Curious minds in the classroom

Wetzels, Anna

CHAPTER 4:

The Effect of a Coaching Program on Teachers' Well-being in Science and Technology Lessons in Primary Education

This chapter is submitted as:
Wetzels, A.F.M., Steenbeek, H.W., & Van Geert, P.L.C. (2015).
The effect of a coaching program on teachers' well-being in science and technology lessons in primary education.
Manuscript submitted for publication.

CHAPTER 4:
The Effect of a Coaching Program on Teachers' Well-being in Science and Technology Lessons in Primary Education

4.1 Introduction

Teachers' well-being is an important factor that co-determines the quality of their teaching (Osborne et al., 2003), which in turn greatly influences pupils' academic performances (Barber & Mourshed, 2007; Rowe, 2003). Well-being is the result of a person's position on two independent dimensions: positive affect and negative affect (Bradburn, 1969; Diener, 1984). The more the positive affect exceeds the negative affect, the higher the feeling of well-being will be. Well-being and happiness are related terms in that they describe almost the same phenomenon, although well-being has a more neutral meaning than happiness. Teachers' (subjective) well-being is not something static and stable, but is a dynamic property, which is constantly being influenced by, and influences other, components of their teaching, such as teachers' feelings of self-efficacy, and the quality of the relation with their pupils (R. G. Lambert, McCarthy, O'Donnell, & Wang, 2009; Sugden, 2010). There is also a constant mutual influence between the quality of teachers' work and their level of well-being on the one hand and influences from the school-context on the other hand, such as school directors' demands to implement new policy with regard to science and technology education.

In order to study well-being, it is important to understand the elements that influence the teacher's positive and negative affect. For instance, one might assume that teachers' positive affect increases when teaching a class of children who are interested in and enthusiastic about the topic discussed, or when speaking with parents who are pleased with the way their child is being taught. Likewise, the negative affect probably increases when the school board decides to implement a new curriculum without giving teachers the opportunity to have an influence on the decision-making process, or when there is not enough time in class to discuss important subjects.

The aim of this paper is to report a study in which aspects that play a role in teachers' well-being, in connection with teaching science and technology (S&T), are examined, the role a teacher coaching program can play in dealing with these aspects, and the effect that such a coaching program can have on enhancing teachers' skills and knowledge with regard to teaching (S&T), and in their feelings of well-being while doing so.

4.1.1 Introducing science and technology in schools and how it potentially threatens teachers' well-being

To ensure children will appreciate and understand S&T later in life it is important for them to encounter it at a young age (Scientific American, 2010). In order to increase high-quality science and technology exposure for children, curricula of primary schools need to be changed in favor of S&T education. Various countries have started nationwide programs to stimulate high quality S&T education for young children (e.g. in Germany, Haus der Kleinen Forscher; in the Netherlands, the Dutch Institute for Educational Policy in Science and Technology (PBT)). In response to these programs, primary school administrators try to stimulate their pupils' enthusiasm for science education by initiating curricula in Science & Technology in all grades, from grade 1 to grade 8. Teachers on the other hand often feel threatened by the prospect of a change in their activities, which is imposed on them by the school administration, which might potentially negatively affect their level of well-being (Barber & Mourshed, 2007). Teachers feel this threat especially when asked to teach new priority fields or things they are not particularly familiar with, such as science and technology.

