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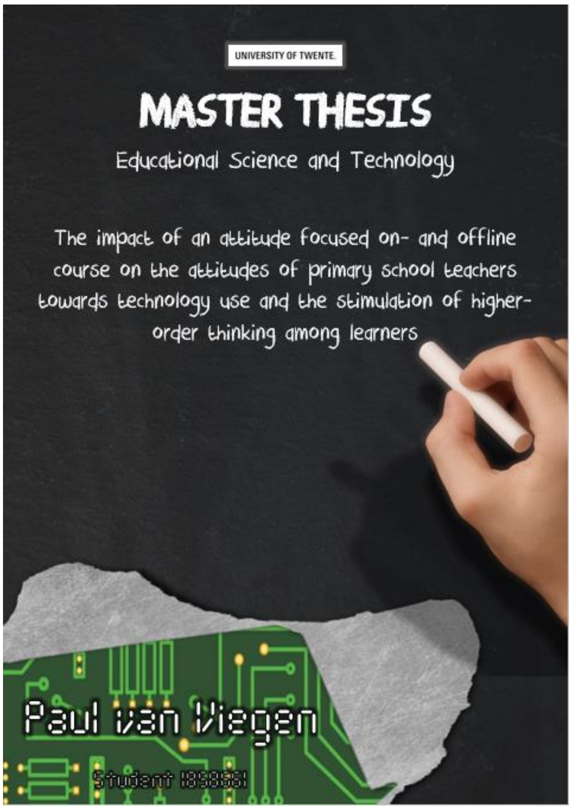

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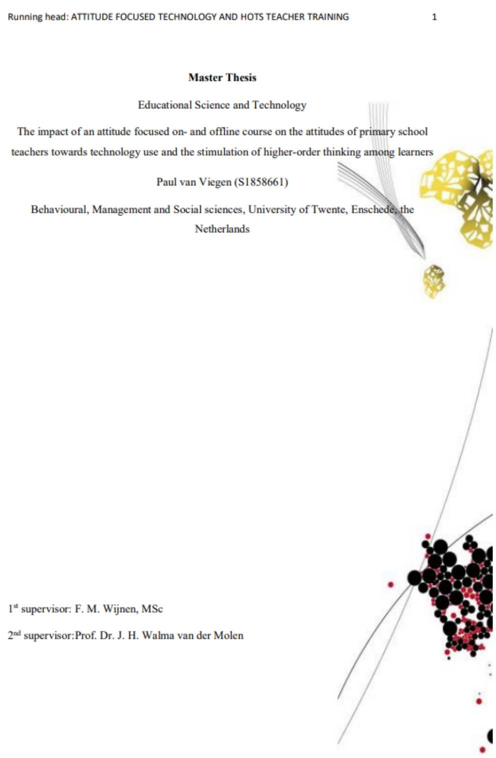

Running head: ATTITUDE FOCUSED TECHNOLOGY AND HOTS TEACHER TRAINING 1

Master Thesis

Educational Science and Technology

The impact of an attitude focused on- and offline course on the attitudes of primary school teachers towards technology use and the stimulation of higher-order thinking among learners

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UNIVERSITY OF TWENTE.

MASTER THESIS

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Paul van Vliegen

Student 1858661

The e-learning in the course developed for this study contained 3 instructional video’s.

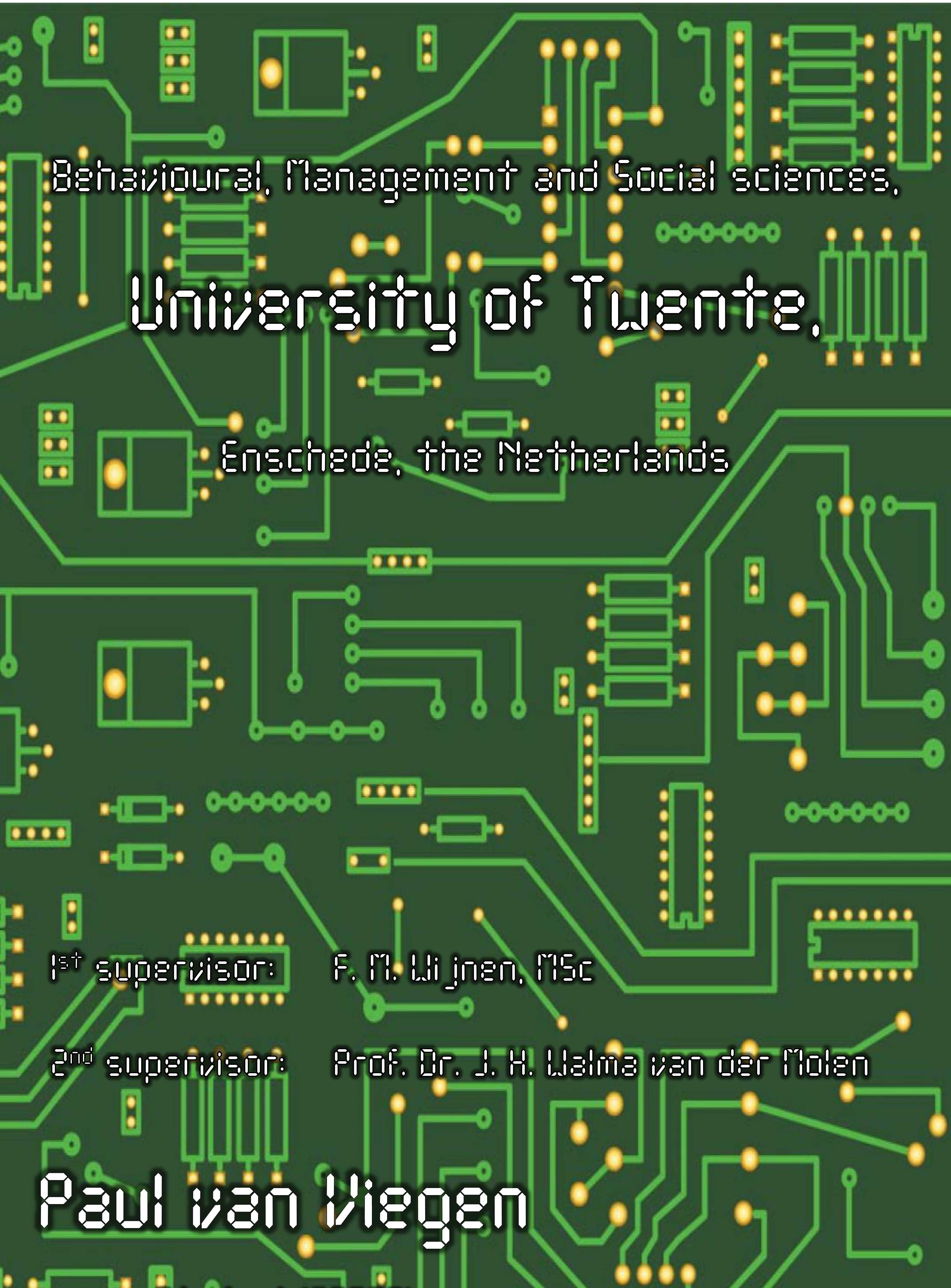
Scan or click on the corresponding QR-code to view the video. Or scan or click on the green QR code to view the whole e-learning.

‘Technology in education’ (Dutch)

‘Learning and living in de 21st century’ (Dutch)

‘Stimulating HOTS among learners’ (Dutch)

Whole e-learning (Dutch)



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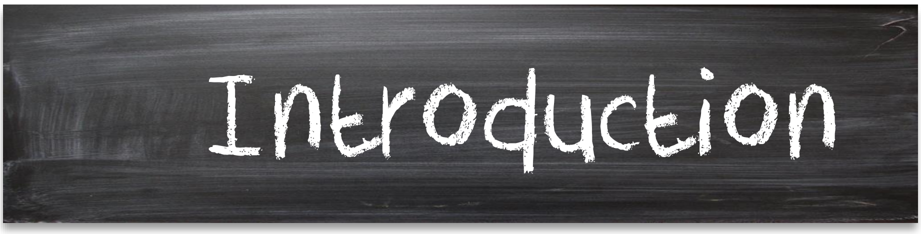
When teachers would change their pedagogics and didactics to ways that stimulate learners to use higher-order thinking skills (HOTS) in addition to lower-order thinking skills (LOTS), this would lead to a better memorization and deeper conceptual understanding of content. Technology can support teachers in this by offering the ability to create powerful learning environments with it. As research shows that teachers' attitudes influence behaviour, focussing on the improvement of attitudes in teacher training seems a promising approach. The purpose of this study was therefore to explore the effects of an on-and offline attitude focused training course on the attitudes of teachers towards the use of technology in classroom and the stimulation of HOTS among learners. A quantitative quasi-experimental pre-test-post-test control group design with non-probability convenience and snowball sampling, combined with qualitative post-training reflections, is used. The participating teachers worked at 6 primary schools in the Netherlands. While teachers in the control condition (*n* = 12) only received the pre- and post-tests, the teachers in the experimental condition (*n* = 14) received the course in addition. This study provides input for the development of effective attitude focused teacher training programs, explorative evidence for the effectiveness of a relatively short on- and offline training for improving teachers' attitudes and points out directions for future research. Although the sample size in the study was small and not all statistical assumptions were met, the quantitative and qualitative results combined, indicate that regarding technology the teachers' anxiety towards in-classroom use can be decreased, the perceived self-efficacy and ease of use can be increased and regarding HOTS the perceived self-efficacy can be increased by the on-and offline training course of this study.

