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[EVALUATION OF A TECHNOLOGY CURRICULUM IN PREVOCATIONAL EDUCATION]

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Summary

An annual shortage of personnel with a technical vocational degree is expected. This trend is alarming with respect to the increasing importance of technology for human welfare and economic prosperity. Students who have developed positive attitudes towards- and conceptions of technology, are more inclined to enter into a technical educational track. To stimulate these attitudes and conceptions within pre-vocational education, a technology curriculum was developed with use of design principles from literature. This study focuses on the evaluation of the technology curriculum. A single case-study was used to investigate the impact of the curriculum on a group of students' attitudes towards- and conceptions of technology, and aspects of the implementation process that contribute to this impact. Impact was measured by use of a questionnaire that students fill in before and after implementation. These two measurements were compared by use of a Wilcoxon Signed-Rank Test. Implementation evaluation entailed documented lesson observations and semi-structured interviews with students and the teacher. Data matrix for intra-case analysis was used to analyze the documentations. Results show that a significant positive impact has been found on the attitude 'the extent to which students enjoy technology'. In particular, the learning content and learning activities such as the appealing assignment, the company visit, the freedom of choice, the creative and physical design tasks within a social setting seem to have had an impact on the degree of 'enjoyment' that students experienced during the curriculum. The results suggest that the role of the teacher in particular has influenced a lack of impact on the other six dimensions of attitudes toward- and conception of technology. The teacher did not make the connection between the learning goals, learning contents, learning activities and technology. It seems that the students could therefore not link their positive experiences directly to (dimensions of) technology. Nonetheless, the results provide relevant input to develop and evaluate future technology curricula.

Samenvatting

Een jaarlijks tekort aan personeel met een technische beroepsopleiding wordt verwacht. Deze trend is alarmerend met het oog op het toenemende belang van techniek voor onze welzijn en economische welvaart. Leerlingen die positieve attitudes en concepties van techniek hebben ontwikkeld, zijn meer geneigd om een technische studie te volgen. Om deze attituden en concepties binnen het voortgezet middelbaar beroepsonderwijs te stimuleren, is er een techniekcurriculum ontwikkeld met behulp van ontwerpprincipes vanuit de literatuur. Deze studie richt zich op het evalueren van dit techniekcurriculum. Een enkelvoudige gevalsstudie is gebruikt om de impact van het curriculum op de attituden en opvattingen van de groep leerlingen tegenover techniek te onderzoeken samen met implementatieaspecten die bijdragen aan deze impact. Impact is gemeten met behulp van een vragenlijst die leerlingen voor- en na afloop van het curriculum hebben ingevuld. Resultaten zijn vergeleken met een Wilcoxon Signed-Rank Test. De implementatie van het curriculum is kwalitatief geëvalueerd met lesobservaties en semigestructureerde interviews met de leerlingen en de docent. Op basis van een datamatrix is een intra-case analyse uitgevoerd. Resultaten laten zien dat er een significante positieve impact is gevonden op de attitude 'mate waarin leerlingen plezier beleven in techniek'. Met name de leerinhouden en leeractiviteiten zoals de aansprekende opdracht, het bedrijfsbezoek, de keuzevrijheid, de creatieve en fysieke ontwerptaken binnen een sociale setting lijken een impact gehad te hebben de mate van 'plezier' dat leerlingen beleefden tijdens het curriculum. De resultaten suggereren dat de rol van de docent er met name ervoor heeft gezorgd dat er geen impact is gevonden op de overige zes dimensies. De docent heeft namelijk niet de link gelegd tussen de leerdoelen, leerinhouden en leeractiviteiten en technologie. Het lijkt erop dat de leerlingen daardoor hun positieve ervaringen niet direct konden koppelen aan (dimensies van) technologie.

Desalniettemin bieden de resultaten relevante input om toekomstige technologie curricula te ontwikkelen en evalueren.

Introduction

In recent years more and more students have opted for a technological follow-up study or study program. However, this increase of students in technological tracks cannot meet the demand for technological personnel in the future (ROA, 2011). This trend is alarming with respect to the increasing importance of technology for human welfare and economic prosperity (OECD, 2006). To answer this future demand, even more students are required to choose and follow a technological educational track. Research shows that young people are interested in technological products, but that their opinions on technological education and work are not positive (Johansson, 2009). Often this lack of enthusiasm is a result of experiences of technology at school, since these experiences form the youngsters' conceptions of technology (de Vries, 2005; Osborne and Collins, 2000).

Barmby, Kind and Jones (2008) state that there is a steady decline in students' attitude towards science and technology over time, particularly in secondary education. However, there is a significant positive relation between attitudes towards technology and the amount of time that technology is taught for, as well as to the teacher (Ardies, De Maeyer, Gijbels & van Keulen, 2014). Researchers Rohaan, Taconis and Jochems (2008) state that teacher knowledge affects teaching and thus affects student's concepts and attitudes towards technology. It is found that students with a more accurate and comprehensive view of technology, have a more positive attitude toward technology (De Vries, 2000). Therefore it is of great importance that teachers have sufficient knowledge of technology and technology education to develop students' technological literacy (Rohaan et al., 2008). It is expected that a positive attitude towards technology will result in a larger number of students choosing technological studies and jobs.

Given the growing attention to the role that attitudes and conceptions can play, and given the fact that future interest is largely formed at school, teachers implementing technology education that influences students' attitudes and conceptions towards technology positively is important. In this study a research group collaborated with a teacher from a secondary school in Oldenzaal, to develop, implement, and evaluate a technology curriculum for students in the third grade of prevocational education. Goal of the curriculum was to positively influence student's attitudes toward- and conceptions of technology.

This study focuses on the evaluation of the technology curriculum. More specific, the aim is to evaluate the impact of the curriculum on the student's attitudes toward- and conceptions of technology, and evaluate the actual implementation of the elements of technology education that can positively contribute to these attitudes and conceptions. This research hopes to contribute to a practical-scientific model in which knowledge about 'effective' elements of technology education is expanded. Follow-up research and development practices within the educational field could potentially use the findings of this study to (re)design technology education and contribute to the discovery and development of students's technological talents.

Theoretical framework

First, a definition will be given of technology education and thereafter a concept will be provided of 'attitude' towards technology. Next, an illustration will be given of elements of technology education that can positively contribute to this attitude. Finally the manner in which the curriculum is represented during the process of curriculum evaluation, will be addressed.

The definition of technology education as stated by the International Technology Education Association (ITEA) will be used: "technology is "human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities" (ITEA, 1996, p. 16). Herewith, technology is described rather comprehensively and is seen as the process of creating and using knowledge to solve problems (Rohaan et al., 2008).

The concept of attitude is seen as an internal, personal psychological tendency to evaluate a particular construct or object positively or negatively. This personal tendency can last for a shorter or longer period of time and can consist of cognitive, affective or behavioral components. The cognitive component of the concept of attitude consists of thoughts or opinions about a certain construct. The affective component consists of feelings and moods, while the behavioral component consists of actual behavior or the intention to do something with regard to the object of attitude (Walma van der Molen, 2007). Naturally the concept of attitude toward technology is a multidimensional construct (Osborne, Simon & Collins, 2003; van Aalderen-Smeets, Walma van der Molen & Asma, 2012; van Aalderen-Smeets & Walma van der Molen, 2013). Based on prior literature, Walma van der Molen (2007) distinguished five dimensions of attitudes toward technology and two dimensions of conceptions of technology. The dimensions of attitudes toward technology are 1. The extent to which students believe that technology is difficult; 2. The enjoyment that students get from technology; 3. The importance to society that students ascribe to technology; 4. The degree to which students expect to choose a technological job; 5. Gender-stereotypical ideas students have about technology. The dimensions of conceptions of technology are 1. Traditional conceptions of technology; 2. Academic conceptions of technology.

Based on these dimensions, Walma van der Molen (2007) developed a measurement instrument that has been used to monitor the attitudes and conceptions of primary school pupils for a number of years. This monitoring has shown that more technology lessons lead to pupils that have fewer gender stereotypical ideas about technology, find technology less difficult, give more credit to the importance of technology for society, experience more fun with technology and have more intentions to choose a technical training or job. In addition, it appeared that having more technology lessons also had an effect on the image of technology and science. Pupils from classes where fewer technology lessons were given, turned out to have a less varied picture of what technology or science can imply than pupils from classes where technology lessons were often given. All pupils agreed that more traditional aspects of technology, such as dealing with machines, fall under the heading of technology. However, in the more broad (science-related) view of technology, which also includes issues such as coming up with solutions or new ideas, clear differences were visible between pupils from classes where more or little technology was taught. Those pupils who received little technology education in the classroom found significantly less often that technology could also include coming up with new ideas or solutions than pupils who were given more technology lessons. In addition, pupils who received little technology lessons found significantly less often that technology also had academic characteristics, such as passing on new ideas to others than pupils who received more technology lessons in class.

Given the impact of more technology lessons in primary education, the question is whether this impact can also be found in secondary education. The assumption is that more technology lessons in secondary education can also lead to a positive influence on the attitudes and conceptions of pre-vocational students with regard to technology. Technology lessons in primary education as well as in secondary education are usually part of a curriculum. According to van den Akker (2003), a consistent and coherent curriculum has a core and nine threads that are connected to each other like a spider web. The curricular spider web consists of a core (rationale) and nine threads: aims and objectives, content, learning activities, teacher role, materials and resources, grouping, location, time and assessment (see figure 1). The spider web illustrates the inter-connectedness of these curriculum components and its potential vulnerability. In order to see which aspects of a technology curriculum can influence the attitudes and conceptions of students, every element of the curricular spider web is investigated for effective principles.