Three important aspects concerning teaching S&T that affect well-being of teachers can be distinguished. First, teachers do not feel they can make their own decisions in general (Goldspink, 2007), and consequently also about the way they teach S&T. Secondly, teachers often feel they lack the competence to provide S&T lessons in class (Goodrum et al., 2001; Jarvis & Pell, 2004; Palmer, 2002), and finally, teachers often lack the knowledge as to how to pass on S&T knowledge in the interactions with their pupils (Furtak, 2006; Roehrig & Luft, 2004). This phenomenon is to be expected, because primary school teachers do not have an S&T background, and in their teacher education they are not specifically trained to teach S&T. This lack of confidence in their own capabilities partly relates to a lack of real knowledge and skills, and partly to their attitudes towards teaching S&T (van Aalderen-Smeets, Walma van der Molen, & Asma, 2012). These aforementioned aspects cause a negative affect, which has a detrimental influence on teachers' well-being, and consequently on their intrinsic motivation for teaching. This is regrettable, because this intrinsic motivation is very often the basis from which they started teaching anyway (Dinham & Scott, 2004). When teachers show enthusiasm, as an affective component of motivation, their instructional behavior has a higher quality (Kunter et al., 2008).

In order to enhance teachers' well-being, and increase their knowledge and skills in S&T instruction, we developed a coaching program for teachers. However, before we discuss this, we will first explore how young pupils learn about S&T, and what teachers need to do to enhance this learning.

4.1.2 How do children learn science and technology in schools?

Currently, most researchers agree that children's learning is not only a cognitive activity that takes place in children's' heads, but must also be conceived of as a socially situated, transactional process (Fogel, 2009; K. Kumpulainen, Hmelo-Silver, & Cesar, 2009; Murphy, 2007; Sorsana, 2008), in which a combination of cognitive, motivational, and social factors intertwiningly play a central role. That is, children's learning is socially 'embedded' and comprises not only their achievements, but also includes their goal orientations, evaluations, and emotions with regard to the specific topic at hand, such as science and technology. That is, motivational aspects resulting in children's explorations, interest and curiosity play a central role in their learning process (Steenbeek & Van Geert, 2013).

This motivation and curiosity are present in young childrens' lives when they explore everything that happens in their environment. They are natural young scientists, without ever being taught science and technology (Schwartz, 2009; Steenbeek et al., 2011). Parents usually encourage their children's exploratory behavior when they are still at home. When these children go to kindergarten however, this curiosity seems to vanish (Engel, 2009). It is possible that when children get older they simply become less curious, and eventually outgrow it. However, that possibility does not seem likely because older children, and even most adults, like to investigate their environment and like to perform real inquiry when this is stimulated (Loewenstein, 1994). So the vanishing of curiosity is quite likely related to the school environment. One of the reasons behind this phenomenon seems to be that teachers rarely ask substantive, curiosity-arousing questions in the class. The questions they do ask tend to measure or determine what knowledge a child already has (e.g., what is a polar bear?), rather than stimulate inquiry by the children (e.g, how can you get to know what a polar bear looks like?). Teachers rarely explore the questions children ask, but tend to remind the children to stay on the tasks they have to perform. Teachers seem to be busy with targets, test scores, and the transfer of knowledge but not with promoting inquiry in the class (Susskind, 1979; Tizard & Hughes, 2002). That is, if teachers ask questions, the minority of these questions require pupils to think; the other questions concern mere recalling of facts or are procedural (Gall, 1970). This actual situation is not in line with results of a survey of teachers, which revealed that they saw curiosity as a very fundamental characteristic for pupils, which they would like to further develop (Engel, 2006). The result of this educational practice seems to be that children lose their interest in science learning throughout their school years. In an extensive review of the literature on pupil's attitude for science learning, Osborne et al. (2003) state that the quality of teaching is crucial for pupils to keep a positive attitude towards science learning. If the teaching of S&T takes place in a manner that

enhances skills for exploring and curiosity, the decline of pupils' motivation for science learning can be prevented.

To provide high-quality teaching, the teacher should act from a state of intrinsic motivation and of well-being. In acquiring a state of well-being, with more positive affect and less negative affect concerning their role as a teacher, attention must be paid to three innate concerns (Ryan & Deci, 2000; Steenbeek & Van Geert, 2007; Steenbeek & Van Geert, 2013) that should be satisfied and in balance with each other, namely the concerns for competence, autonomy and relatedness. For teachers, the concern for competence means that they need to strive for knowledge and skills for teaching; the concern for autonomy means that a teacher strives for working independently and can initiate new activities, without being dependent on outside pressure, and finally, the concern for relatedness means that the teacher strives for a good quality level of teacher-pupil interaction. A coaching program can provide teachers with tools to reach balanced concerns.