Keywords: technology, higher-order thinking skills, attitude, primary education, teachers



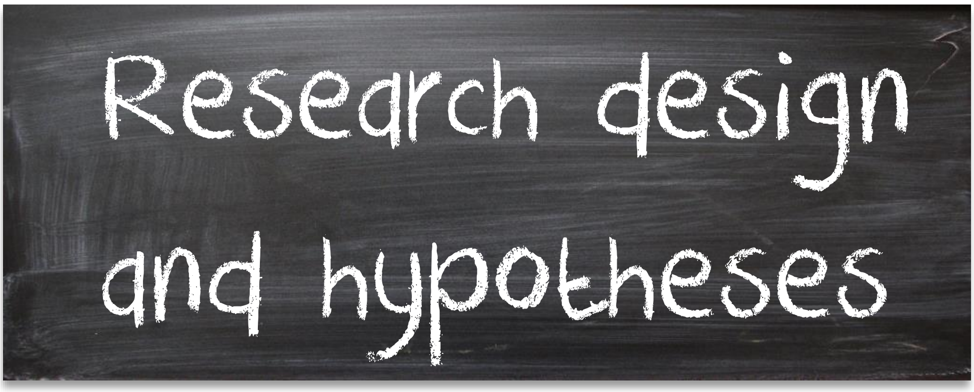
In history, dramatic educational reforms were expected when new types of technology where introduced. However, these often failed to appear (Spector, 2001). For example, in the 1980s, according to David (1994) technology such as the personal computer was expected to transform education. Still, in the early 1990s there was little use of it in schools. Nowadays, things have changed. Technology, such as computers, are now widespread in education (Mullis, Martin & Loveless, 2016). The pedagogics and didactics of teachers, however, generally are still the same (Orlando, 2013; Cuban, as cited in Alenezi, 2016). The primary way of teaching with technology is aimed at the transfer of knowledge, which is generally associated with lower-order thinking skills (LOTS) in Bloom's Taxonomy, namely remembering, understanding and applying (Smeets, 2005; Niederhauser & Lindstrom, 2006). This particularly use of LOTS is problematic because it are the higher-levels, analysing, evaluating and creating, in Bloom's revised hierarchical framework about educational objectives that are associated with higher-order thinking skills (HOTS). When learners use HOTS, this leads to better memorization of information and a deeper conceptual understanding (Jensen, McDaniel, Woodard, Kummer, 2014). This implies that education would improve when learners are stimulated to use HOTS instead of merely LOTS.

Technology can support this by offering the ability to create powerful learning environments with it (Smeets, 2005; Drent and Meelissen, 2008). According to Jonassen (1999) these type of learning environments are connected to the environment outside the school, stimulate cooperation between learners, foster active and independent learning, adapt the curriculum to the needs and capabilities of learners, and facilitate learners in higher-order thinking processes. The use of technology can thus be beneficial for education, only to truly benefit from it, changes in teachers' pedagogy and didactics are needed with a focus on fostering the higher-levels of Bloom's revised taxonomy (Krathwohl, 2002; Adams, 2015).

The need for a different way of educating learners is reinforced by the rapid developing society of today. Because of the rapidity of the developments it is increasingly difficult for the educational system to prepare learners for their life to come, e.g. the professions that learners eventually will have might currently not exist (Dede, 2011). Hence, it is important for the educational system to provide learners with competences and confidence to deal with a complex and uncertain future (Carr & Claxton, 2004). Being able to solve problems, think critical and creative, is crucial in this (Morgan, 1996, as cited in Hopson, Simms & Knezek, 2001; Voogt and Roblin, 2012). The need for the stimulation of HOTS is thus not only induced by the potential learning gains, but also by the importance of the development of these skills, for learners to be able to function well in society.

Changing the way learners are educated can be challenging. Attempts to make changes frequently fail, because they are implemented top down and do not take the attitudes, beliefs, competences and practices of teachers into account, which are strongly influencing an educational change (Voogt & Roblin, 2012; Hermans, Tondeur, van Braak & Valcke, 2008; Niederhauser and Stoddart, 2001; Atkins & Vasu, as cited in Seraji, Ziabari and Rokni, 2017). When they are not addressed, the potential of stimulating HOTS and using technology for improving learning might not be realized. The teacher should be seen as an agent of the change on its own, instead of merely being variable that needs to be changed. When a change is implemented, what is seen in the classroom, is shaped by a dialog between the beliefs and experience of the teacher and the advocated change (Luttenberg, Imants & van Veen, 2013). This might explain why there is still little innovative use of technology in schools. Since new technology is introduced, teachers will often use it in ways that fit their beliefs on teaching and learning, instead of changing their pedagogics and didactics to the new possibilities that come available (Admiraal, et al., 2017). To be able to improve teachers' technology use it is thus of high importance to take the teachers beliefs into account. Especially focussing on teachers' attitudes seems to be a promising approach in this. Regarding the intention of teachers to use technology in their lessons, for instance, attitude namely has a strong influence on teachers' behaviour (Lee, 2010; Kreijns, Vermeulen, Kirschner, van Buuren, & van Acker, 2013; Teo, 2010). The attitude towards something influences the intention to perform a certain behaviour, which on its turn influences the actual behaviour (Ajzen, 1991). This suggests that to improve the actual use of technology in classrooms it might be advantageous to focus on stimulating a positive attitude towards (1) the use of technology in classroom and (2) the stimulation of HOTS within learners, among teachers. This approach has already been found effective regarding science education (Van Aalderen-Smeets & Walma van der Molen, 2015).

The purpose of this study is therefore to develop and test the effects of a teacher training course aimed at the stimulation of positive attitudes towards the use of technology in classroom and the stimulation of HOTS among learners.



The main research question of the study is:

What is the impact of an on- and offline course about the use of technology in education and the stimulation of higher-order thinking among learners on primary teachers' attitudes towards (1) technology use in the classroom and, (2) stimulating higher-order thinking among learners?

To be able to answer this question the following sub-questions are answered:

To what extent can an on-and offline course lead to a change in the attitude of primary school teachers regarding the use of technology in the classroom?

To what extent can an on- and offline course lead to a change in the attitudes of primary school teachers regarding stimulating HOTS within learners?

It is hypothesized that the course has a positive impact on primary school teachers' attitudes towards (1) technology use in the classroom and (2) stimulating higher-order thinking among learners.

For this study a quantitative quasi-experimental pre-test-post-test control group design with non-probability convenience and snowball sampling, combined with qualitative post-training reflections, is used. See figure 1 for an overview of the research design.

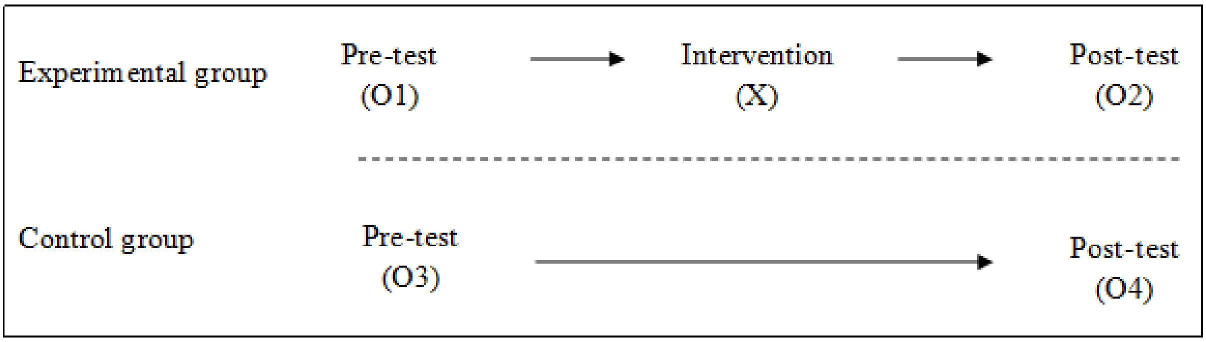
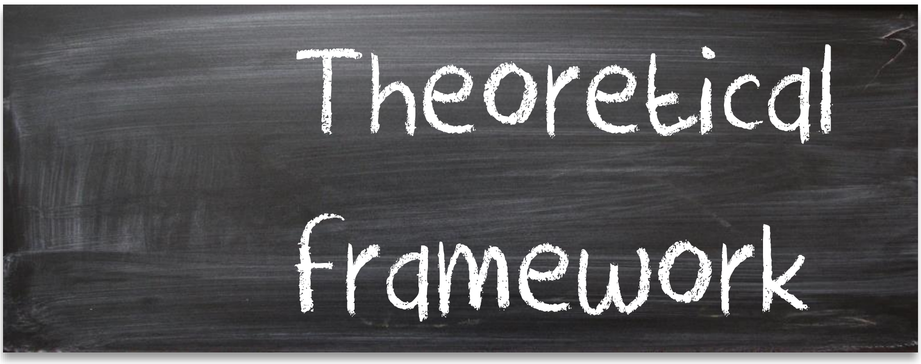


Figure 1. Overview of quasi experimental research design.
Note. O2 is quantitative survey combined with qualitative reflections.