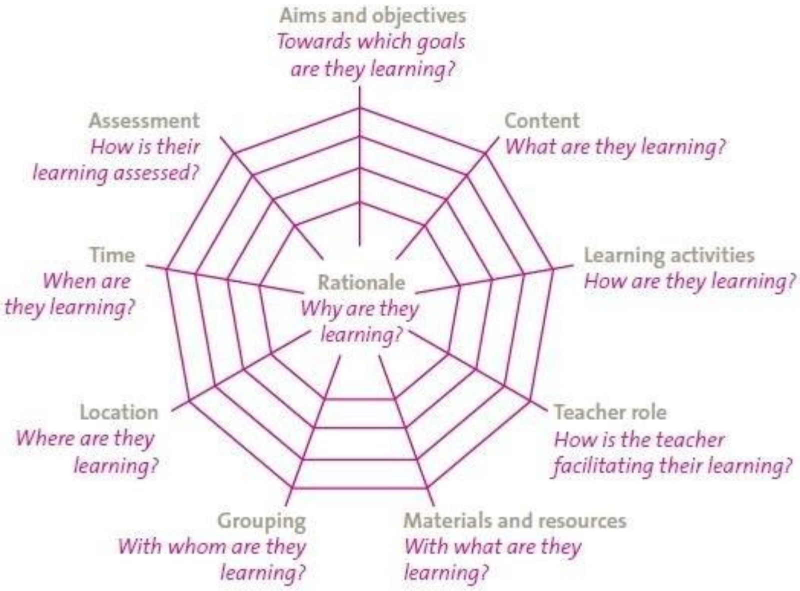

Figure 1: Curricular spider web

Aims and objectives

First element that is discussed is 'aims and objectives'. Lin, Lawrence, Lin and Hong (2012) examined four variables that correlate with the variable 'future intended interest in technology and science'. Two of these variables were affective factors (current interest in technology and pleasure in technique) and the other two were related to cognitive factors (development of self-image and self-efficacy). Both affective factors had a greater influence on 'future intended interest in technology and science' than the self-related cognitions and self-efficacy. The results suggest that affective and cognitive pathways to scientific competences are divergent and that they have to be activated in different ways. According to Lin, Lawrence, Lin and Hong (2012) teachers should put less emphasis on performance but more on generating interest in technology and science. Bell, Lewenstein, Shouse and Feder (2009) also argue that affective factors play a special role in stimulating and supporting learning motivation for science and technology in both formal and informal learning environments. Walma van der Molen (2007) assumes that the stimulation of an inquiry learning attitude should be stimulated during the integration of technology education and that this attitude could also stimulate a more positive attitude towards research, inventing, and the importance of technology and science for society. A form of education in which this inquiry learning attitude can be stimulated is project education. Tanis, Dobber, Zwart and van Oers (2014) explain that students can learn with their hearts within project education, because the authenticity of such projects makes students feel involved.

Learning content and learning activities

Second and third elements are 'learning content' and 'learning activities'. These two elements of the curricular spider web are closely connected and effective principles for these two elements are usually intertwined. ITEA (1996) identifies some universal features of good education in technology. First of all, technology education should provide knowledge about basic technological concepts and processes and should develop students' technical skills. Preferably, this educational goal is accomplished by means of problem solving, exploring, designing, analyzing, innovating, and making. Students need to receive explicit instructions about the essential knowledge and operational technical principles before 'designing', to ensure that their learning process runs smoothly (Esjeholm & Bungum, 2012; Kirschner, Sweller & Clark, 2006). Next, education in technology should always connect hands (doing) and mind (knowing). This implies that technology education should involve activities that make students design and create (use their hands) as well as think and understand (use their minds) (Raizen, 1997; McCormick, 2004). In general, the most accepted and appropriate pedagogical approach for technology education is 'learning by design' (de Beurs, 2003; in van Graft & Kemmer, 2007). The pedagogical-didactical guidelines implied by 'learning by design' are: the starting point for learning should be an authentic problem, the learner should feel ownership of the problem and the problem-solving process, the learner's thinking should be challenged, and reflection should be supported (Savery & Duffy, 2001). For learning by design, it also means that the steps of the design cycle (i.e., investigate, design, create, evaluate) should be followed. Learning by design suggests that learning is more effective when the learner is actively engaged in the construction of knowledge rather than passively receiving it (Rohaan et al., 2008). According to Palmer (2008) the pedagogical approach 'learning by design' generates situational interest in technology, and multiple experiences of situational interest can lead to long-term interest, which consequently is an effective motivator to choose an educational track in technology. In addition to interest, the enjoyment that students experience during education in technology is an effective motivator as well (Autio, Hietanoro & Ruismaki, 2011). There are specific aspects of 'learning by design' that lead to increased student interest and enjoyment in technology. An aspect that relates to the elements 'learning content' and 'learning activities' is a design task or design problem that appeals to students and is in alignment with their interests and living environment (Autio, Hietanoro & Ruismaki, 2011; Jin, Lawrenz, Lin & Hong, 2012). Final aspect that relates to these elements is 'freedom of choice' during the draft of the design proposal (Autio, Hietanoro & Ruismaki, 2011; Palmer, 2008). Especially for students from 15 to 16 years old, freedom of choice leads to a higher degree of autonomy and motivation (Alfieri et al., 2011).

In addition to in-school activities, visits to technology-oriented companies could potentially provide students with a stimulating 'real-world' setting to develop more broad and positive images of and attitudes toward technology and technical professions (Post & Walma van der Molen, 2014). Post and Walma van der Molen (2014) formulated a set of guidelines for technology-oriented company visits that could improve the desired attitudinal effects. First guideline is that school boards should make sure that students visit a balanced selection of technical oriented companies that includes both traditional and modern businesses of technology. Second guideline is that all parties involved in the company visits should be made aware of the goals of the visits and they should all share a commitment to improve student's conceptions and attitudes. Third guideline is about in-school preparations. They should include (1) pre-orientation activities that aim to familiarize students with the physical environment of the companies (e.g., presenting a slide show with photos of the companies' facilities; showing a brief video tour made by one of the on-site workers, etc.) and (2) identifying and confronting student's misconceptions and stereotypical beliefs about technology and technical professions (e.g., group discussions to identify common misconceptions and stereotypical beliefs, inviting technical professionals from a few of the participating companies to visit the schools to discuss possible misconceptions and to share their personal considerations that led to their current technical professions, and informing students about available study options). As part of these preparations, it also seems important to improve parents' images of and attitudes toward technology and technical professions. Parents function as role models for students and they are likely to have a strong influence on student's image and attitude development (either intentionally or unintentionally) through often ill-informed conversations about the relevance of technology, the availability and range of modern day technical professions, and the student's (latent) technical talents and professional ambitions. Finally, teachers should actively evoke student reflection during the company visits by helping students to connect their on-site experiences to the classroom curriculum. Emphasis should ultimately be on connecting student's design work to nurturing their technical interests, talents and professional ambitions (Post & Walma van der Molen, 2014).

Role of the teacher

Fourth element is the role of the teacher. Jarvis and Rennie (1996) reason that if students associate the appropriate broad and positive technology experiences with technology, they are more likely to value and choose technology as a study or career later in life. Therefore they recommend that teachers should point out which classroom activities are related to technology, so more students will be able to make sense of the word 'technology' in different contexts. Aside from this specific teacher's activity to stimulate the desired attitudinal effect, the manner in which the teacher relates to the students and the design process has an impact on how the students experience the 'design-based learning process' (Enyedy & Goldberg, 2004). When a teacher positions himself as a co-designer and actively participates in the design process, the students are more involved in the design process and the learning effects are greater. The teacher is expected to provide guidance on three aspects: learning 'design-based learning', collaboration and content learning (Tanis, Dobber, Zwart & van Oers, 2014). Learning 'design-based learning' refers to the guidance of a teacher in the metacognition of students. Guiding learners in the process of learning 'design-based learning' appears to be one of the most effective strategies. Metacognitive guidance is about supporting thinking about learning. A teacher can do this by giving students instruction at every stage of the design process (Ben-David & Zohar, 2009). During collaboration, the guidance of the teacher must be focused on the interaction processes in the groups. Effective collaboration means that students are positively dependent on each other, are individually responsible, are all equally involved and show good social skills. Finally, a teacher works on content learning by improving the substantive discussions in the groups and in the classroom (Tanis et al., 2014). The quality of what is learned depends on the quality of the conversations. The teacher has the task to make the knowledge that emerges explicit. He listens to how students use evidence to substantiate their claims. The teacher can also be a role model by giving a specific contribution, for example by asking questions about the content of the student's claim without judging. It is important that students feel free to continue their own line of thought.

Materials and resources

The fifth element is 'materials and resources'. The physical environment in which students learn can also influence their motivation for learning: when students have a higher motivation, their satisfaction with their learning is greater, which can lead to better learning outcomes (Fraser &

McRobbie, 2012; Fraser & Walberg, 1991). Learning environments which offer suitable and optimal challenge, plenty of different stimuli, and a chance to feel autonomy achieves effective motivation (Deci & Ryan, 1985; Stipek, 1996). For technology education in particular, the presence of sufficient space, materials and qualitative tools, with which students can shape their design ideas, leads to increased student interest and enjoyment in technology (Autio, Hietanoro & Ruismaki, 2011). When digital technology, such as 3D programming or printing is used, the quality of the digital infrastructure is a prerequisite. This helps the teacher to stay focused on the process of teaching instead of trying to solve problems with the digital equipment (van Keulen & van Oenen, 2015).

Grouping

The sixth element is grouping. Social involvement during technology education stimulates enjoyment, for female students in particular (Palmer, 2008). In Palmer's study social involvement was stimulated through communication and collaboration as students moved around and worked together. Deci (1992) argues that humans have a basic need or drive for social contact, and that this can explain why interpersonal involvement can arouse interest. Aside from 'novelty' and 'autonomy', social involvement is a factor that humans seem to have an inherent need for (Anderman, Noar, Zimmerman & Donohew, 2004) which probably explains its tendency for generating interest.

Location

The seventh element is location. Technology education is usually given in a classroom at school. Depending on the school and the facilities available, a specific designed classroom for this type of education is present or not. Tubin, Mioduse, Nachmias and Forkosh-Baruch (2003) state that, if possible, a separate technical classroom should be present. As indicated in the 'materials and resources' element, the presence of sufficient space, materials and qualitative tools, with which students can shape their design ideas, leads to increased student interest and enjoyment in technology (Autio, Hietanoro & Ruismaki, 2011) and should be present (Ely, 1999). Aside from space for the shaping of students' design ideas, space for social involvement seems important as well. As Palmer (2008) stated, social involvement requires for students to be able to move around and work together. According to Wyffels (2006) it is important that the classroom layout reflects the interests, the living environment and the activities of the students. The arrangement of the benches or tables of the students can invite to learning and dialogue. In conclusion, the classroom layout can contribute to a large extent to the working atmosphere in the classroom.

Time

The eighth element is time. For (the implementation of) education in technology, sufficient time should be made available (Tubin et al., 2003). In addition to sufficient preparation and development time for teachers (Ely, 1999), sufficient teaching time and a sufficient frequency of education in technology is required for students to develop their knowledge, skills and attitude (Mawson, 2007; Walma van der Molen, 2007).