4.1.3 Intervening for improvement of S&T teaching: the video coaching for teachers (VFC-T)

The literature stresses the importance of using a mix of active and inquiry learning, children's self-regulated exploration and questioning, and educational guidance and teaching by teachers with high-level educational skills (Alfieri et al., 2010; Kirschner et al., 2006; Mayer, 2004) for successful S&T education to occur. This requires highly developed questioning skills that not all teachers possess, and for which they need to be thoroughly trained (Barber & Mourshed, 2007; Roth, 1996). The intervention for teachers that we developed to enhance their potential for teaching science in the classroom focused on enhancing teachers' questioning skills, framed around the use of steps from the Empirical cycle, a method of research in which data is produced by experiment and observation (Dejonckheere et al., 2009). Therefore, theory about the empirical cycle (De Groot, 1961) and scaffolding (Van de Pol et al., 2010; Van Geert & Steenbeek, 2005) was provided.

The idea is that by working on requiring more knowledge and skills for teaching S&T, the teacher will experience a higher quality of teachable science moments (Bentley, 1995; Hyun & Marshall, 2003) during S&T lessons, causing more enthusiasm and motivation for S&T both in the pupils and in the teacher. This then will increase teachers' well-being, and enhance the fulfillment of the teacher's three aforementioned concerns.

In other words, we hypothesize that a positive S&T teaching-learning spiral will be boosted, causing a positive effect on various aspects that relate to teachers'

S&T teaching, and their pupils' S&T learning. Note that this regards a self-enhancing and self-supporting process, in which learning and enthusiasm in the teacher enhances learning and enthusiasm in students, and the other way around.

Training programs have virtually no effect if the chosen instructional method is not adequate. A coaching program can only be effective when combined with classroom observation, micro teaching, video feedback and practice in the classroom (Wade, 1984). Especially video-feedback is a powerful form of training to enhance teachers' skills (Seidel et al., 2011). With this in mind, we developed a Video Feedback Coaching Program for teachers (VFC-T). The program focuses on teachers' actions in the classroom, by means of coaching based on observable behavior, if necessary second by second, so that behavior moves to a conscious, rather than unconscious, level (Van den Heijkant et al., 2004).

4.1.4 Questions and hypotheses of the present study

The study is framed by the following questions:

1. To what degree does the intervention influence teachers' intrinsic motivation and well-being while teaching S&T?
2. To what degree does the intervention influence teachers' behavior with regard to the use of questions that elicit scientific reasoning eliciting in the classroom, as shown in their verbal utterances?

Our hypothesis was that trained teachers will experience a positive S&T teaching-learning spiral, causing a positive effect on various aspects that relate to teachers' S&T teaching, and their pupils' S&T learning. More specifically, we expect that this positive effect will show in teachers reporting higher levels of intrinsic motivation and well-being while teaching S&T (study 1). In addition, we expect trained teachers to ask more questions that are related to the 'empirical cycle, which can also be referred to as 'scientific thinking circle' (Dejonckheere et al., 2009; de Groot, 1961), and less questions that are 'knowledge-based'. Furthermore, we expect them to elaborate more on the answers pupils give, and to ask more supplementary questions.

4.2 Study 1

4.2.1 Method

4.2.1.1 *Participants*

The study started as a part of a broader professional development program with fourteen teachers, of whom two withdrew from the program because of pregnancy. The twelve participating teachers came from five schools that showed

interest in S&T education, and wanted to incorporate S&T in their school program. Two schools already had some experience in teaching S&T, whereas three schools had almost no experience in it.

