000) developed the CBATS (Context Beliefs About Teaching Science) to measure the influence and occurrence of context factors. But, this instrument also does not combine the measurement of perceived external obstacles with other aspects of attitude or self-efficacy. As mentioned previously in this discussion, in the above-described studies teachers were thus unable to display their beliefs and emotions on related constructs and aspects of attitude and were forced to focus exclusively on one or some aspects of attitude. Because of this, primary teachers' interrelated beliefs about and feelings towards different components and attributes of their attitudes towards science and technology still remain unclear and, as a consequence, interventions that are aimed at increasing teachers' attitudes still fall short on including the complete range of attitudinal aspects.

Concluding remarks

To summarize, we believe that the present qualitative focus group study uncovered important insights that would not have been uncovered with the use of survey research only. The present study has important implications for both the creation of a reliable and valid attitude instrument and the theoretical development of the concept of primary teachers' attitudes towards science and technology. Based on the theoretical framework and the present study, the DAST was revised and the underlying components and attributes can now be studied with large groups of in-service and pre-service teachers. In future research, we may now further investigate the distinction between teachers' personal and professional attitudes towards science and technology and we may develop professionalization interventions that are targeted at specific attitude attributes and measure the effects of these interventions with the appropriate sub-scale of the DAST and evaluate the outcomes relative to scores on other sub-scales.

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