Assessment

Ninth and final element is assessment. According to Krajcik, Czerniak and Berger (1999) traditional questions would fail to assess the multimode of knowledge, skills and attitudes that students learned, eg., their ability to work as a team, the application of their (design) knowledge and skills, and the desired attitudinal impact. Frank and Barilai (2004) argue that assessment in science and technology education should take into consideration intangible parts of the educational project and not emphasize the final products or presentations only. The real learning is often in the doing or in the process leading up to the product. Therefore, they recommend to grade students' (group)work based on the assessment of tangible and intangible outcomes. In an example that was provided, the students’ performance in a project was assessed based on meetings and discussions between the teacher and the team, observations of the students’ work in classroom, group report and portfolio, personal reflective reports, and an exhibition at the end of the course (posters, multimedia presentations, and the artifacts). A rubric was also developed and validated for this assessment. Throughout the course students were given feedback regarding their progress. Feedback given as part of formative assessment helps learners become aware of any gaps that exist between their desired goal and their current knowledge, understanding, or skill and guides them through actions necessary to obtain the goal (Black & William, 2006).

To grasp the process from curriculum ideals to the actual learning outcomes of students, this study makes use of the 'typology of curriculum representations' (van den Akker, 2003). In this typology (see figure 2) a distinction is made between the three levels of the 'intended', 'implemented', and 'attained' curriculum’. For the technology curriculum, the intended domain refers predominantly to the influence of the curriculum developers (in various roles), the implemented curriculum relates especially to the world of the school and the teacher, and the attained curriculum has to do with the students.

Intended	Ideal	Vision (rationale or basic philosophy underlying a curriculum)
	Formal/ written	Intentions as specified in curriculum documents and/or materials
Implemented	Perceived	Curriculum as interpreted by its users (especially teachers)
	Operational	Actual process of teaching and learning (also: curriculum in action)
Attained	Experiential	Learning experiences as perceived by learners
	Learned	Resulting learning outcomes of learners

Figure 2: Typology of curriculum representations

The present study

The present study is a program evaluation in which the technology curriculum is the educational program to be evaluated. Goal of this evaluation study is to investigate whether the intended characteristics of the curriculum lead to the desired impact. This impact evaluation will be complemented by investigating the implementation process of the curriculum: implemented curriculum. Herewith, quality and quantity of curriculum components can be integrated with the impact measurement and possibly explain why certain effects do or do not occur (Rossi, Lipsey & Freeman, 2003).

The curriculum is the educational program to be evaluated, which means a systematical investigation of its effectiveness within the context of the pre-vocational school and with the purpose to investigate the effectiveness of 'the elements for technology education' as described in the theoretical context (Rossi, Lipsey & Freeman, 2003). Program evaluation starts with formulating a program goal and a program theory. A program goal is a statement, usually general and abstract, of a desired state toward which a program is directed. The goal of the curriculum is to positively influence pre-vocational students' conceptions of- and attitudes towards technology. A program theory is a set of assumptions about the manner in which the program relates to the educational benefits it is expected to produce and the strategy and tactics the program has adopted to achieve its goals and objectives. The program theory of this curriculum is the aforementioned elements within each curricular spider web component that the curriculum should meet.

To fulfill the goal of this evaluation study, the following overarching research question, with two sub questions was formulated: *How does the implemented technology curriculum influence prevocational students' attitudes towards- and conceptions of technology?*

1. What is the impact of the technology curriculum on prevocational students' attitudes towards- and conceptions of technology?

2. Which elements of the implemented technology curriculum have influenced prevocational students' attitudes towards- and conceptions of technology?

The context of the study

In this study, the aforementioned elements of the curricular spider web have been used to design the technology curriculum. In the next section, the formal intended curriculum will be described with references to elements from the theory. It is expected that the incorporation of these elements into a technology curriculum ensures that students' attitudes and conceptions with regard to technology are positively reinforced.

The official title of the technology curriculum is 'the sustainable discotheque'. During the curriculum the students work on a project in project groups of three or four persons. This grouping of students was decided on to stimulate social involvement during the project. Social involvement stimulates enjoyment and has the potential to generate interest in technology. The students have a total of six lessons of three hours each, to complete the project. The fourth lesson was canceled due to circumstances, so only five lessons remained. As basis for the technology curriculum, the phases associated with the pedagogical approach 'learning by design' are followed. Specific elements within this pedagogical approach can generate situational interest and enjoyment in technology. It is important to start with an authentic and appealing assignment. Therefore the managing director of the local and popular discotheque acts as the actual client for the project groups. He orders the project groups to each re-design one of the dancing rooms of the discotheque. The managing director and the teacher will assess the final designs and will potentially use the winning design as the basis for the real re-design and re-build of the dancing rooms. A scale model and the lighting plan of the dancing room have to be made with concrete materials (hands-on). The designs must also meet up to a number of criteria (minds-on): the re-designed room has to 1. save energy, 2. generate its own energy, 3. be redecorated with sustainable materials. From theory we know that technology education should involve hands-on and minds-on activities. To ensure that the learning process of students runs smoothly, a student manual was made in which explicit instructions about the essential knowledge and operational technical principles before 'designing' are provided. Although the design assignment was very clear and a number of criteria had to be met, it was also important to leave enough 'freedom of choice' for the students to express their own ideas and creativity. Freedom of choice, especially for students this age, leads to a higher degree of autonomy and motivation. During the curriculum, the students visit the discotheque. A visit to a technology-oriented companies could potentially provide students with a stimulating 'real-world' setting to develop more broad and positive images of and attitudes toward technology and technical professions. On site the students will questions to the person that gives a tour of the discotheque. They can ask questions that relate to the design task, and career-oriented questions. Finally they can take measurements of the room that their project group will re-design. After this visit the teacher will reflect with the students on what they experienced and perceived in relation to technology and in relation to their design challenge. Theory states that the teacher should help the students to connect their on-site experiences to the classroom curriculum. Especially connecting student's design work to nurturing their technical interests, talents and professional ambitions is important. The role of the teacher is therefore very important and described in a teacher manual. During the curriculum the teacher needs to gain insight into different preconceptions of students, point out which classroom activities are related to technology, and guide students in (1) meta-cognitive skills, (2) collaboration skills, and (3) knowledge about basic technological concepts and processes and technical skills. Especially the connection between learning content and activities and technology is an important task for the teacher. From theory it becomes clear that if students associate the appropriate broad and positive technology experiences with technology, they are more likely to value and choose technology as a study or career later in life. During the third lesson, students from vocational education will help the students with their designs of the lighting plan. Students are also given the opportunity to ask study- and career-oriented questions to these students. The technology curriculum in implemented in two connected classrooms. On classroom to provide instruction and one specific technology classroom to work on the designs. All the materials, tools, space and resources that the students need to shape their design ideas, will be present in the classrooms. Theory shows that this leads to increased student interest and enjoyment in technology. During the final lesson, the project groups will present their designs of the dancing room to the entire class, the teacher, the managing director, the study- and career counselor, and the mentor of the class. Ass recommended by theory, the teacher provides formative assessment during the project, yet the final assessment is based on two tangible and one intangible outcome. Assessment in technology education should take into consideration intangible parts of the educational project and not emphasize the final products or presentations only. The real learning is often in the doing or in the process leading up to the product. In this technology project the students will be assessed on their designs, their presentations and their efforts during group work. More detailed information about the learning content and learning activities during the curriculum is presented in table 1.

Table 1: The main learning content and learning activities during the lessons of the curriculum

Lesson	Content and learning activities
1	The managing director of the discotheque explains the assignment. Project groups are formed with three or four students. The groups formulate questions related to the design assignment and (study)career orientation. These questions will be asked when they visit the technical company (lesson 2). The students receive information on the project goals, content and activities and receive information on the importance of sustainability. The students come up with ideas for sustainability of their initial designs by use of mindmap.
2	The students and teacher receive a tour of the discotheque. The students are guided by an employee of the company. Students ask the questions they formulated. The students take measurements of the dancing rooms as a basis for their scale models.
3	Teacher and students reflect on the company visitation in relation to their own design plans and in relation to technology. Two vocational students (electrical engineering) present themselves and elaborate on their own (study) career process. Students and teacher ask questions to the student(s) regarding study career choice and talent and skills needed. Students work on the design with use of the student manual and with guidance of the vocational students and the teacher.
4	This lesson was canceled.
5	The project groups work on their designs and complete them. The project groups check (as part of the cycle of design) if their designs meets all the design criteria and then make their final adjustments. The project groups prepare their presentation/pitch: PowerPoint and other materials.
6	The project groups present their own designs. The managing director and the teacher announce the best design and winning group. Feedback is

	given on the designs and presentations. The groups of students work with the ‘talent tool’ in the student manual: a tool to identify and discuss the students’ talents that were used during the technology curriculum.

Methods

Design

A case study approach was used (Yin, 2003). The case was the technology curriculum, the context was a prevocational school in Oldenzaal, and the units of analysis were one teacher and twenty one students. According to Yin's perspective, a case study design allows for making a contribution to the theoretical understanding, analytical generalization, of the consequences and alignment of this intervention on the school- and class level. This case study approach offers the opportunity to collect data by using multi-methods (Schell, 1992).

Participants

One teacher and 21 students participated in this study on a voluntary basis. The teacher is male and formally has a bachelor degree for teaching electrical engineering and has taught project education in the two years before implementation of the technology curriculum. All students were in year 3 of the mixed and theoretical pathway of pre-vocational education and the class consisted of 11 boys and 10 girls. Their average age is 15 years with a range of 14 -16.

Instruments

Three data collection methods (questionnaires, interviews, observations) were used for triangulation of findings (Yin, 2003).

Questionnaire

To measure the impact of the technology curriculum on prevocational students' attitudes towards- and conceptions of technology, an online questionnaire was administered to 21 students before and after implementation of the curriculum. The questionnaire was adapted from Walma van der Molen (2007) and was originally developed for students in primary schools that implemented science and technology in their curriculum. Two teachers and three experts have critically examined the questionnaire and found it appropriate for students in pre-vocational education (see Appendix A). At the beginning of the questionnaire, each student was asked to provide some personal information on age and gender. The remaining part of the questionnaire measured students' *Attitudes toward technology* and their *Conceptions of technology*. Responses to all attitude statements were scored on a four-point scale (1 strongly disagree, disagree, 3 agree, 4 strongly agree). Each attitude component was measured with a set of statements. Weighted sum-scores for each attitude component were constructed by averaging a student's score on each set of items that defined the attitude component. An average score between 1 and 2 indicates that on average very little or little applies to the students; a score between 2 and 3 indicates that this applies somewhat to the students; a score between 3 and 4 indicates that this is widely applicable to the students. The questionnaire consisted of 30 statements regarding technology.