The teachers (two male, ten female) had a mean age of 40.3 years, with an age range from 25 to 60 years, and also a wide range of experience (mean level of experience 15. 6 years, ranging from 2 to 37 years). Four teachers already had some experience in teaching S&T, while eight had no such experience. All participants were elementary school teachers working with children in grades 1-4. Children's age varied from four to eight years. All schools were situated in rural areas in the north of the Netherlands, with virtually no children from ethnic or cultural minorities. The teachers were accustomed in teaching all subjects in their class and were coached in how they could best teach S&T. The S&T lessons did not have their priority, and they did not spend much time on teaching S&T.

4.2.1.2 *Design*

The first study lasted one school year, from October until May, in which the try-out version of the VFC-T took place as part of a professional development trajectory for teachers. The professional development involved six team-based theory sessions for each school, where teachers received information about a number of S&T examples, for instance, floating and sinking and the use of cogwheels. In addition, they obtained information about ways of scaffolding (Van Geert & Steenbeek, 2005), and about the teacher's role in children's problem solving. The coaching took place individually. Four or five science classes of each teacher were recorded by the coach, and parts of these recordings, in particular, those concerning the teacher's behavior and the interaction with pupils were extensively discussed with the teacher. The aim of the coaching was to enhance elementary teachers' knowledge and ability to teach science and technology. The coach taught them how to interact with pupils while teaching science, by providing them with tools to enhance their questioning and scaffolding skills. Furthermore, the coach helped to enhance the teachers' intrinsic motivation and well-being, by teaching them to establish a positive spiral of inspiring teachable science moments, in which pupils expressed their enthusiasm and curiosity about S&T. This positively affects teachers' enthusiasm and curiosity, which they can subsequently express in their teaching.

Each teacher prepared an S&T lesson for every coaching session. Coaching took place on the same day. Teacher and coach discussed the video recordings of the lessons, focusing on the teacher's interaction with the children. Attention was paid to S&T talent eliciting remarks of teachers, and the teachers were encouraged to show more of this talent eliciting behavior in their next lessons. The pro-

fessional development and coaching activities were carried out by three teacher educators, who worked at two teacher training colleges near the schools that participated. The teacher educators all had experience with teacher training and with the coaching of pre-service teachers. They understood the context of the VFC-T, and in several preparatory meetings with the researchers, this context was discussed with them. The first author was present at every coaching session to ensure that all sessions were recorded on video.

4.2.1.3 *Data collection and analysis*

Data were systematically collected through open-ended research methods, such as classroom observations, video recordings of the classroom activities, and video recordings of the coaching sessions with regard to the classroom activities. At the end of the school year and the professional development and coaching program, the twelve participants of the coaching program were interviewed by the researcher using a semi-structured interview technique. In addition, four teachers not participating in the coaching program were interviewed. One aim of the interviews was to examine how the teachers assessed both professional development and coaching in the past period. Another was to examine if the teachers could see any change in their own behavior, as well as in their pupils'. The researchers asked questions about teachers' motivation, their opinion regarding the coaching and the professional development program, and the trajectory's benefits for the teachers and the pupils. The researchers, who participated in the coaching and professional development program, performed the interviews themselves. The length of the interviews ranged from 35 to 75 minutes. All interviews were recorded on tape and transcribed. Afterwards, all teachers' statements were categorized.

4.2.2 Results

4.2.2.1 *Benefits of the VFC-T for the teacher*

When asked about the eventual benefits of the coaching program, ten out of the twelve teachers said that they were very satisfied with the outcomes of the program. They had observed changes in their own teaching, changes in their pupils' attitude, and changes in the interaction in the classroom. Two teachers were not very satisfied, and these were teachers who did not, as a result of organizational problems at their school, receive the coaching section of the program as intended, with proper use of video recordings. Despite this, the trainers received a 7.8 on a scale from 1-10 as an overall mark.