Attitude

Throughout literature, in general, attitude can be defined as the psychological tendency of evaluating an object in terms of favourable or unfavourable attribute dimensions such as good or bad, positive or negative and comfortable or uncomfortable (Ajzen & Fishbein, 2000; Ajzen, 2001). An attitude towards an object is formed around multiple evaluations of attributes that a person links to the object. The attitude is a summarization of these evaluations, in which each evaluation contributes with a certain degree to the attitude (Ajzen & Fishbein, 2000). The attitude towards an object influences the intention to perform certain behaviour which on its turn influences the actual behaviour (Ajzen, 1991). Teachers however can hold multiple attitudes towards the evaluative object at the same time. (Ajzen, 2001). For example, Asma, Walma van der Molen, and van Aalderen-Smeets (2011) argue that regarding teaching science teachers might have professional attitudes, as well as personal attitudes which can be contrary to each other. The context determines which attitude is dominant at a certain timepoint (Ajzen, 2001).

According to Wijnen, Walma van der Molen and Voogt (in progress), the attitudes of teachers towards technology use in classroom are formed by evaluations around four dimensions, namely *beliefs*, *affect*, *perceived behavioural control* and *social norm* (figure 2). The evaluations on the dimensions are on their turn formed by evaluations on eight sub-components.

Beliefs is formed around the beliefs teachers have about the *relevance* of using technology for preparing learners for their future lives, the *usefulness* of technology as a tool for learning, and the *ease of use* of technology in teaching. This means that for a teacher to have positive beliefs, the teacher should think technology use in classroom is relevant for the preparation of learners for their future lives in society, is useful as a tool for learning and is easy to use.

Affect is formed around the feelings of *anxiety* regarding using technology in the classroom, and the feelings of *enjoyment* teachers allocate to using technology in classroom. This means that for a teacher to have positive affect towards the use of technology in classroom, the teachers should have low feelings of anxiety and high feelings of enjoyment when using technology in classroom.

Perceived behavioural control is formed around the perceived level of *self-efficacy* of a teacher to use technology in the classroom, and the perceived *context-dependency* to be able to use technology in the classroom. This means that for a teacher to have a positive perceived behavioural control, the teacher should find himself capable of using technology in classroom and independent of external context factors.

Social norm is formed around the *subjective norm* of individuals that are important to a teacher, regarding the use of technology in the classroom. This means that for a teacher to have a positive perceived social norm, the teacher should find individuals important to the teacher positive about the use of technology in classroom.

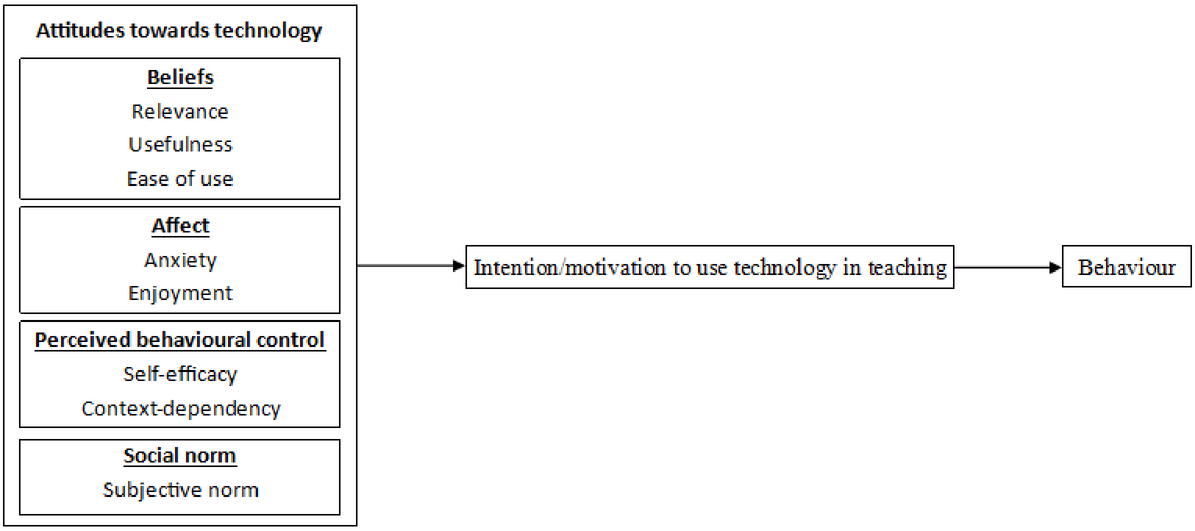


Figure 2. Theoretical framework for primary school teachers' attitudes towards in classroom use of technology (Wijnen et al., in progress).

The attitudes of teachers towards the stimulation of HOTS within learners are formed by evaluations on two dimensions, namely *beliefs*, and *perceived behavioural control* (figure 3). These are formed by evaluations on four sub-components.

Beliefs is formed around the beliefs teachers have about the *relevance* of stimulating HOTS for learning and the future lives of learners, and the *learners' ability* to use HOTS. This means that for a teacher to have positive beliefs, the teacher should think stimulating HOTS is important for the personal development of learners and that all learners are capable of using HOTS.

Perceived behavioural control is formed around the perceived level of *self-efficacy* regarding stimulating HOTS within learners, and *context-dependency* to be able to stimulate HOTS in learners. This means that for a teacher to have a positive perceived behavioural control, the teacher should perceive himself capable of stimulating HOTS within learners, independent of external context factors.

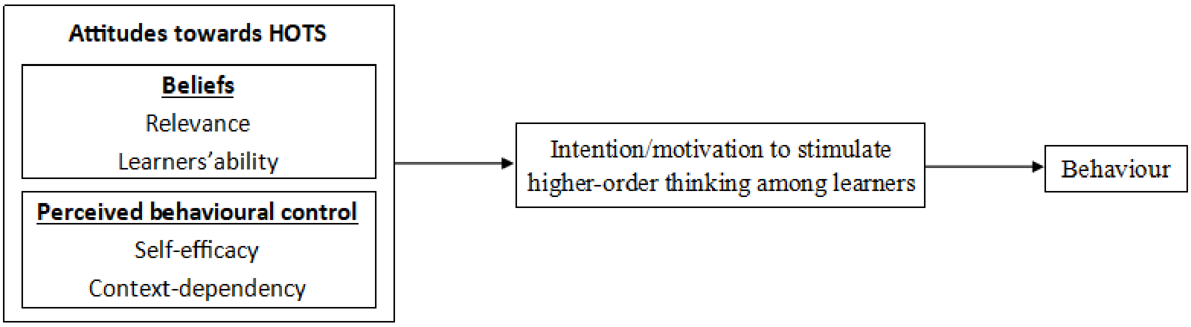


Figure 3. Theoretical framework for primary school teachers' attitudes towards stimulating HOTS among learners (Wijnen et al., in progress).