The questionnaire consisted of 30 statements regarding technology. The first part of the questionnaire consisted of 7 statements that assessed student's personal view on what technology relates to and the second part consisted of 23 statements that assessed student's personal attitude toward various facets of technology. First, a principal axis factor analysis was conducted on the 7 items with oblique rotation (direct oblimin). The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .74. An confirmatory analysis was run to obtain eigenvalues for each factor in the data. Two factors had eigenvalues over Kaiser's criterion of 1 and in combination explained 67.69 % of the variance in student's scores. The two factors that were found confirmed the two original dimensions in Walma van der Molen's instrument. The first factor represents 'traditional conceptions of technology', where students indicated to what extent they thought that, for example, technology is related to technical devices or machinery (factor loadings ranged between .56 and .88; and the internal consistency was indicated by a Cronbach's alpha of .78), and the second factor represents 'academic conceptions of technology', including some scientific elements, where students indicated, for example, to what extent technology is related to coming up with new ideas of or solving problems (factor loadings ranged between .79 and .91; Cronbach's alpha of .85).

Next, a principal axis factor analysis with oblique rotation (direct oblimin) was conducted on the remaining 23 items that assessed student's personal attitude toward various facets of technology. The Kaiser-Meyer-Olkin measure verified the sampling adequacy for the analysis, KMO = .79. An confirmatory analysis was run to obtain eigenvalues for each factor in the data. Although Walma van der Molen (2007) found five factors during the development of the instrument, factor analysis revealed that only four factors had eigenvalues over Kaiser's criterion of 1 and in combination explained 74.97 % of the variance in student's scores, see Table 2.

Table 2: Summary of confirmatory factor analysis results for the SPSS attitudes towards- and conceptions of technology questionnaire
(*N* = 21)

	Rotated Factor Loadings			
Item	1. The enjoyment that students get from technology & 2.The degree to which students expect to choose a technological job	3. The extent to which students believe that technology is difficult	4. The importance to society that students ascribe to technology	5. Gender-stereotypical ideas students have about technology
Technology is interesting	**.79**	-.17	.04	-.07
I find it annoying to fix something myself	**.75**	-.14	.07	.07
I enjoy designing	**.80**	.10	-.11	-.07
I enjoy putting things together	**.93**	.15	-.04	.34
I enjoy learning more about technology	**.72**	-.16	-.05	-.19
I enjoy fixing things myself	**.87**	-.06	-.04	.05
Technology is important for society	.01	-.22	**-.79**	-.11
The government should spend more money on technology	.19	-.00	**-.73**	-.05
Technology has a great influence on people	.01	-.22	**-.71**	-.32
Everyone needs technology	-.06	-.15	**-.81**	-.09
When a country does a lot with technology. it becomes more wealthy	-.02	.18	**-.86**	.13
Technology makes life more comfortable	.05	.03	**-.84**	.05
Technology is good for the income of the	.02	.17	**-.85**	.14

country				
Boys know more about technology than girls	.18	.20	.01	**-.78**
Boys are better car mechanics than girls	.08	.14	.01	**-.85**
Boys are better with computers than girls	-.01	.16	-.12	**-.84**
I want to have a technological job	**.86**	-.04	-.07	-.07
I want to have a job in technology	**.85**	.03	.00	-.21
I want to have a technological education	**.89**	.00	.02	-.15
Technology is only for smart people	.00	**.86**	.10	-.05
Technological devices are hard to use	-.00	**.75**	-.17	-.20
Technology is difficult	-.11	**.75**	.02	-.29
I find it difficult to learn about technology	-.12	**.79**	.05	.02
Eigenvalues	8.47	4.45	3.12	1.21
% of variance	36.83	19.35	13.56	5.24
α	.92 & .96	.87	.92	.90

Table 2 shows the factor loadings after rotation. The items that cluster on factor 1 should ideally have clustered on two separate factors to represent the dimensions ‘the enjoyment students have with technology’ and ‘the extent to which students foresee a future in technology’. However, the original instrument was developed with data gathered from primary school pupils. The students in this study have an average age of 15 years and receive many career development and guidance activities at their secondary school. The consequence of this may be that they think much more about their interests, preferences and qualities in relation to a future study or job and consequently connect these two "factors" with each other. Within the decision-making process of students for a (future) study or career, it has been demonstrated that their interest and pleasure in a subject is related to a (future) study or career choice (Terlouw, 2009). In this regard, decision has been made to keep and use the five original dimensions (factors) in this study to measure the impact of the curriculum. All other items confirm the remaining three dimensions in Walma van der Molen’s instruments, and suggest that factor 2 represents the extent to which students believe that technology is difficult, factor 3 represents the importance to society that students ascribe to technology and that factor 4 represents gender-stereotypical ideas students have about technology. Assumptions for normality and homogeneity of variance were not fulfilled. Because the data were not normally distributed for five variables, a Wilcoxon Signed-Ranks Test was used to find out whether the pre- and post-scores for attitudes towards- and conceptions of technology differed significantly.

Interviews

To measure the implemented perceived curriculum and the attained experiential curriculum (see figure 2), one semi-structured interview was conducted with the teacher at the end of each lesson and one semi-structured interview was conducted with multiple (2 till 4) students at the end of each lesson. After the first lesson two fixed students (1 boy and 1 girl) and one random student were interviewed. For the second lesson, the two fixed students were interviewed. After the third lesson, an interview was held with one fixed student and one random student. After the fifth lesson (the fourth lesson was canceled), the two fixed students and one random were interviewed and after the sixth and final lesson the two fixed students were interviewed. To gather information about the teacher's and students' perceptions regarding the implemented curriculum, several topics were questioned (see Appendix B). The topics are based on the curriculum components of the curricular spiderweb (van den Akker, 2009, p.12). For each curriculum component, closed and/or open questions were asked. The interviews were transcribed and every segment was displayed in a data-matrix for intra-case analysis (Miles & Huberman, 1994). Components of the curricular spider web were used as categories within the data-matrix (see appendix C). After this deductive approach to categorize the qualitative data from the interviews, the data within the categories was coded. The answers to the closed questions were only counted and displayed in tables. For example: 'was there enough time, too little time, or too much time for the learning activities during this lesson?'. For the open questions, a coding scheme has been made inductively from the data (see appendix E). A question that was asked to both the teacher and the students was: 'what did you learn this lesson?'. The answers were coded as knowledge, skill, attitude or nothing. Thereafter the frequencies of the codes were counted. Subsequently, three interviews with students and one interview with the teacher were coded by a second researcher. Cohen's kappa was used to measure the interrater reliability. The score was 0.78, which indicates that the reliability is sufficient to good (Fleiss & Cohen, 1973). The counted and coded data were added to the data matrix. To draw conclusions from them, all the data was viewed both over the duration of a single lesson and across all lessons, to discover patterns. This also included the data from the observations. The patterns were summarized and then discussed with an expert. Based on this, the conclusions were amended or supplemented where necessary.

Observations

To measure differences between the intended curriculum and the implemented curriculum, all lessons were observed. The intended curriculum was developed with use of the components of the curricular spider web. The component 'role of the teacher' was described in the teacher manual and all other components were described in the students' manual. Therefore the teacher manual and the students' manual were used to observe whether and how the intended curriculum was implemented. The first step was to document the implemented components of the curricular spider web. For this purpose, both manuals were used during the lessons to see whether or not the component was being implemented as intended. On an observation form (see Appendix E) was then checked per component whether the component was implemented, whether it was implemented as intended, followed by notes from the researcher about notable deviations or events during the lessons. With member checking, the documented observations were viewed by the teacher and he could comment on their accuracy. These comments were used to refine the documentations. Next, the same deductive approach as mentioned above, was used to categorize the data in the data-matrix (see Appendix D). The analysis of the data within the data matrix was informed by Miles and Huberman's (1994) strategies of generating meaning. More specific, occurrences were counted. For example, did the teacher guide the students visibly on the three aspects (yes/no). How many times per aspect did he guide the students (counting). Furthermore the researchers' notes were used to interpret and illustrate these counted occurrences. Finally, the completed data-matrix provided a chain of evidence with multiple sources for each component of the curricular spider web.

Procedure

At the start of the first lesson the students voluntarily filled in the digital survey. This was repeated at the end of the final lesson. To guarantee anonymity, personal details such as the name or student number were not asked. Over the course of six weeks all lessons were observed and documented with use of the observation form. During this activity the students were not approached. Teacher was only approached when necessary. Near the end of each lesson, one to three students were individually approached to answer questions from the interview. Two fixed students and one random student were questioned. Advantage of the setup with fixed students is that it allows to follow a set of two students along the course of the lessons, so their perceptions and experiences reflect the storyline of the curriculum. The selection and questioning of random students can provide more and richer information and serves as a means to guard reliability. A one sided and biased view could emerge when only fixed students are interviewed. The fixed students were selected by the teacher. Teacher was asked to select two students from the class, a boy and a girl, that he considered representative for the entire class. The random students were selected by the researcher. The teacher was also approached at the end of each lesson for an interview.

Validity

Based on the validity procedures provided by Creswell and Miller (2000) and Miles and Huberman (1994), deliberate choice has been made to employ triangulation, member checking and researcher reflexivity this study. Triangulation was used across data sources (teachers and students) and across methods (observations and interviews) to search for convergence among multiple and different sources of information. Herewith the study relied on multiple forms of evidence. The narrative accounts of the interviews were reviewed by the teacher and six fixed students to check whether the accounts are realistic and accurate. In this study, short statements and detailed descriptions from lesson observations and interviews will also be used to help understand how the teacher and students experienced the curriculum.