To the question what teachers had actually learned during the VFC-T, and what they were doing differently in their own lessons, the twelve teachers provided a total of 66 answers. These 66 statements could be divided in six categories, as shown in table 2.

Table 2 | *Benefits for teachers*

Category	Number of statements	Examples of teachers' statements
Preparation of the lessons	16	"In advance thinking about what question to use"
Knowledge of S&T	14	"Acquiring more experience in technology lessons"
Interaction during lessons	13	"keep on asking", "keep mouth shut", "use supplementary questions"
Change in oneself	10	"awareness", "flexibility in learning goals in a lesson"
Observing talents in children	8	"to discover talent in children"
Abstract level	5	"give space to pupils", "let pupils look more critical"

The interviews demonstrated that teachers noticed that the interaction in the class had changed. Most answers indicated that teachers themselves talked less, and gave more opportunities for children to discover topics themselves by means of asking the children various kinds of substantive questions. An important learning point for teachers was to discover that they could understand their pupils' way of thinking more. A lesson could be successful even though the whole intended subject matter was not discussed, but instead there had been extensive interaction concerning topics that interested pupils and that compelled them to think. The teaching goal was confined to discussing the entire content of a lesson, but it could also be to evoke interest in children, make them curious, and make them reflect on topics.

Teachers also stated that the coaching sessions made them listen to their pupils more often and with greater interest. Additionally, the coaching sessions resulted in giving the teachers a better understanding of what motivated their pupils. They were very happy with the enthusiasm their pupils showed during S&T lessons. In this way the teachers enjoyed their own classes more.

4.2.2.2 *Benefits of the VFC-T for pupils according to the teachers*

Teachers were asked if they could see any change in behavior and attitude on

behalf of their pupils in the classroom. To this question, the teachers provided a total of 43 answers. These 43 statements could be separated in six categories, as shown in table 3. For example, a statement was made seventeen times about change in their pupils' affect. Teachers said they encountered more enthusiasm, initiative and involvement in the classroom.

Table 3 | *Benefits for pupils*

Category	Number of statements	Examples of teachers' statements
Affect	17	"Enthusiasm", "initiative", "involvement"
Cognitive aspects	10	"Pupils are more critical", "learn a lot"
Motivational aspects	2	"Working motivated"
Confidence	11	"Pupils who usually do not attract attention take more part in the classroom activities"
No change observed	3	"Too early to see a change"

According to teachers, pupils enjoyed lessons more, especially when S&T was involved, as can also be concluded from the fact that 17 answers (table 3) had an affective component. Teachers observed that the children who normally gave the right answers were not in the lead, but that other children could also show their skills and take initiative. Reasoning, initiative and enthusiasm are traits that are noticed and appreciated by teachers in the S&T lessons. Three statements referred to the fact that the teacher could not identify changes in the classroom. Two of these answers were given by teachers with whom the coaching program was not executed as intended, due to organizational problems in the school.

4.2.3 Discussion

As a result of the interviews, it becomes clear that most of the teachers felt like they alter their methods of lesson preparation, they know more about S&T, and they interact differently during the lessons. This interaction consists of more listening and more asking supplementary questions. Each teacher saw positive changes, sometimes only in his or her own behavior, sometimes also in the behavior of pupils. Teachers were very happy with the changes they saw in themselves, and the positive effects this had on their pupils' behavior, for instance, the enthusiasm their pupils showed during S&T lessons.

This study has shown that a VFC-T has a positive effect on teacher well-being as this is what teachers themselves report. Nevertheless, interviews, as a research method, have some important limitations, in that participants can show an interview bias. Moreover, interviews only provide qualitative results. Therefore, a second study has been carried out with more emphasis on quantitative results, with the aim of providing data on the real interaction in the classroom, for instance, teacher's questioning. Another aim was to improve the VFC-T, by focusing more on talent eliciting questions, and on making participation in the VFC-T less demanding on the teachers, given their heavy workload.