HOTS

There are several definitions of HOTS throughout literature (Lewis & Smith, 1993). In this study Bloom's revised taxonomy of educational objectives is used for defining HOTS. According to Polly & Ausband (2009) this taxonomy can be used for identifying and categorizing different thinking skills. Although this taxonomy was originally published in 1956, it was revised by Anderson et al. in 2001. In the revised version the nouns were changed to verbs and the top levels changed positions. While in the original model *evaluation* was placed at the top of the taxonomy and *synthesis* was placed one level lower, now *creating* is placed at the highest level and *evaluating* is placed one level below it. The reasoning for this is that to be able to evaluate one does not necessarily has to be able to create, while to be able to create, meaning: making of a novel product or coherent whole by integrating parts of information, one mostly would have to evaluate the information first (Krathwohl, 2002).The revised Bloom's Taxonomy can be divided in LOTS and HOTS. LOTS are *remembering* and *understanding,* and HOTS are *analysing*, *evaluating* and *creating* (Zoller, 1993; Crowe, Dirks & Wenderoth, 2008). According to Crowe, Dirks and Wenderoth (2008), it is at the level *applying* of the taxonomy where the transition between LOTS and HOTS happens. *Applying* can therefore be seen as lying in between both. While the taxonomy is seen as a hierarchical framework of which a lower-level of the taxonomy should be mastered before one would be able to perform the processes of a higher-level (Krathwohl, 2002; Anderson et al., as cited in Jensen, McDaniel, Woodard & Kummer, 2014), this hierarchy does not necessary count for HOTS (Crowe, Dirks and Wenderoth, 2008). In other words: to be able to create one does not always need to be able to evaluate, while one has to be able to remember information to be able to understand it. Although this initially contradicts the explanation of Krathwohl (2001) about that *creating* changed places with evaluating in the revised taxonomy because of the hierarchy of the cognitive processes involved, the author also states that the hierarchy is not as strict in the revised version of Bloom's taxonomy as in the original version. This places emphasis on a more flexible hierarchy of the top-level skills of Bloom's revised taxonomy. In general, when learners use HOTS this will lead to deeper conceptual understanding as well as an increase in the memorization of the information (Jensen, et al. 2014).

Technology

When new technology is introduced, often new possibilities for educating learners become available. It is however important to state that it is not the technology that has added value for education, it is the change in pedagogics and didactics made possible by the new technology, that can be beneficial (Tay, 2016; Fullan, & Langworthy, 2014; Venezky, 2002; OECD, 2015).This is important to note, because it implies that when new technology is adopted by a teacher, and there are few or no changes in the pedagogics and didactics of the teacher, the added value of the new technology will be low as it is used as a substitute of the old (Puentedura, 2013). It also implies that older technology, that might be used in education for a long time, can be used in an innovative way by changing pedagogics and didactics. Therefore, in this study, no distinction between old and new technology is made and technology is defined as all electronic technology that is- or can be used in education.

Participants

The participants within this study consisted of 5 male and 21 female primary education teachers between the ages of 23 and 64, from six schools in the eastern part of the Netherlands. There were 14 teachers from 1 school in the experimental condition and 12 teachers from 5 schools in the control condition. The teachers worked with learners from all educational levels in the Dutch primary education, with expected ages between 4 and 12 years old. School leaders from 26 schools were approached and asked for participation in the study. Of the schools, teachers from 1 school were willing to participate in the course and fill in two questionnaires, which was the experimental condition and teachers from 5 schools were willing to only fill in two questionnaires, which was the control condition. The other 20 schools in general expressed that they recognised the importance of the topics from the study, only could not participate because of time constraints and a high workload. There were 4 teachers in the experimental condition, who did not complete the post-test and 2 teachers in the control condition who did not complete the post-test for unknown reasons as can be seen in figure 4.

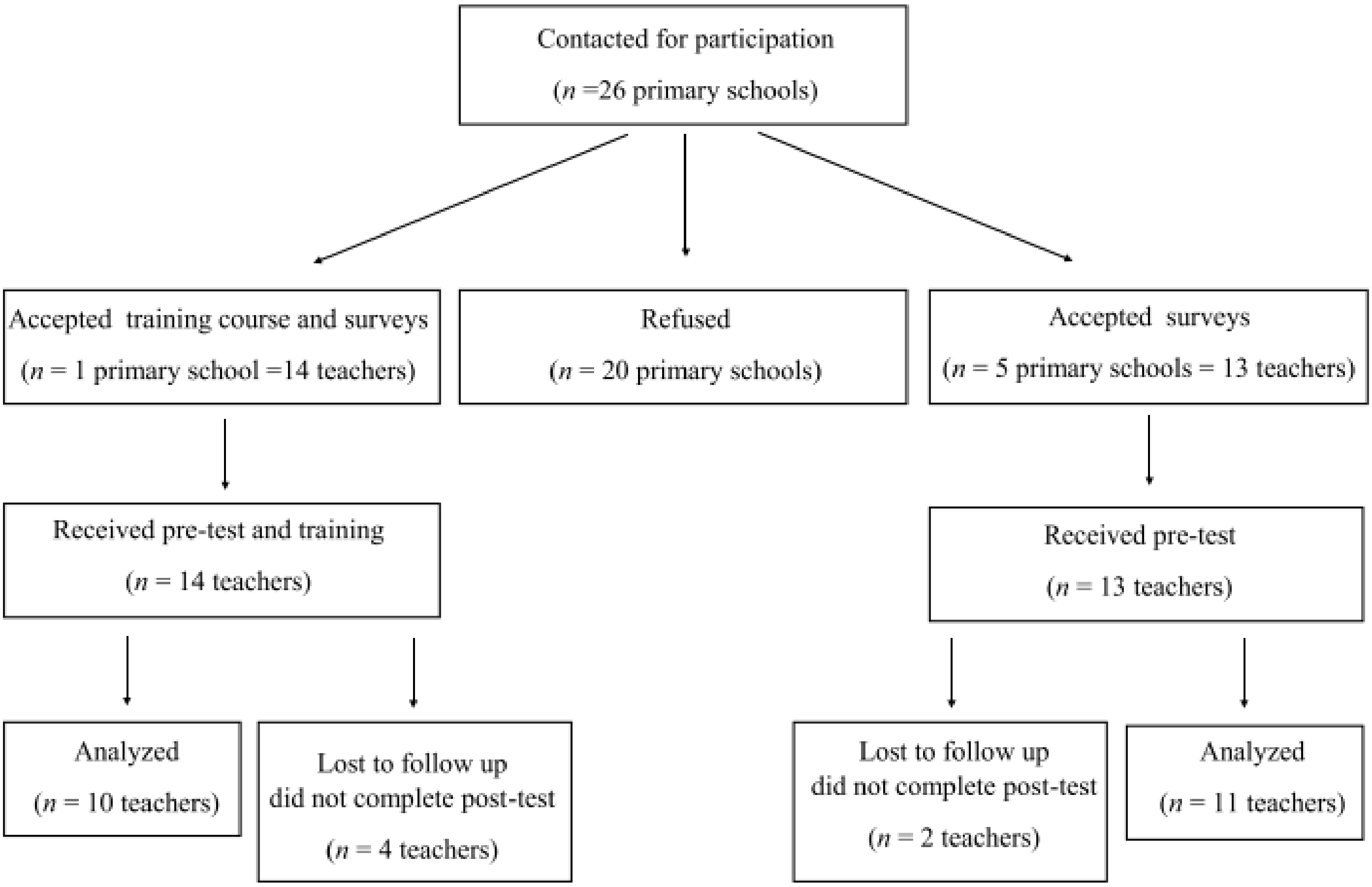


Figure 4. Flow of participants trough stages of the study.

Instruments

To measure the primary teachers' attitudes towards the use of technology in the classroom and towards the stimulation of HOTS among learners, a customized instrument of Wijnen, Walma van der Molen and Voogt (in progress) is used as the pre- and post-test. The main difference between the original instrument and the customized instrument is, that the original instrument was developed to measure the attitudes towards *newer* technology, and the customized instrument (Appendix A) was designed to measure the attitude of teachers towards technology in general. For this, texts were adjusted by removing words such as 'new', and a list with examples of types of new technology is supplemented with other types of technology. The essence of the questions however remained the same and in the same order and was therefore expected to be equally reliable. The customized instrument exists of four parts that measure different constructs (1= *background characteristics*, 2= *Pedagogical beliefs*, 3= *Attitude towards technology*, 4= *Attitude towards stimulating HOTS*. Each part mainly consists of multiple statements to which teachers can indicate their level of agreement via a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). All tests were distributed and executed online. The items of the attitude scales were automatically randomized by the software (Qualtrics), for both attitude objects.

Description of the course and materials

The on- and offline course developed in this study aimed at stimulating positive evaluations on the dimensions of primary school teachers' attitudes towards technology use in classroom, and stimulating higher order thinking within learners. As mentioned, the attitudes towards technology use in classroom are formed around evaluations on four dimensions, namely *beliefs*, *affect*, *perceived behavioural control* and *social norm*. The attitudes towards the stimulation of HOTS within learners are formed around two dimensions, namely *beliefs* and *perceived behavioural control* (Wijnen, Walma van der Molen & Voogt, in progress). To stimulate positive evaluations, this implied that the sub-components of the attitude dimensions needed to be addressed in the design of the attitude focused course, meaning that the design aimed at positively influencing the sub-components, as positive evaluations on the sub-components would lead to positive evaluations on the attitude dimensions.

Objectives

To address all sub-components, the course was designed with the objectives as shown in table 1.