Researcher reflexivity

Final validity procedure is researcher reflexivity. Researcher reflexivity is in this study particularly important because the researcher has multiple roles throughout the research: co-designer of the curriculum and curriculum evaluator. Therefore the researchers' beliefs and biases will be acknowledged and described to allow readers to understand the researcher's position, and then to suspend those biases as the study proceeds (Cresswell & Miller, 2000). In the four years previous to this research, the researcher worked as a teacher in primary education. Along with the lesson observation forms, this work experience served as a reference while observing. Therefore certain interpretations of the observed 'teaching in practice' could have been influenced. However, the experience of teaching also allowed the researcher to better understand the struggles of the teacher that were observed. The researcher co-developed the curriculum with a co-researcher and the teacher. As a result the researcher felt in part ownership of- and responsibility towards the curriculum. When researcher observed that the parts of the project were not implemented as intended, she experienced this as frustrating. Especially because the intended curriculum was very known to the researcher and she could make no interventions to influence the implementation process. Researcher discussed these frustrations with the members of research project in order to maintain focus and objectivity. Although her feeling of ownership of the curriculum could influence the interpretations of the observations, researcher's knowledge of the connection between curriculum components and design criteria enabled her to better observer important elements of the curriculum in action. The final process component that the researcher struggled with was the interaction with the students. Although the researcher sat at the back of the classroom to observe, some students asked questions. If possible, the researcher directed the students to ask the question to the teacher, but on some occasions she found she should answer them herself. Consideration was whether the answer of the researcher would influence the learning process of the students. If the researcher thought this was not the case, then she answered the question.

Results

In this section the results of the first research question, *What is the impact of the technology curriculum on prevocational students' attitudes towards and conceptions of technology?*, are described. Thereafter, results of the second research question are presented, *Which elements of the implemented technology curriculum have influenced prevocational students' attitudes towards- and conceptions of technology?*

The impact

To investigate the impact of the technology curriculum on student's attitudes towards- and conceptions of technology, a Wilcoxon Signed-Ranks Test was conducted. Herewith a comparison could be made between the student's attitudes toward- and conceptions of technology before and after enactment of the curriculum.

The output indicated that post-test scores (Mdn = 2.66), for the dimension 'the enjoyment that students get from technology' were statistically significantly higher than pre-test scores (Mdn = 2,33), Z = -1.813, p < .038, r = -.28. This result suggests that the technology curriculum had an impact on student's attitude towards the enjoyment they get from technology. Specifically, the result suggests that the students who enacted in the curriculum find technology more enjoyable. No significant differences in the median scores were found for the students on the other six dimensions.

Between curriculum intentions and learning outcomes: lesson observations, student's perceptions and teacher's perceptions

To investigate the potential influence of the nine elements of the curricular spider web on the student's attitudes toward- and conceptions of technology, the data from the lesson observations, teacher interviews and student's interviews were analyzed. In the following section these findings are integrated in an effort to determine whether and how these elements have contributed to the (lack of) attitudinal impact.

Aims and objectives

The learning objectives have been partially and indirectly implemented. The observations of the lessons and the perceptions of the students show that the formal learning goals have not been shown and appointed by the teacher. These learning aims and objectives explicitly focus on strengthening the conceptions and attitudes of the students with regard to technology. Although the teacher tells during the first lesson that the content and activities of the technology curriculum will probably surprise the students positively, he does not link this conscious interpretation of the project to the formal learning objectives. The perceptions of the teacher show that he mainly describes skills as learning outcomes and therefore probably does not consciously deal with the attitudinal learning objectives. The perceptions of the students confirm this finding, for the students also mention skills and knowledge as main learning outcomes during the lessons of the curriculum. Nevertheless, during the five lessons of the project the teacher discussed with the entire class some aspects that are indirectly related to the attitudes and conceptions with regard to technology. More precisely, this concerns the importance of sustainability and the design cycle. The result could be that the students still relatively often call an attitude element as learning output. The attitudes that were mentioned had to do with the importance of renewable energy, the importance of getting feedback, and the relationship between building on the scale model and ideas and creativity. Student, girl: "I have built ... to realize my own ideas, to be creative."

Learning content and learning activities

Most of the learning content and activities have been implemented as intended. These contents and activities seem to have had a very positive influence on the perceptions of the students (Table 3).

They mainly mention creative and physical design tasks such as creating a mind map, measuring the room, designing, drawing, making a 3D model and tinkering. Freedom of choice and collaboration were also mentioned as positive elements. Finally, the students indicated that they liked the visit to the discotheque and the presentation of vocational students (electrical engineering). It is striking that the students themselves seem to be surprised by their positive perceptions and indicate that these positive perceptions were against their prior expectations. The negative perceptions of students are minimal and do not seem to directly influence the desired attitudinal effects: the long bike ride to the discotheque and the lengthy instruction of the teacher during the first lesson (only one student mentioned this). The observations and the perceptions of the teacher are also mainly positive. Although most of the intended contents and activities were implemented, the teacher does not explicitly link these contents and activities to the learning objectives. However he does implicitly relate elements of the project to technology, such as the importance of the design cycle, the importance of sustainability, creativity and collaboration. The teacher himself only has negative perceptions on his own instruction and guidance. These perceptions are reflective in nature. The teacher indicates what and why he would have done differently. Teacher: "The collaboration process was the same for the students that worked on the scale model and those who were working on the lighting: they worked separately from each other. In the end their designs were only a bit joined together. Coincidentally a student has a long thread to the lights, so then we can fix the lighting in a certain manner. It was not thought through beforehand: hey we're going to do it this way! So the next time I can guide the students by saying: if you are working on that LED lighting, think beforehand: where does the design of the scale model come in to determine the LED lighting points? ".

Table 3: The perceptions of the students on the learning content and learning activities

Lesson	Positive	*N*	Negative	*N*	Neutral	*N*
1	To make the mindmap	3	Nothing Instruction of the teacher	2 1		
2	Visiting the 'dancing' To measure the room	1 1	Cycling to the 'dancing'	2		
3	Information provided by the vocational students To design, to draw, to create a 3D product	1 1	Nothing	2		
4	-	-	-	-	-	-
5	To make the scale model To be creative To think of something yourself	1 2 1	Nothing	2		
6	To present the design	2	Nothing	2		

Role of the teacher

The teacher has implemented his role for the most part as intended. During the lessons of the project, the teacher seemed to be able to maintain a good balance between giving the required instruction and guiding the project groups on the aspects of collaboration and content learning. The aspect 'guiding students in acquiring metacognitive skills' was not observed or noticed by the students and the teacher, but was nevertheless addressed during the classroom instruction at the beginning of each lesson. The observations showed a positive teacher who seemed very involved with the project and also felt responsible for the (design) process of the groups of students. This is in line with the perceptions of the students. Except for one comment (about the lengthy explanation during the first lesson), the students only make positive comments about the guidance of the teacher. Boy: "Yes, he came by to ask how it was and he also helped with soldering. The teacher is very clear and also tells that he only explains something for a little while.". The observations showed that the teacher, while guiding collaboration processes, mainly asks closed questions to the project groups. He did not discuss the quality of the group conversations or how these could be improved. The teacher seems to be aware of the importance of collaboration, but in his ‘teaching repertoire’ he does not seem to be equipped to adequately guide the students in this process. To a lesser extent, this also applied to his guidance of students in content learning (measuring the room, making a mind map, discussing ideas, soldering LED lighting and making PowerPoint). The teacher frequently asked open questions, but these often seemed to be focused on completing the design (scale model + lighting). Questions that were focused on technical principles, origin of ideas, underlying images and attitudes have not been observed. Although there are still strong aspects of improvement for the role of the teacher, the shift from traditional teaching to guiding the students in their design process, seems to have had a positive influence on the perceptions of the students.

Materials and resources

The element 'materials and resources' was implemented as intended. Except for one girl, all students indicated that all the necessary materials and resources were present during the entire project. The girl in question said that there was too little duct tape during lesson five. The teacher is also positive about the content and form of the student’s manual, but indicated that in his role he should have referred more to it in order for the students to understand its importance. Nevertheless, the perceptions of the students and the observations showed that the students frequently used the student’s manual in relation to their design processed. Especially the mind map is a part that was mentioned throughout the project as a (creative) source.

Time

The element ‘time’ is for the most part implemented as intended. Due to circumstances one of the six lessons was canceled, but due to the work rate of the students this did not influence the work processes and the completion of the final designs. The work pace was high, which somewhat astonished the teacher: "For the rest, I think it all went very quick. I expected that they would need more time. We only started with the scale model last week and if you see what the result is in two weeks, it is a lot. I thought that one of the project groups would never finish.". Table 4 shows that most students also perceived that they had enough time for the technology curriculum.

Table 4 : Perceptions of the students on the amount of time per lesson

	Too little time	Enough time	Too much time
Lesson	Count	Count	Count
1	0	2	1
2	0	2	0
3	0	2	0

4	-	-	-
5	0	3	0
6	1	1	0

The results of the element ‘time’ may even indicate that the absence of the fourth lesson was beneficial for the perceptions of both students and the teacher on this element. The observations showed that the teacher did not spend the time precisely on the activities as they are described in the student’s- and teacher's manual. For example the time at the start and final phase of each lesson that was intended to address the aims and objectives and reflect on them, was not implemented. Nevertheless, all other learning activities have been implemented. The general impression during the lessons was that the teacher thoroughly prepared the lessons and therefore had enough time and space to guide the students and pay attention to their design processes. The element ‘time’ therefore seems to strongly correlate with all of the aforementioned elements of the curricular spider web and indirectly had a positive influence on the attitudinal impact on students.

Grouping

The element 'grouping' was implemented as intended. What is striking from the perceptions of the students is that liked the combination of being able to work together, but also being able to sometimes work on a part of the design assignment alone. They indicated that it is nice to be able to divide the tasks, but also that it is nice to be able to fall back on the knowledge and skills of others. One girl preferred to 'collaborate' over other grouping forms: *"Fine, because I do not like working alone, I love making something together."*. The teacher also seemed to prefer the importance of collaborating over providing instruction to the entire class, and stated that next time he would shorten the long instruction during lesson one. The element ‘grouping’ seemed to have contributed greatly to the pleasure that students experience during the design process and therefore also contributed in part to the attitudinal impact.

Location

The location(s) where the technology curriculum took place largely corresponded with the theory about how such locations should look like. The two classrooms at school seemed to support the students in their design process: both in the development of their designs and in their social interaction (involvement). In addition, the external location of the discotheque seemed to be in alignment with the student’s living environment and interests. Most students recognized the location, however they experienced it as surprising and new because the visit was during the day, instead of a night. What is striking about the student’s perceptions is that they described the workspaces in school positively with words such as' big ','fits well with the assignment' and 'enough space to sit apart with your group members'. The project groups sat together at a round table during the design phase. This seating seemed to stimulate social processes positively. Both the observations and the perceptions of the teacher indicated that the students collaborated positively, frequently and motivated. The impression during the second lesson at the discotheque is that the students were curious about the location but also used their time effectively to measure the dancing rooms.