4.3 Study 2

4.3.1 Method

4.3.1.1 *Participants*

The study started with seven elementary school teachers working with children in grades 1-4 from three different schools. The teachers (one male, six female) had a mean age of 36.4 year, while there was a wide age range from 24 to 56 years old, and also a wide experience range, from 2 to 33 years, with a mean experience of 14 years. The three schools taking part in this study were already incorporating S&T in their school program. All teachers, none of whom had any experience in teaching S&T, participated voluntarily.

4.3.1.2 *Design*

The second study was conducted at three schools for primary education. To improve the design of the coaching program, a literature study was carried out on coaching, scaffolding and questioning. On the basis of this literature study, the VFC-T was improved, and afterwards carried out by the first author in February until April. In comparison with the first coaching format, the new format was based on rigid scheduling, and involved an introduction session of two hours, in which teachers received information about scaffolding (Van Geert & Steenbeek, 2005), questioning (Oliveira, 2010), and the empirical cycle (De Groot, 1961). During this session, teachers learned how scaffolding could take place by asking talent eliciting questions and supplementary questions. Moreover, they learned that questions resulting from the empirical cycle could be used when teaching S&T because these questions are particularly fit for eliciting talented behavior. In the seven weeks following that introduction session, four coaching sessions were scheduled, while the teacher gave a regular S&T lesson, lasting from 20-30 minutes, with a small group of pupils from their class. The lessons were recorded, and coaching took place approximately half an hour after the lesson, and lasted about 30 minutes. Before the coaching session could take place, the coach selec-

ted four or five fragments from the video to be discussed. These fragments were selected with a focus on teacher questioning during the interaction with the children. The focus of the coaching session was to enable the teacher to discover, in interaction with the coach, how to change behavior by discussing fragments that were representative of the teacher's behavior.

4.3.1.3 *Variables*

To determine the effect on teachers' questioning, a coding scheme was developed. First, the main verbal statements were coded: 'questions', 'encouragement', 'remarks relating to the content', and 'other remarks' in order to distinguish the different verbal expressions teachers used in class. Second, the variable 'questions' was categorized in terms of the empirical cycle: 'knowledge questions', 'prediction questions', 'research design questions', 'observational questions' and 'questions about the explanation'. Additional categories of questions were: 'supplementary questions', 'other questions relating to the content', and 'other questions'. We expected that there would be a difference between the pre-intervention and the intervention in terms of an increase of teachers' scientific reasoning eliciting questions (from now on TSEQ), such as 'prediction questions', 'research design questions', 'observational questions', and 'questions about the explanation'. We also expected that the teachers would ask more supplementary questions.

4.3.1.4 *Data collection*

Data were systematically collected through classroom observations, video recordings of the classroom activities, and video recordings of the coaching sessions with regard to the classroom activities. Prior to the introduction sessions, two S&T lessons were recorded as a pre-intervention, without coaching afterwards. The video recordings were captured with a digital camcorder, focusing mainly on the teacher, to record the teacher's behavior.

4.3.1.5 *Data analyses*

The first ten minutes of one pre-intervention lesson and two lessons in which coaching took place with four teachers were coded by using The Observer 10.5. To assess the reliability of the coding system, a second observer was trained to code a representative part of the recorded lessons. An inter observer agreement of 74% was found for the variable 'questions' (Kappa =.70). This agreement is substantial, which means that the coding system can be used reliably. The differences between pre-intervention and intervention lessons were analysed using Monte Carlo permutation analyses (Todman & Dugard, 2001). This is a non-parametric permutation test, particularly suitable for small sample sizes as is the case here. The probability that results are caused by chance alone, is estimated by simulating the chance-alone condition. This simulation is done by randomly

shuffling all results on a variable during three sessions and with four teachers numerous times (1000 or more). The original result is then compared with the distribution of the results obtained by the random model.