Table 1

Objectives for the attitude focused teacher training course

At the end of the course the teacher should…		
Technology	1	…believe technology use in classroom is relevant for the preparation of learners for their future lives in society
	2	…believe technology is a useful tool for learning
	3	…believe technology is easy to use
	4	…have low feelings of anxiety when using technology in classroom
	5	…have high feelings of enjoyment when using technology in classroom
	6	…find himself capable of using technology in classroom
	7	…find himself independent from external context factors to be able to use technology in classroom
	8	…think that for the teacher important individuals are positive about the use of technology in classroom
HOTS	9	…believe that the stimulation of HOTS is important for the personal development of learners
	10	…believe that all learners are capable of using HOTS
	11	…perceive himself capable of stimulating HOTS within learners
	12	…perceive himself independent from external context factors to be able to stimulate HOTS within learners

The objectives were expected to be addressed by the use of online instructional videos, and an offline workshop in which teachers could use a newly developed scheme to collaboratively discuss and develop lessons. Instructional videos and a short reflection assignment, aimed at addressing objective 1, 2, 3, 9, and 10. The workshop aimed at addressing objective 2, 3, 4, 5, 6, 7, 8, 11, and 12.

Expected effects instructional videos

Expected was that if teachers would watch and reflect on videos about why technology use in classroom is important for the preparation of learners for their future lives in society, why and how technology is a useful tool for learning, why the stimulation of HOTS is important for the personal development of learners and that every learner is capable of using HOTS, this would lead to changes in the attitude domain of *beliefs*. Teachers would namely receive new knowledge, which they briefly reflect on and could integrate in their existing knowledge and beliefs about teaching. This process of integrating is further stimulated by the workshop part of the course.

Expected effects workshop

Expected was that the offline workshop part of this study would lead to changes in the teachers' attitude sub-components *affect*, *perceived behavioural control* and *social norm*, as described by Wijnen, Walma van der Molen and Voogt (in progress). This was expected because in the workshop the teachers collaboratively design and discuss when learners need to use HOTS and how this can be stimulated. Further, they explore the possibilities of the use of technology in their education in such a way that it contributes to the learning goals. In the process teachers were expected to reflect on their current practice of teaching and think of how the newly gained knowledge from the instructional videos in the e-learning part, can be integrated in their lessons. During the designing of lessons, teachers had the opportunity to repeatedly discover and discuss how lessons can be aimed at stimulating HOTS, how this would lead to deeper learning and how technology can support in this. Beside contributing to the belief that stimulating HOTS is important and technology is a useful tool for learning, teachers might have been able to gain more self-confidence in designing such lessons. In the collaborative activity teachers were expected to actively process and generate new knowledge together with colleagues. This is important because active learning and generating new knowledge are associated with deeper learning and because teachers are learning together, they can learn from each other and can support each other's ideas, which might lead to an increase in self efficacy and the perceived social norm (Johnson & Johnson, 2008; Prince, 2004; Timperley, 2008) .

Description instructional videos

The online e-learning part of this study was written and spoken in Dutch and mainly consisted of 3 instructional videos about (video 1) why and how technology is a useful tool for learning, which had a play time of 2:36 minutes, (video 2) why technology is important for the future lives of learners in society, which had a play time of 4:25 minutes and (video 3) why the stimulation of HOTS among learners is important and how a teacher can do this, which had a play time of 6:40 minutes. All videos contained a male voice over which was complemented with images, animations and videos, as can be seen in figure 5. The videos were stored on Youtube.com and could be played embedded in the e-learning or on the website of Youtube by clicking the title of the video. The videos were hidden on Youtube, which means that they could only be seen via a direct link and were unable to be found on Youtube via the search box by the control group.

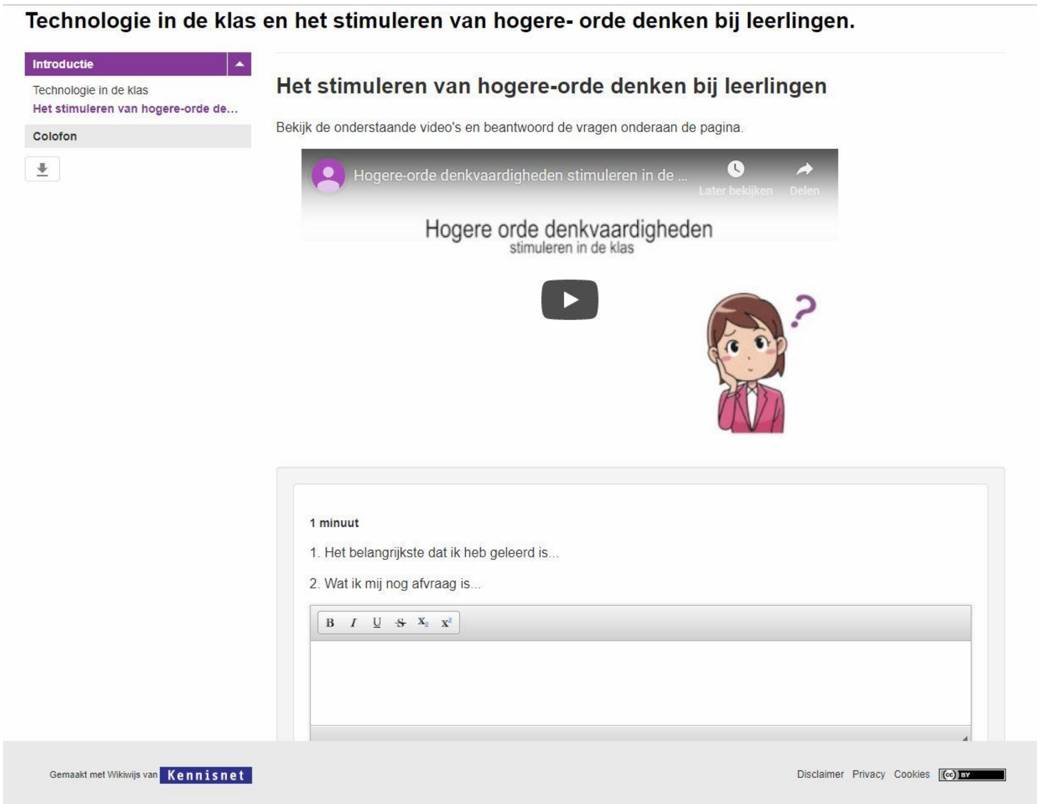


Figure 5. Video 3 as displayed in the e-learning on Wikiwijs.nl

The e-learning started with a page that informed the teachers about the educational objectives of the e-learning which were (1) at the end of the lesson you can tell how technology can be used in classroom in such a way that it has added value and (2) at the end of the lesson you can tell why it is important to stimulate higher-order thinking among learners and how this as a teacher can be done in the classroom. Furthermore, the page informed the teachers about that the e-learning was meant as preparation for the workshop and explained the structure of the e-learning (figure 6).

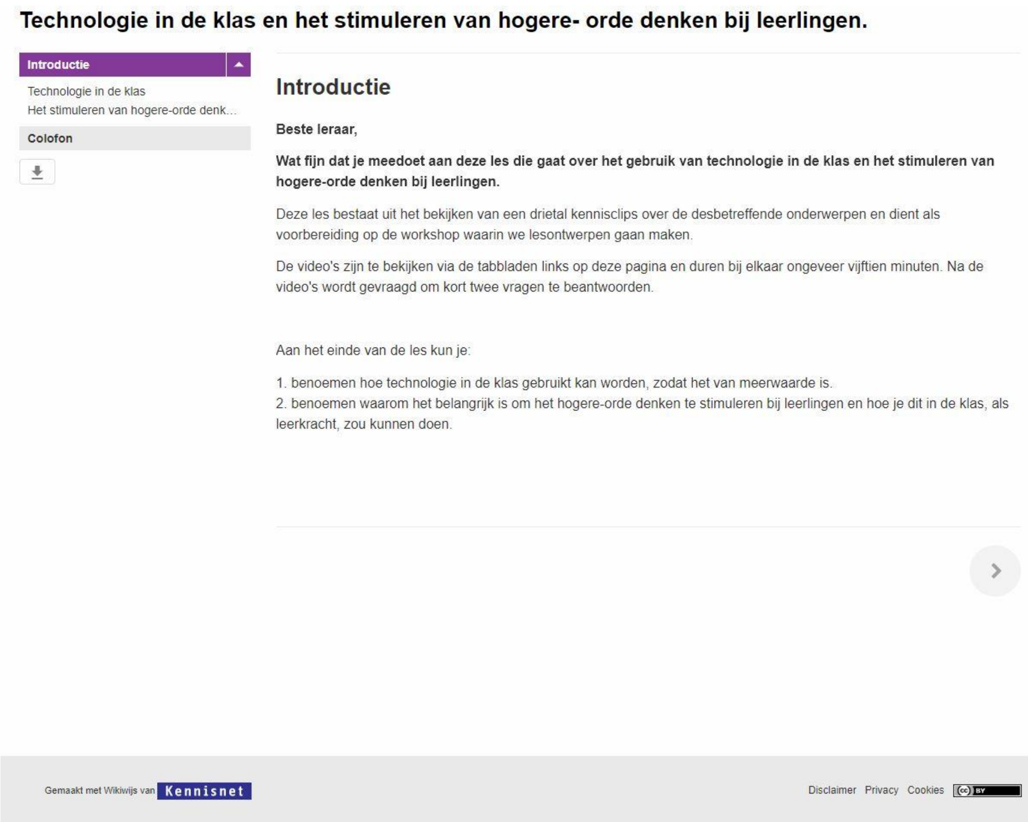


Figure 6. Welcome page as displayed in the e-learning on Wikiwijs.nl

The instructional videos were placed in two tabs. The two videos about technology were placed in the upper tab and the video about HOTS were placed in the tab below. In each tab there was a short assignment asking the teacher to write in one minute about what was the most important thing that the teacher has learned and about what remained unclear for the teacher (figure 7).