Assessment

The students’ (group)work was graded based on the assessment of tangible (product and presentation) and intangible (work attitude and effort of individual students) outcomes. Although the teacher implemented the element ‘assessment’ as intended, the students only seemed partly aware of the method of assessment. They all indicated that they are assessed on several components, but majority of the students could not name the three components. However, they consistently mentioned that 'the process' is part of their final grade and were also positive about this procedure. Girl: *"You get grades for several things and not one thing. You know what you did badly and what you did well. The next time you can do something about it."*. The students seemed to perceive the feedback from the teacher positively and indicated that they also knew what they could improve. Observations and perceptions of the teacher showed that he gave mainly formative feedback to students on their design products and on their metacognitive skills. In accordance with the element 'role of the teacher', the teacher did not seem to be adequately equipped in his teaching repertoire concerning the guidance of collaboration processes that could influence the intangible outcomes. In spite of this, the fact that these intangible outcomes were part of the assessment seemed to have a positive influence on the perceptions of the students on this element. In Table 5, the main conclusions for each curricular spiderweb element are summarized.

Table 5: the main conclusions for each curricular spiderweb

Element of the curricular spiderweb	Conclusions
Aims and learning objectives	The formal learning goals have not been shown and appointed by the teacher. However, he did discuss some aspects that are indirectly related to the attitudes and conceptions with regard to technology. This might have been the reason for students to mention some attitudinal learning gains.
Learning content and learning materials	The students and the teacher are almost entirely positive towards the implemented learning content and activities: creative and physical design tasks, freedom of choice and collaboration. However, the teacher does not explicitly link these contents and activities to the learning objectives and therefore to technology.
Role of the teacher	The teacher was positive and very involved with the (design) process of the groups of students. His role of 'guiding students in acquiring metacognitive skills' was not observed. His roles of 'guiding students in their collaboration process and learning content' were observed, yet these roles were not as intended. The teacher mainly asked closed questions and seemed focused on the completion of the designs. Finally, the teacher did not explicitly link the learning content and activities to technology.
Material and resources	Majority of the students said that the required materials and resources were present. The student manual and mind map were frequently used.
Time	The teacher thoroughly prepared the lessons and therefore had enough time and space to guide the students and pay attention to their design processes. The fourth lesson was cancelled, and this seemed to be a positive event, for the students and the teacher experienced enough time, with enough pressure to complete the design tasks.
Grouping	The perceptions of the teacher and the student are positive. The students liked the combination of being able to work together, but also being able to sometimes work on a part of the design assignment alone.
Location	The location (two classrooms) seemed to support the students in their design process: both in the development of their designs and in their

	social interaction (involvement). In addition, the external location of the discotheque seemed to be in alignment with the student's living environment and interests.
Assessment	The students indicated that they are assessed on several components, but majority of them could not name the three components. However, they consistently mentioned that 'the process' is part of their final grade and were also positive about this procedure.

Discussion

This study evaluated the impact and the implementation process of the technology curriculum that aimed to positively enhance prevocational students' attitudes towards- and conceptions of technology. This single case study aimed to integrate impact components with implementation components to explain why certain effects do or do not occur (Rossi, Lipsey & Freeman, 2003). The goal was to contribute to the theoretical and practical understanding of how a specific curriculum in a specific context for a specific group of people played out (Yin, 2003). The results are used to answer the research question: *How does the implemented technology curriculum influence prevocational students' attitudes towards- and conceptions of technology?*

The impact of the technology curriculum on students' attitudes and conceptions

The results of the Wilcoxon Signed-Ranks Test indicate that the technology curriculum had a positive impact on the extent to which they enjoy technology. Specifically, the result suggests that the students who enacted in the curriculum find technology more enjoyable. Even though the median scores on the other six dimensions (traditional conceptions, academic conceptions, relevance, difficulty, gender stereotype ideas, future) moved in the desired direction, no significant differences in the scores were found for the students on these dimensions.

The implementation of the technology curriculum

The results of the qualitative data suggest that the positive impact found, can be attributed to elements of the implemented curriculum. Especially the elements 'learning content' and 'learning activities' seem to have contributed to the positive perceptions of the students on the implemented curriculum. Data from the observations and interviews suggest that the design assignment appealed to the students and was in aligned with their interests and living environment. As Autio et al., (2012) stated, these aspects influence the students interest and enjoyment in technology. In addition, the company visit, the freedom of choice and the creative and physical design tasks within a social work setting seem to have had an impact on the enjoyment that students experienced during the project. It should be noted that this 'pleasurable' assignment seemed to come as a surprise to the students. The reasoning is that when the students expect a negative experience, the actual experienced curriculum can more easily be better than the expected curriculum (Kaldi, Filippatou, & Govaris, 2009). Therefore this prior negative expectation could have enhanced the extent to which the students in fact enjoyed the curriculum.

No impact was found on the dimension 'academic conceptions' of students. However, devising ideas with the help of a mind map, being creative with, among other things, the arrangement of the dance room, solving a design problem related to sustainability are activities that relate to broad images of technology. However, the results indicate that the teacher failed to connect these experiences of the students to the concept of technology (Jarvis & Rennie, 1996). The students also dealt with traditional images of technology: learning how to assemble a power circuit. However, this skill was a means (and not a goal) to be able to design the sustainable room in the discotheque. Van den Akker (2003) endorses the importance of the elements 'learning content' and 'learning activities', and claims that they represent the core of a curriculum. Implementing this core as it was intended therefore seems to be relatively more important to the found attitudinal impact than the other elements. However, several other elements of the curricular spider web seem to have supported students in their social work process and physical and creative design tasks. The location, the materials and sources, the grouping and the assessment largely correspond to the theory about how these elements should look like in technology education (Tubin et al., 2003). And more importantly, they are perceived as predominantly positive by the students. Van den Akker (2003) also stated that almost all elements play a role at school and class level. Consistency is crucial for successful and sustainable implementation of innovations. The elements 'location', 'materials and resources', 'grouping' and 'assessment' have a strong coherence with the elements 'learning content' and 'learning activities' and thus seem to support the positive influence of the latter.

Finally, the lack of impact on the other five dimensions can also be attributed to elements of the implemented curriculum. In particular the element ‘role of the teacher’ and consequently the element ‘aims and objectives’ seem to have contributed to this lack of impact (Osborne, Simons & Collins, 2003). Although the observations and interviews show that all learning contents and learning activities are largely implemented by the teacher as intended, the teacher does not explicitly relate these contents and activities to technology. The observations already showed that the teacher does not explicitly mention the 'learning objectives' during the project, while this was the intention. As Jarvis and Rennie (1996) pointed out, the students were not able to link these activities directly to broad and positive experiences with technology within the context. And especially contextual elements such as a 'real' client, a company visit, and the support from vocational students from a technological educational track, could probably have had an influence on the dimension 'The degree to which students expect to choose a technological study or job'. In addition, the technology curriculum contained many examples of the importance of technology in relation to sustainability. The teacher mentioned the importance of sustainability several times, the students also saw this as a learning yield, but the link with technology was not explicitly made by the teacher (Jarvis & Rennie, 1996). Parts of the technology curriculum that relate to the dimensions 'difficulty of technology' and 'gender stereotype ideas' are not linked to technology as well. The role of the teacher as it should ideally be carried out is described in the teacher manual. This manual was developed by two experts and has been discussed with the teacher on one occasion only. During development of the technology curriculum, the experts and especially the teacher, put emphasis on the content and activities of the technology curriculum and its translation in a student manual. As a logical consequence it can be stated that the intended role of the teacher as described in the teacher manual, had little chance of successful implementation (Coenders, 2010).

Scientific and practical implications

The results of this study show a first step towards the design of future technology curricula that strengthen attitudes towards- and conceptions of technology. Although this has already been demonstrated in primary education (Walma van der Molen, 2007), this study indicates that there are certainly opportunities to positively influence the attitude of students in secondary education as well. Although many elements have been implemented in the technology curriculum that could influence the conceptions and attitudes in the desired direction, the role of the teacher appears to have been a determining element. Future research should perhaps focus on combining all elements, but with special attention to the role of the teacher (Walma van der Molen, de Lange & Kok, 2009). Walma van der Molen, de Lange and Kok (2009) recommend three dimensions to develop teachers’ attitude towards technology: the cognitive, affective, and behavioral dimension.

Although it is not news that the teacher makes the difference (Jarvid & Rennie, 1996), the role of the teacher has not been emphasized during the development of the curriculum. During the development process, the teacher and an expert focused on the development of the students’ manual, whereas the expert and the researcher developed the teacher’s manual and went through this manual only shortly with the teacher. However, the teacher, and therefore his role during the technology curriculum, is one of the most influential factors in effective technology education (Osborne, Simons & Collins, 2003). In order to influence students’ attitudes towards- and conceptions of technology positively, teachers need to have or develop the associated knowledge, skills, and attitudes. Therefore it is recommended that all future development practices include the teacher(s) (Handelzalts, 2009; Coenders, 2010).

Limitations

In this study an important limitation is the scale size. Because only one case was investigated, the conclusions should be interpreted with caution (Ochieng, 2009). The data collected on perceptions of students came from only two fixed students and one random student per lesson. Greater depth of analysis might have been obtained by conducting interviews with more students or use an alternative instrument to collect the perceptions of all the students. In addition, it is important to also look critically at the interview and associated questions, to reconsider whether this is the best way to measure what has been investigated. In addition, the questionnaire could also be critically examined to determine whether a five-point scale is preferred instead of a four-point scale (Lozano, García-Cueto & Muñiz, 2008). This is due to the higher age of high school students compared to primary school pupils. A five-point scale provides them with freedom of choice and could reflect a more accurate picture of their attitudes and conceptions regarding technology. In addition, factor analysis revealed that the dimensions "pleasure in technology" and "future in technology" were loaded under one factor. For students of this age, attitude elements and intrinsic motivation play a role in the decision-making process for a future study (Kemper, van Hoof, Visser, de Jong, 2007). In addition, the "life span, life space theory" of Super (1990) shows that adolescents from the age of 14 acquire information about their personal interests, capacities and occupations, aimed at making career choices. Although it almost seems logical that the students in this study closely relate the two abovementioned dimensions, it is advisable to further investigate and develop the reliability and usability of this questionnaire for students in this age group. Next, this study only investigated the one teacher that enacted the curriculum. If two or more teachers implement the same curriculum, a comparison between their perceptions and 'teaching in action' could provide more insight in effective implementation aspects. Final limitation is the short time-span in which the technology curriculum was implemented and in which the impact was found. As Palmer (2008) already stated, the impact that was found will very likely be situational and decrease over time.