4.3.2 Results

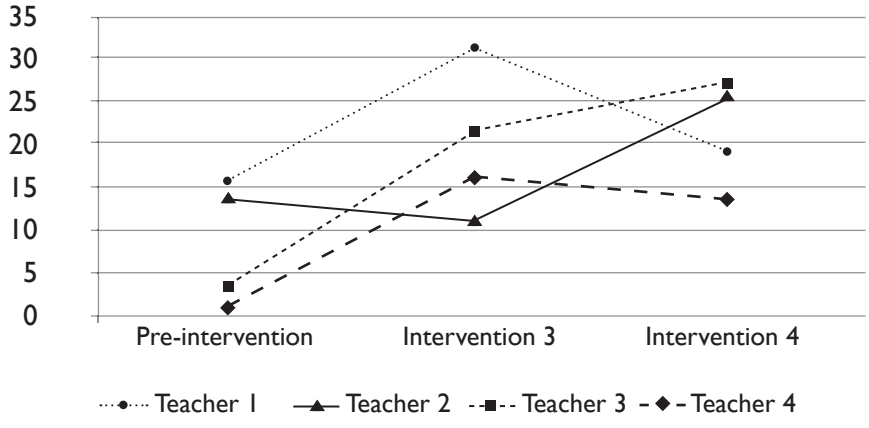
4.3.2.1 *Teacher's scientific reasoning eliciting questions (TSEQ)*

The effect of asking a higher amount of TSEQ and elaborating more on answers can be seen in table 4 and figure 5. The amount of TSEQ asked during part of the lesson increased from 34 in the pre-intervention session with 142% for all teachers together to 82.5, the mean of the intervention sessions (p=.04). The amount of increase differed among the teachers, but every teacher benefited from the intervention.

Table 4 | *TSEQ*

Questions empirical cycle	Pre-intervention	Intervention 3	Intervention 4	Mean of interventions
Teacher 1	16	31	19	25
Teacher 2	14	11	26	18.5
Teacher 3	3	21	27	24
Teacher 4	1	16	14	15
Total	34	79	86	82.5

Figure 5 | *TSEQ*



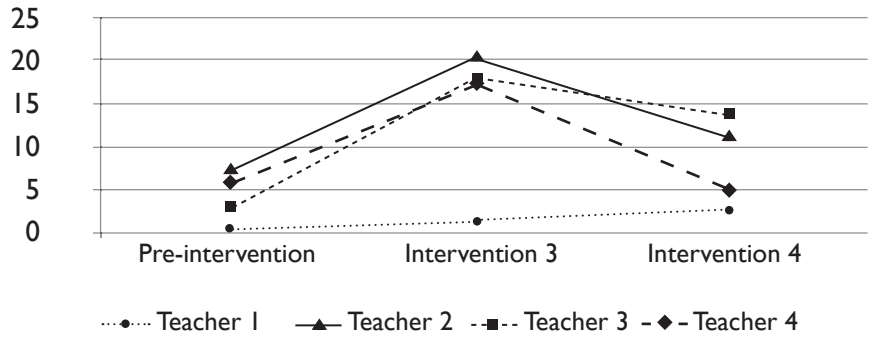
4.3.2.2 *Supplementary questions*

The same effect can be seen with regard to the supplementary questions (table 5 and figure 6). In the pre-intervention lesson, supplementary questions were asked 16 times, while the mean of intervention 3 and 4 was 45.5 questions, an increase of 184%. (p=.04). All teachers increased their supplementary questions, although the degree to which their questions increased differed considerably.