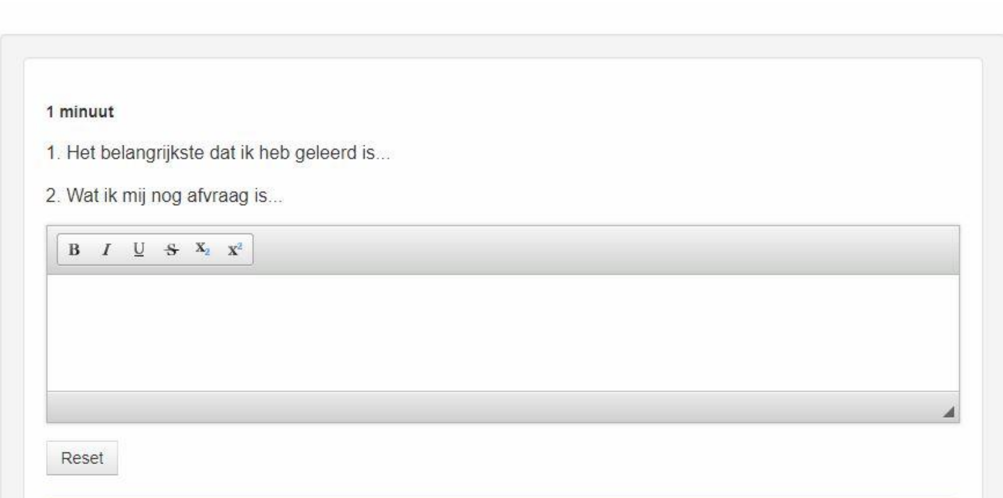
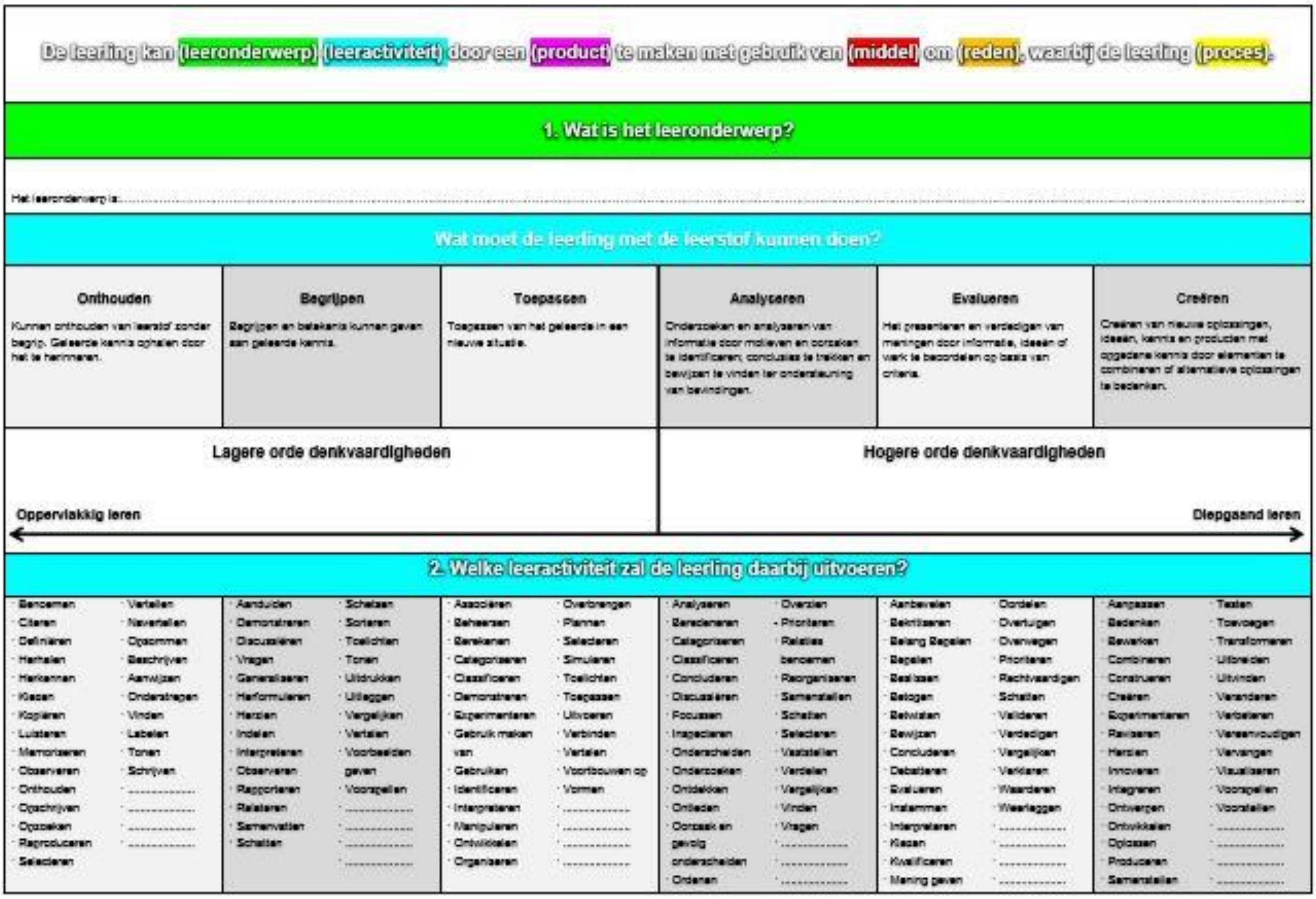


Figure 7. Short reflective assignment as displayed in the e-learning on Wikiwijs.nl

Description workshop

The one-hour workshop was held in a regular classroom of the higher grades in the participating school. After a short introduction about the objectives and the procedure of the workshop, a 30-minute lecture was held by the researcher in which the e-learning was summarized and the A1 sized scheme with which the teachers can develop lessons was introduced. After that the teachers formed small groups based on teaching the same age group of learners for the assignment of collaboratively designing lessons by the use of the scheme and other supporting materials. The supporting materials were a A4 sized sheet in which the steps of the scheme were explained, a A4 sized sheet of paper that displayed a board on which the teachers could write their lesson objectives and a collection of A5 sized cards that briefly explained the types of technology that were named in the scheme (appendix E). Teachers designed and discussed lessons for approximately 25 minutes and the researcher walked between the groups and asked questions about for example the progress and if there were uncertainties about the assignment or the lessons they were designing. When necessary the researcher assisted teachers in the use of the scheme by giving examples and asking questions. The workshop ended with a recap of the workshop and the same one-minute reflective assignment as in the e-learning, only this time on paper and with an actual duration of about five minutes, giving everyone the opportunity to finish the assignment.



De leerling kan (leeronderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om (reden), waarbij de leerling (proces).

1. Wat is het leeronderwerp?

Het leeronderwerp is:..........

Wat moet de leerling met de leerstof kunnen doen?