Suggestions future research

On the level of curriculum evaluation, this study did not investigate gender differences. In the selection of theory for 'effective' elements of a technology curriculum, this variable was not taken into account. However, some research shows that in general boys and girls seem to have different preferences when it comes to technology education (Virtanen, Räikkönen & Ikonen, 2014). If these preferences are taken into account during development and research practices, more precise conclusions could be drawn on elements of a technology curriculum that have potential influence on the attitudes toward- and conceptions of technology of boys and girls. Another recommendation for future research would be to evaluate a technology curriculum that seemingly implements all the elements as intended, to gain even better insight into the aspects of these elements that contribute separately or combined to the desired attitudinal impact. Final recommendation is to investigate the influence of multiple experiences with these kind of technology curricula on student's attitudes toward- and conceptions of technology. As Palmer (2008) stated, multiple experiences of situational interest can lead to long-term interest. When a teacher consequently connects these experiences to nurturing student's technical interests, talents and professional ambitions, this process might be an effective motivator to choose an educational track or job in technology.

References

Alfieri, L., Brooks, P. J., Aldrich, N. J., & Tenenbaum, H. R. (2011). Does discovery-based instruction enhance learning? *Journal of Educational Psychology*, *103*(1), 1–18. https://doi.org/10.1037/a0021017

Anderman, E. M., Noar, S. M., Zimmerman, R. S., & Donohew, L. (2004). The need for sensation as a prerequisite for motivation to engage in academic tasks. *Advances in Motivation and Achievement*, *13*, 1–26. https://doi.org/10.1016/s0749-7423(03)13001-4

Autio, O., Hietanoro, J., & Ruismäki, H. (2010). Taking part in technology education: elements in students' motivation. *International Journal of Technology and Design Education*, *21*(3), 349–361. https://doi.org/10.1007/s10798-010-9124-6

Bame, E., Dugger, W., De Vries, M., & McBee, J. (1993). Pupils' Attitudes Toward Technology—PATT-USA. *The Journal of Technology Studies*, *19*(1), 40–48. Geraadpleegd van http://www.jstor.org/stable/43603608

Barmby, P., Kind, P. M., & Jones, K. (2008). Examining Changing Attitudes in Secondary School Science. *International Journal of Science Education*, *30*(8), 1075–1093. https://doi.org/10.1080/09500690701344966

Bell, P., Lewenstein, B., Shouse, A., & Feder, M. (2009). *Learning Science in Informal Environments: People, Places, and Pursuits.*. Washington D.C., U.S.A.: The National Academies Press.

Black, P., & Wiliam, D. (1998). Assessment and Classroom Learning. *Assessment in Education: Principles, Policy & Practice*, *5*(1), 7–74. https://doi.org/10.1080/0969595980050102

Coenders, F. (2010). Teachers' professional growth during the development and class enactment of context-based chemistry student learning material. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

Creswell, J. W., & Miller, D. L. (2000). Determining Validity in Qualitative Inquiry. *Theory Into Practice*, *39*(3), 124–130. https://doi.org/10.1207/s15430421tip3903_2

De Vries, M. J. (1988). Techniek in het natuurkunde-onderwijs. Doctoral dissertation, Technical University of Eindhoven, Eindhoven, The Netherlands.

De Vries, M.J. (1994). Technology education in Western Europe. In Layton, D., editor*, Innovations in Science and Technology Education*, volume V, pages 31–44. UNESCO, Paris.

Ely, D. P. (1990). Conditions that Facilitate the Implementation of Educational Technology Innovations. *Journal of Research on Computing in Education*, *23*(2), 298–305. https://doi.org/10.1080/08886504.1990.10781963

Esjeholm, B., & Bungum, B. (2012). Design knowledge and teacher–student interactions in an inventive construction task. *International Journal of Technology and Design Education*, *23*(3), 675–689. https://doi.org/10.1007/s10798-012-9209-5

Fleiss, J. L., & Cohen, J. (1973). The Equivalence of Weighted Kappa and the Intraclass Correlation Coefficient as Measures of Reliability. *Educational and Psychological Measurement*, *33*(3), 613–619. https://doi.org/10.1177/001316447303300309

Fraser, B. J., Tobin, K., & McRobbie, C. J. (2012). *Second International Handbook of Science Education*. Dordrecht, Nederland: Springer Netherlands.

Fraser, B. J., & Walberg, H. J. (1991). *Educational environments: Evaluation, antecedents and consequences*. New York, U.S.A.: Pergamon Press.

Handelzalts, A. (2009). Collaborative curriculum design in teacher design teams. Doctoral dissertation, University of Twente, Enschede, The Netherlands.

ITEA. (2006). *Technological literacy for all. A rationale and structure for the study of technology* (2nd edn. International Technology Education Association, Reston). Geraadpleegd van https://www.iteea.org/file.aspx?id=42633

Kaldi, S., Filippatou, D., & Govaris, C. (2011). Project-based learning in primary schools: effects on pupils' learning and attitudes. *Education 3-13*, *39*(1), 35–47. https://doi.org/10.1080/03004270903179538

Kemper, P., Hoof, J. van, Visser, M., & Jong, M. de (2007). Studiekeuze in kaart gebracht: gedragsdeterminanten van scholieren bij het kiezen van een vervolgopleiding. *Tijdschrift voor Hoger Onderwijs, 25*(4), 270-280.

Kind, P., Jones, K., & Barmby, P. (2007). Developing Attitudes towards Science Measures. *International Journal of Science Education*, *29*(7), 871–893. https://doi.org/10.1080/09500690600909091

Krajcik, J. S., Czerniak, C., & Berger, C. (1999). *Teaching Children Science: A Project-based Approach*. New York, U.S.A.: McGraw-Hill.

Lin, H., Lawrenz, F., Lin, S., & Hong, Z. (2012). Relationships among affective factors and preferred engagement in science-related activities. *Public Understanding of Science*, *22*(8), 941–954. https://doi.org/10.1177/0963662511429412

Lozano, L. M., García-Cueto, E., & Muñiz, J. (2008). Effect of the Number of Response Categories on the Reliability and Validity of Rating Scales. *Methodology*, *4*(2), 73–79. https://doi.org/10.1027/1614-2241.4.2.73

Marsh, C. J., & Willis, G. (1999). *Curriculum: Alternative Approaches, Ongoing Issues*. New Jersey, U.S.A.: Merrill.

Mawson, B. (2006). Factors Affecting Learning in Technology in the Early Years at School. *International Journal of Technology and Design Education*, *17*(3), 253–269. https://doi.org/10.1007/s10798-006-9001-5

McCormick, R. (2004). Issues of Learning and Knowledge in Technology Education. *International Journal of Technology and Design Education*, *14*(1), 21–44. https://doi.org/10.1023/b:itde.0000007359.81781.7c

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: an expanded sourcebook*. Londen, Engeland: Sage Publications.

Moti, F., & Barzilai, A. (2004). Integrating alternative assessment in a project-based learning course for pre-service science and technology teachers. *Assessment & Evaluation in Higher Education*, *29*(1), 41–61. https://doi.org/10.1080/0260293042000160401

Ochieng, P. A. (z.d.). An analysis of the strenghts and limitations of qualitative and quantitative research paradigms. Geraadpleegd op 9 januari 2019, van http://www.scientiasocialis.lt/pec/files/pdf/Atieno_Vol.13.pdf

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education*, *25*(9), 1049–1079. https://doi.org/10.1080/0950069032000032199

Palmer, D. H. (2008). Student interest generated during an inquiry skills lesson. *Journal of Research in Science Teaching*, *46*(2), 147–165. https://doi.org/10.1002/tea.20263

Post, T., & Walma van der Molen, J. H. (2014). Effects of company visits on Dutch primary school children's attitudes toward technical professions. *International Journal of Technology and Design Education*, *24*(4), 349–373. https://doi.org/10.1007/s10798-014-9263-2

Raizen, S. A. (1997). Making way for technology education. *Journal of Science Education and Technology*, *6*(1), 59–70. https://doi.org/10.1023/a:1022521002691

Researchcentrum voor Onderwijs en Arbeidsmarkt. (2011). *De arbeidsmarkt naar opleiding en beroep tot 2016*. Geraadpleegd van http://www.hobeon.nl/uploads/weblog/roa_r_2011_8.pdf

Rohaan, E. J., Taconis, R., & Jochems, W. M. G. (2008). Reviewing the relations between teachers' knowledge and pupils' attitude in the field of primary technology education. *International Journal of Technology and Design Education*, *20*(1). https://doi.org/10.1007/s10798-008-9055-7

Rossi, P. H., Lipsey, M. W., & Freeman, H. E. (2003). *Evaluation: a systematic approach* (7e ed.). California, U.S.A.: Sage.

Savery, J. R., & Duffy, T. M. (2001). *Problem based learning: An instructional model and its constructivist framework* (Technical report, Center for Research on Learning and Technology, Indiana University, Bloomington, IN). Geraadpleegd van https://pdfs.semanticscholar.org/549c/9ea78fe19aa609a66e84ea0b2ecda5e731bf.pdf

Schell, C. (1992). *The value of the case study as a research strategy* (Manchester Business School). Geraadpleegd van http://www.finance-mba.com/Case%20Method.pdf

Super, D.E. (1990). A life-span, life-space approach to career development. In D.Brown, L.Brooks, & Associates. *Career Choice and development: Applying contemporary theories to practise* (2nd ed.). San Fransisco: Jossey-Bass

Tanis, M., Dobber, M., Zwart, R., & Van Oers, B. (2014). *Beter leren door onderzoek. Hoe begeleid je onderzoekend leren van leerlingen?* (VU, Amsterdam). Geraadpleegd van http://www.nro.nl/wp-content/uploads/2014/12/Beter-leren-door-onderzoek_VanOers-obv-review.pd

Terlouw, C. (2009). *Leren door te stromen en aan te sluiten. Op zoek naar een geschikte balans van wrijving en (be)geleiding*. Lectorale rede Saxion 11 juni 2009. Enschede: Saxion, Kenniscentrum onderwijsinnovatie/Lectoraat Instroommmanagement & Aansluiting.