Table 5 | *Supplementary questions*

Supplementary questions	Pre-intervention	Intervention 3	Intervention 4	Mean of interventions
Teacher 1	0	1	3	2,0
Teacher 2	7	20	12	16,0
Teacher 3	3	18	14	16,0
Teacher 4	6	18	4	11,5
Total	16	57	34	45,5

Figure 6 | *Supplementary questions*



4.3.3 Discussion

The participating teachers showed a significant improvement in the number of TSEQ, as well as supplementary questions, asked during a lesson. Before they participated in this research, the teachers had virtually never taught S&T in class themselves. During the pre-intervention, it was striking that three of the four teachers had the misconception that pupils had to work independently, without help of the teacher, when attending S&T class. Teachers asked questions, but the

questions being asked did not stimulate children's thinking, observing, or sharing their views of the topic, such as the questions used within the empirical cycle. A question during the pre-intervention lesson was, for example: "do you need a drill?", while after the introduction lesson, questions might be: "what do you see happening right now?" or "Why do you think this pencil floats?" When pupils answered these questions, teachers displayed more scaffolding behavior, by asking for explanations for the pupil's answer. In the later lessons, the teachers made more use of supplementary questions, while they rarely did that in the pre-intervention lessons.

During the coaching after each lesson, some teachers indicated that prior to the intervention, they did not expect children this young to be able to answer these questions. They were surprised to see that the S&T lessons taught in this manner made their pupils very enthusiastic. At the last coaching session, all six teachers indicated that they were very satisfied with everything they had learned during the VFC-T. This kind of teaching S&T was new to them, but they thought it would be much easier from then on to teach S&T. The theory about questioning and the empirical cycle was helpful for them, and they enjoyed the interaction with their pupils, as well as the enthusiasm the pupils showed during S&T class. Finally, the teachers reported that the way of questioning was not only helpful in S&T lessons, but that all other lessons could benefit from this new method.

4.4 General discussion

The major question of this study is whether the teachers' well-being increased as a result of better teaching. The answer to this question can be positive: in interviews, teachers mentioned they were very satisfied with the results of the coaching. Each teacher saw positive changes, either in his or her own behavior, or in the behavior of pupils, or in both. Teachers were very happy with the changes they saw in themselves, and the positive effects this had on their pupils' behavior. They learned a lot, and felt more capable of teaching. The amount of positive emotions considerably increased after the coaching, in this particular context of science and technology teaching to young children. The results from study 1 were based on a qualitative method, namely the analysis of interview data. It might be objected that interviews about the effect of interventions lead to biased answers, favoring positive outcomes, although, if the teachers would have been hostile or negative towards the intervention, the expectation would be that their answers would be biased towards negative outcomes. In order to check whether the qualitative results reflect only the teachers' positive biases and are not related to actual changes, we tested the expectations that trained teachers ask more questions that are related to the empirical cycle (Dejonckheere et al., 2009; de Groot, 1961). Furthermore, we expected them to elaborate more on

the answers pupils give and to ask more supplementary questions. The results from study 2 showed that the VFC-T has a positive effect on the cognitive quality of the questions the teachers asked.

What is remarkable is that during the last intervention session, almost all teachers showed a considerable decrease in supplementary questions in comparison with the pre-intervention session. An explanation for that could be that during the coaching sessions, emphasis was put on empirical cycle questions teachers could ask, whereas less attention was paid to the supplementary questions that could be used. As can be seen in table 4, those purporting to the empirical cycle did not show this significant drop.

An important question for future research is whether the increase in questioning quality also resulted in an increase in cognitive levels of the answers that the children gave. The qualitative results from study 1 are positive, just as the experience we had in the classroom during study 2. Children gave real substantive answers to the questions being asked, and did not react to these questions by saying "I don't know", or I do not understand that". Although we did not analyse the pupils' answers quantitatively, we think that there is a positive relationship between the teaching behavior and the cognitive performance of the pupils. A follow up study is scheduled to determine the effects of the VFC-T on children's thinking. Additional questions that should be answered in future research are whether the increase in the quality of the questions of the teacher has a durable effect on the teacher, whether it transfers to other teaching situations, and whether it leads to an increase in the quality of pupils' independent reasoning, without the help of the teacher, for instance, when working with peers.