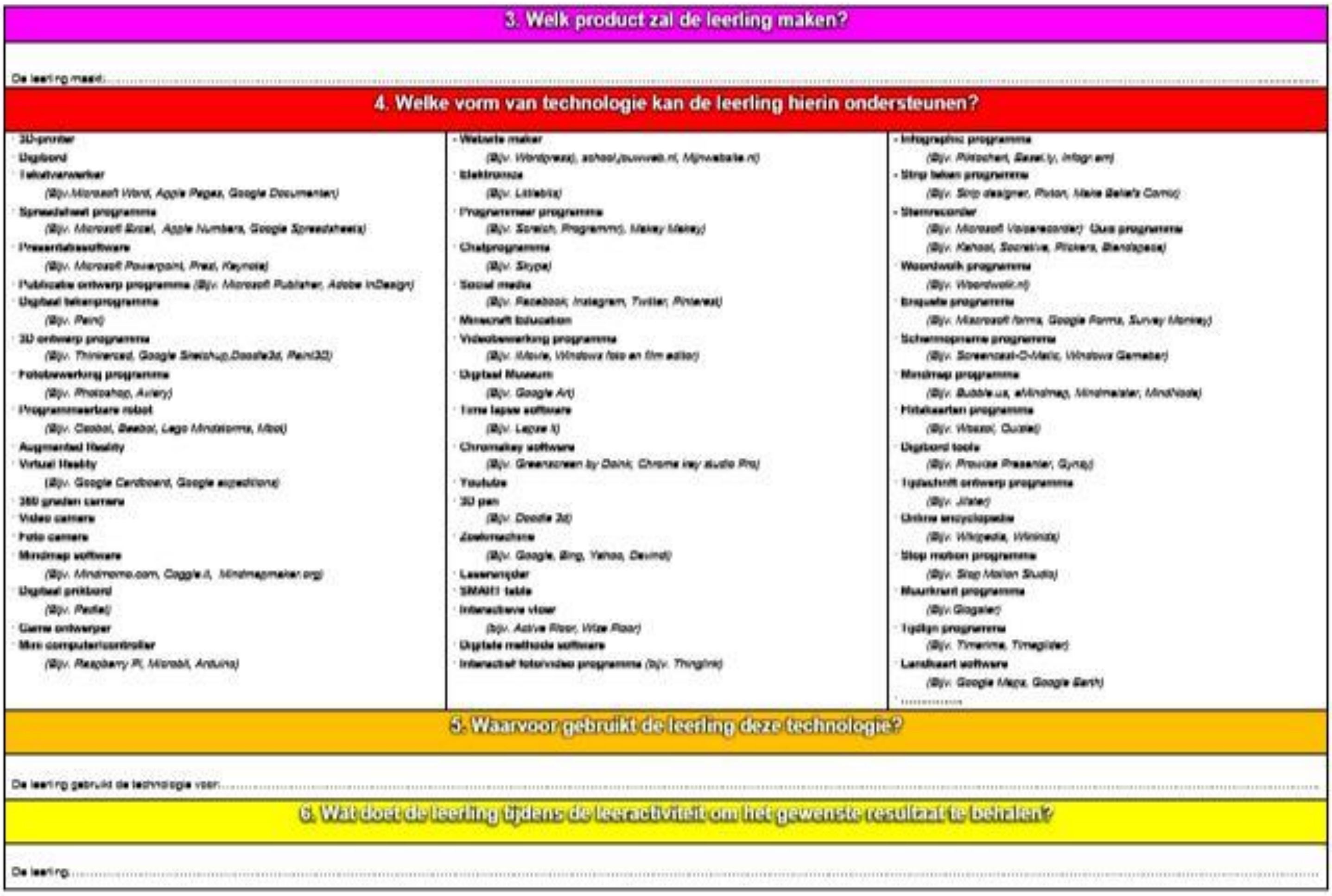
Onthouden	Begrijpen	Toepassen	Analyseren	Evalueren	Creëren
Kunnen onthouden van leerstof zonder begrip. Geleerde kennis ophalen door het te herinneren.	Begrijpen en betekenis kunnen geven aan geleerde kennis.	Toepassen van het geleerde in een nieuwe situatie.	Onderzoeken en analyseren van informatie door motieven en oorzaken te identificeren, conclusies te trekken en bewijzen te vinden ter ondersteuning van bevindingen.	Het presenteren en verdedigen van meningen door informatie, ideeën of werk te beoordelen op basis van criteria.	Creëren van nieuwe oplossingen, ideeën, kennis en producten met opgedane kennis door elementen te combineren of alternatieve oplossingen te bedenken.

Lagere orde denkvaardigheden — Hogere orde denkvaardigheden

Oppervlakkig leren ⟷ Diepgaand leren

2. Welke leeractiviteit zal de leerling daarbij uitvoeren?

Onthouden		Begrijpen		Toepassen		Analyseren		Evalueren		Creëren	
Benoemen	Vertellen	Aanduiden	Schetsen	Associëren	Overbrengen	Analyseren	Overzien	Aanbevelen	Oordelen	Aanpassen	Testen
Citeren	Navertellen	Demonstreren	Sorteren	Beheersen	Plannen	Beredeneren	Prioriteren	Bekritiseren	Overtuigen	Bedenken	Toevoegen
Definiëren	Opsommen	Discussiëren	Toelichten	Berekenen	Selecteren	Categoriseren	Relaties benoemen	Belang Bepalen	Overwegen	Bewerken	Transformeren
Herhalen	Beschrijven	Vragen	Tonen	Categoriseren	Simuleren	Classificeren	Reorganiseren	Bepalen	Prioriteren	Combineren	Uitbreiden
Herkennen	Aanwijzen	Generaliseren	Uitdrukken	Classificeren	Toelichten	Concluderen	Samenstellen	Beslissen	Rechtvaardigen	Construeren	Uitvinden
Kiezen	Onderstrepen	Herformuleren	Uitleggen	Demonstreren	Toepassen	Discussiëren	Schatten	Betogen	Schatten	Creëren	Veranderen
Kopiëren	Vinden	Herzien	Vergelijken	Experimenteren	Uitvoeren	Focussen	Selecteren	Betwisten	Valideren	Experimenteren	Verbeteren
Luisteren	Labelen	Indelen	Vertalen	Gebruik maken van	Verbinden	Inspecteren	Vaststellen	Bewijzen	Verdedigen	Reviseren	Vereenvoudigen
Memoriseren	Tonen	Interpreteren	Voorbeelden geven	Gebruiken	Vertalen	Onderscheiden	Verdelen	Concluderen	Vergelijken	Herzien	Vervangen
Observeren	Schrijven	Observeren	Voorspellen	Identificeren	Voortbouwen op	Onderzoeken	Vergelijken	Debatteren	Verklaren	Innoveren	Visualiseren
Onthouden	....	Rapporteren	....	Integreren	Vormen	Ontdekken	Vinden	Evalueren	Waarderen	Integreren	Voorspellen
Opschrijven	....	Relateren	....	Manipuleren	....	Ontleden	Vragen	Instemmen	Weerleggen	Ontwerpen	Voorstellen
Opzoeken	....	Samenvatten	....	Ontwikkelen	....	Oorzaak en gevolg onderscheiden	....	Interpreteren	....	Ontwikkelen	....
Reproduceren	....	Schatten	....	Organiseren	....	Ordenen	....	Kiezen	....	Oplossen	....
Selecteren			....		....		....	Kwalificeren	....	Produceren	....
								Mening geven	....	Samenstellen	....



3. Welk product zal de leerling maken?

De leerling maakt..........

4. Welke vorm van technologie kan de leerling hierin ondersteunen?

- 3D-printer
- Digibord
- Tekstverwerker
  (Bijv. Microsoft Word, Apple Pages, Google Documenten)
- Spreadsheet programma
  (Bijv. Microsoft Excel, Apple Numbers, Google Spreadsheets)
- Presentatiesoftware
  (Bijv. Microsoft Powerpoint, Prezi, Keynote)
- Publicatie ontwerp programma (Bijv. Microsoft Publisher, Adobe InDesign)
- Digitaal tekenprogramma
  (Bijv. Paint)
- 3D ontwerp programma
  (Bijv. Thinkercad, Google Sketchup, Doodle3d, Paint3D)
- Fotobewerking programma
  (Bijv. Photoshop, Aviary)
- Programmeerbare robot
  (Bijv. Ozobot, Beebot, Lego Mindstorms, Mbot)
- Augmented Reality
- Virtual Reality
  (Bijv. Google Cardboard, Google expeditions)
- 360 graden camera
- Video camera
- Foto camera
- Mindmap software
  (Bijv. Mindmomo.com, Coggle.it, Mindmapmaker.org)
- Digitaal prikbord
  (Bijv. Padlet)
- Game ontwerper
- Mini computer/controller
  (Bijv. Raspberry Pi, Microbit, Arduino)
- Website maker
  (Bijv. Wordpress), school.jouwweb.nl, Mijnwebsite.nl)
- Elektronica
  (Bijv. Littlebits)
- Programmeer programma
  (Bijv. Scratch, Programmin), Makey Makey)
- Chatprogramma
  (Bijv. Skype)
- Social media
  (Bijv. Facebook, Instagram, Twitter, Pinterest)
- Minecraft Education
- Videobewerking programma
  (Bijv. iMovie, Windows foto en film editor)
- Digitaal Museum
  (Bijv. Google Art)
- Time lapse software
  (Bijv. Lapse It)
- Chromakey software
  (Bijv. Greenscreen by Doink, Chroma key studio Pro)
- Youtube
- 3D pen
  (Bijv. Doodle 3d)
- Zoekmachine
  (Bijv. Google, Bing, Yahoo, Devindi)
- Lasersnijder
- SMART table
- Interactieve vloer
  (bijv. Active Floor, Wize Floor)
- Digitale methode software
- Interactief foto/video programma (bijv. Thinglink)
- Infographic programma
  (Bijv. Piktochart, Easel.ly, Infogr.am)
- Strip teken programma
  (Bijv. Strip designer, Pixton, Make Belief Comix)
- Stemrecorder
  (Bijv. Microsoft Voicerecorder) Quiz programma
  (Bijv. Kahoot, Socrative, Plickers, Blendspace)
- Woordwolk programma
  (Bijv. Woordwolk.nl)
- Enquete programma
  (Bijv. Microsoft forms, Google Forms, Survey Monkey)
- Schermopname programma
  (Bijv. Screencast-O-Matic, Windows Gamebar)
- Mindmap programma
  (Bijv. Bubble.us, eMindmap, Mindmeister, MindNode)
- Flitskaarten programma
  (Bijv. Woozel, Quizlet)
- Digibord tools
  (Bijv. Prowise Presenter, Gynzy)
- Tijdschrift ontwerp programma
  (Bijv. Joomag)
- Online encyclopedie
  (Bijv. Wikipedia, Wikikids)
- Stop motion programma
  (Bijv. Stop Motion Studio)
- Muurkrant programma
  (Bijv. Glogster)
- Tijdlijn programma
  (Bijv. Timerime, Timeglider)
- Landkaart software
  (Bijv. Google Maps, Google Earth)
- ....