Tubin, D., Mioduser, D., Nachmias, R., & Forkosh-Baruch, A. (2003). Domains and Levels of Pedagogical Innovation in Schools Using ICT: Ten Innovative Schools in Israel. *Education and Information Technologies*, *8*(2), 127–145. https://doi.org/10.1023/a:1024554313858

Tytler, R., Osborne, J., Williams, G., Tytler, K., & Cripps Clarck, J. (2008). *Opening up pathways: Engagement in STEM across the primary–secondary school transition* (Australian Department of Education). Geraadpleegd van https://docs.education.gov.au/system/files/doc/other/openpathinscitechmathenginprimsecschtrans.pdf

Van Aalderen-Smeets, S. I., Walma van der Molen, J. H., & Asma, L. J. F. (2011). Primary teachers' attitudes toward science: A new theoretical framework. *Science Education*, *96*(1), 158–182. https://doi.org/10.1002/sce.20467

Van den Akker, J. (2003). Curriculum perspectives: An introduction. In J. van den Akker, W. Kuiper, & U. Hameyer (Reds.), *Curriculum landscapes and trends* (pp. 1–10). Dordrecht, Nederland: Kluwer Academic Publishers.

Van den Akker, J. (2009). Curriculum design research. In T. Plomp, & N. Nieveen (Reds.), *An introduction to educational design research* (pp. 37–51). Geraadpleegd van http://www.slo.nl/downloads/2009/Introduction_20to_20education_20design_20research.pdf

Van Graft, M., & Kemmer, P. (2007). *Onderzoekend en ontwerpend leren bij natuur en techniek* (Amsterdam: Programma Verbreding Techniek Basisonderwijs). Geraadpleegd van http://downloads.slo.nl/Documenten/LOOLbasis.pdf

Virtanen, S., Räikkönen, E., & Ikonen, P. (2014). Gender-based motivational differences in technology education. *International Journal of Technology and Design Education*, *25*(2), 197–211. https://doi.org/10.1007/s10798-014-9278-8

Walma van der Molen, J. H. (2007). *De ontwikkeling van een attitude-instrument op het gebied van wetenschap en techniek voor leerlingen in het basisonderwijs* (Eindrapportage VTB Attitude Monitor).

Walma van der Molen, J., de Lange, J., & Kok, J. (2009). Theoretische uitgangspunten bij de professionalisering van leraren basisonderwijs op het gebied van wetenschap en techniek. In H. van Keulen, & J. Walma van der Molen (Eds.), *Onderzoek naar wetenschap en techniek in het Nederlandse basisonderwijs* (pp. 29-39). Den Haag: Platform Bèta Techniek.

Walma van der Molen, J., & Van Aalderen-Smeets, S. I. (2013). Investigating and stimulating primary teachers' attitudes towards science: A large-scale research project. *Frontline Learning Research*, *1*(2). https://doi.org/10.14786/flr.v1i2.27

Wyffels, D. (2006). *Hoe Coach Ik Mijn Klas?*. Tielt, België: Lannoo.

Yin, R. K. (2003). *Case study research, design and methods*. Newbury Park, U.S.A.: Sage.

Appendices

Appendix A

List with items that belong to the digital questionnaire 'attitudes towards- and conceptions of technology'.

Traditionele en academische opvattingen	Dimensie
Over techniek	
Geef aan hoeveel techniek te maken heeft met computers	Traditioneel
Geef aan hoeveel techniek te maken heeft met oplossingen bedenken	Academisch
Geef aan hoeveel techniek te maken heeft met elektriciteit	Traditioneel
Geef aan hoeveel techniek te maken heeft met producten ontwerpen	Academisch
Geef aan hoeveel techniek te maken heeft met het bedenken van nieuwe ideeën	Academisch
Geef aan hoeveel techniek te maken heeft met het omgaan met machines	Traditioneel
Geef aan hoeveel techniek te maken heeft met het omgaan met apparaten	Traditioneel

Per stelling kunnen leerlingen aangeven in hoeverre ze deze onderschrijven (op een schaal van 1 tot 4, van 'heel weinig', 'weinig', 'veel', tot 'heel veel').

Attitude	
Over techniek:	
Techniek is interessant	Plezier
Techniek is belangrijk voor de samenleving	Belang
Jongens weten meer van techniek dan meisjes	Seksestereotype
De regering moet meer geld uitgeven aan techniek	Belang
Vervelend om zelf iets te repareren	Plezier
Techniek heeft grote invloed op mensen	Belang
Leuk om dingen te ontwerpen	Plezier
Techniek is alleen voor slimme mensen	Moeilijk
Leuk om dingen in elkaar te zetten	Plezier
Later graag een technisch beroep	Toekomst
Iedereen heeft techniek nodig	Belang
Technische apparaten zijn moeilijk te gebruiken	Moeilijk
Later graag een baan in de techniek	Toekomst
Jongens zijn betere automonteurs dan meisjes	Seksestereotype
Techniek is moeilijk	Moeilijk
Leuk om meer te leren over techniek	Plezier
Later graag een technische opleiding	Toekomst
Jongens zijn beter met computers dan meisjes	Seksestereotype
Leuk om zelf iets te repareren	Plezier
Als een land veel aan techniek doet, wordt het rijker	Belang
Moeilijk om over techniek te leren	Moeilijk
Techniek maakt leven prettiger	Belang
Techniek is goed voor inkomsten van het land	Belang

Per stelling kunnen leerlingen aangeven in hoeverre ze deze onderschrijven (op een schaal van 1 tot 4, van 'helemaal niet mee eens', 'niet mee eens', 'mee eens', tot 'helemaal mee eens').

Appendix B

Interview questions for the teacher(s) and students

Questions teacher:

Leerdoelen: Wat hebben de leerlingen geleerd?
Leerinhoud en leeractiviteiten: Wat vond je van de inhoud/activiteiten deze les? Hoe verliep de les?
Rol van de docent: Wat was jouw rol deze les?
Materialen en bronnen: Wat vind je van de gebruikte materialen en bronnen?
Groepering: (evt) Wat vind je van de groepering (vorm) van de leerlingen
Tijd: Wat vind je van de beschikbare tijd voor deze les/project?
Beoordeling: Wat vind je van deze wijze van beoordelen?

Questions students:

Leerdoelen: Wat heb je deze les geleerd?
Leerinhoud en leeractiviteiten: Wat vond je van de inhoud/activiteiten deze les? Wat vond je leuk/niet leuk?
Rol van de docent: Ben je deze les ergens bij geholpen/begeleid? Heb je om hulp gevraagd?
Materialen en bronnen: Waren alle materialen en bronnen die je nodig had aanwezig? Wat vind je van de materialen die je nodig had deze les?
Groepering: Op welke manier/werkvorm heb je deze les gewerkt?
Tijd: Had je genoeg, te weinig, of teveel tijd voor deze les?
Beoordeling: Wat vind je van deze wijze van presenteren (beoordelen)?

Appendix C

Data-matrix for intra-case analysis

Element	Observaties	Interview docent	Interview leerlingen
Leerdoelen	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6
Leerinhouden- en activiteiten	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6
Rol van de docent	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6
Materialen en bronnen	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6
Groepering	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6
Tijd	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6
Locatie	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6

Beoordeling	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6	Les 1 les 2 Les 3 Les 4 Les 5 Les 6

Appendix D

Observatieschema

	Geimplementeerd? Ja-Nee	Zoals bedoeld? Ja-Nee	Aantekeningen:
Leerdoelen	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	
Inhoud en activiteiten	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	
Rol docent begeleiden bij: 1. metacognitie 2. samenwerken 3. inhoudelijk leren	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	
Materialen en bronnen	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	
Groepering	Les 1: Les 2: Les 3: Les 4: Les 5:	Les 1: Les 2: Les 3: Les 4: Les 5:	

	Les 6:	Les 6:	
Locatie	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	
Tijd	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	
Beoordeling	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	Les 1: Les 2: Les 3: Les 4: Les 5: Les 6:	

Appendix E

Codeerschema – inductief – interview leerlingen

Component curriculair spinnenweb	Vraag - interview	Code(s)	Tellen
Leerdoelen	Wat heb je deze les geleerd?	Kennis Vaardigheid Houding Niets	
Leerinhoud en leeractiviteiten	Wat vond je van de inhoud/activiteiten deze les? Wat vond je leuk/minder leuk?	Positief Negatief Neutraal	
Rol van de docent	Ben je deze les ergens bij geholpen? Door wie? Heb je om hulp gevraagd?	Instructie/uitleg door docent: positief Instructie/uitleg door docent: negatief	Ja – Nee Docent Student (hbo-mbo) Medeleerling Ja – Nee
Materialen en bronnen	Waren alle materialen en bronnen die je nodig had aanwezig? Wat vind je van de materialen en bronnen die je nodig had?		Ja – Nee
Groepering	Op welke manier (samenstelling groep) heb je deze les gewerkt? Wat vind je van deze werkwijze?	Werkwijze: positief Werkwijze: negatief	Alleen Samen – tweetal Hele groep Combinatie
Tijd	Had je genoeg tijd, te weinig tijd, of teveel tijd voor deze les?		Genoeg Te weinig Te veel
Beoordeling	Wat vind je van deze wijze van beoordelen?	Positief Negatief Neutraal	

Codeerschema – inductief – interview docent

Component curriculair spinnenweb	Vraag - interview	Code(s)	Tellen
Leerdoelen	Wat hebben de leerlingen geleerd?	Kennis Vaardigheid Houding Niets	
Leerinhoud en leeractiviteiten	Wat vond je van de inhoud/activiteiten deze les? Hoe verliep de les?	Positief Negatief Neutraal	
Rol van de docent	Wat was jouw rol deze les	Begeleidend Coachend Instructeur	
Materialen en bronnen	Wat vind je van de gebruikte materialen en bronnen?		
Groepering	Op welke manier (samenstelling groep) heb je deze les gewerkt? Wat vind je van deze werkwijze?	Werkwijze: positief Werkwijze: negatief	Alleen Samen – tweetal Hele groep Combinatie
Tijd	Had je genoeg tijd, te weinig tijd, of teveel tijd voor deze les?		Genoeg Te weinig Te veel
Beoordeling	Wat vind je van deze wijze van beoordelen?	Positief Negatief Neutraal	