5. Waarvoor gebruikt de leerling deze technologie?

De leerling gebruikt de technologie voor..........

6. Wat doet de leerling tijdens de leeractiviteit om het gewenste resultaat te behalen?

De leerling..........

Figure 8. Scheme for designing of lessons with HOTS and technology.

Scheme

The scheme that the teachers used for designing lessons (figure 8 and larger view in appendix B) displayed a 'fill in the blanks' sentence at the top. The 'blanks' existed of words that should be replaced by the teachers by answering the questions in the colours that correspond with the colours in the to be filled in sentence. Furthermore, the colours correspond to the sheet that explains the steps that the teachers need to take to answer the questions (appendix C). The scheme is used from the top to the bottom. First the scheme asks what the subject matter is that needs to be learned, second what the learner should be able to do with the subject matter, to what level the learner needs to learn and what learning activity therefore is applicable, third which product the learner will make, which is the output, fourth which type of technology could assist the learner in making this product, fifth what the learner will use this type of technology for, and sixth what the learner needs to do during the process to reach the learning objective. When all 'blanks' are filled in on the answer board (appendix D) a learning objective is displayed.

Procedure

The ethics commission of the University of Twente was asked for approval of this study. School leaders were approached via email and/or telephone and asked to participate with their school in the study. Next, they were asked if they knew other schools that might be willing to participate. Together with the school leaders, teachers were selected and asked to participate in the course. For the control condition in addition to the school leaders, individual teachers were approached as well and asked for participation in the study. Next, they were asked if they knew other teachers that might be willing to participate. School leaders and teachers were informed with the purpose of the study and confirmed their participation through informed consent.It was expected that the teachers within a school would have interaction about the treatment and would therefore be able to influence each other. Therefore, all the participating teachers from a school were assigned to the same condition. Teachers from one school received the training and teachers from five schools received no training. All participating teachers from the experimental condition received a link for pre-test via the school leader. All participating teachers from the control group received a link for the pre-test directly via their school email address. Teachers were notified that the tests were anonymous and background characteristics were being collected. When the teachers in the experimental condition received the pre-test and the online course via the school leader, they could plan their own time to go through it at their own pace in a timeframe of a week. One week later, in the second week, the teachers in the experimental condition participated in the workshop at their school. The third week the participating teachers received nothing and had the opportunity to execute the lessons that were designed in the workshop. This was suggested at the end of the workshop. It is however not measured if this was actually done. At the end of the third week the participating teachers received the post-test via the school leader. The participants in the control condition received the post-test at the same time via their email address, while having received nothing in the period between the pre- and post-test. At the end of the test participants were thanked for their participation and provided with the opportunity to share contact details to receive the final anonymized report of the study. An overview of the planning of the activities per condition is given in figure 9.

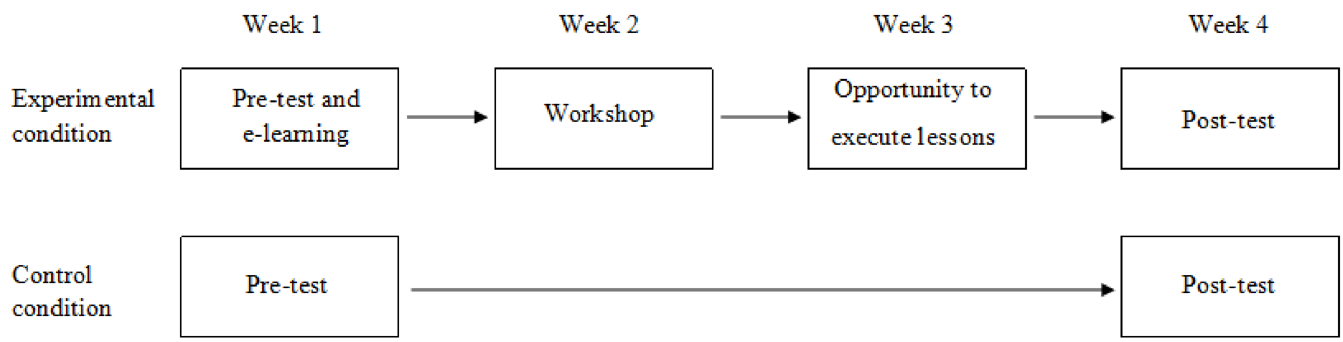


Figure 9. Overview of the planning of the activities per condition.

Data analysis

The quantitative data from the teacher surveys was analysed by the use of SPSS v. 25.0 software. First was analysed if the data fulfilled the statistical assumptions needed for further analysis. Second Cronbach's alpha was calculated to measure the reliability of the scales. Third to establish an effect of the training course, multiple mixed ANOVA were run to compare pre-and post-test scores on the attitude sub-component scales between the two conditions. Fourth T-tests were run to investigate pre-and post-test scores on the attitude sub-component scales for statistical significant differences per condition. The qualitative data (teacher written reflective notes) was analysed by extracting, sorting and counting the same self-reported learning outcomes.

Reliability

As the instrument used for measuring the teachers' attitude sub-components of technology use in classroom and the stimulation of HOTS among learners was still in development by Wijnen et al. (in progress), the instrument was not in advance proven valid and reliable. As the sample size (*n* = 26) was too small for conducting a factor analysis, Cronbach's Alpha was used instead to measure and establish the internal consistency of the test items expected to load to the different factors, which are the sub-components of the attitude dimensions. Of the 12 factors measured by the instrument that is used in this study, 11 were found sufficient reliable with an internal consistency of Cronbach's alpha ranging from .68, which was found acceptable, to .89, which was found good. One sub-component factor, namely teacher's context dependency regarding the stimulation of HOTS among learners, was unintentionally left out of the questionnaire and could therefore not be measured in this study. For the items expected to belong to this factor consequently no Cronbach's alpha score could be constructed.

The perceived usefulness of technology subscale originally consisted of 4 items ($\alpha = .76$). Item Q11_3 (Appendix F) was deleted for a higher internal consistency ($\alpha = .84$).

The perceived ease of use of technology subscale consisted of 3 items ($\alpha = .71$).

The perceived relevance of technology subscale consisted of 3 items ($\alpha = .84$).

The perceived self-efficacy regarding technology subscale consisted of 6 items ($\alpha = .89$).

The perceived anxiety regarding technology use subscale consisted of 3 items ($\alpha = .86$).

The perceived enjoyment regarding technology use subscale consisted of 4 items ($\alpha = .72$).

The perceived social influence regarding technology use subscale consisted of 4 items ($\alpha = .78$).

The context dependency regarding technology use subscale originally consisted of 5 items ($\alpha = .66$). Item Q11_31 was deleted for a higher internal consistency ($\alpha = .68$).

The perceived relevance regarding the stimulation of HOTS subscale consisted of 4 items ($\alpha = .86$).

The perceived learners' capability regarding HOTS subscale consisted of 5 items ($\alpha = .84$).

The perceived self-efficacy regarding the stimulation of HOTS subscale consisted of 4 items ($\alpha = .88$).

Analysis

The effects of the on- and offline training course for primary school teachers on the attitude domains regarding in classroom use of technology and the stimulation of HOTS among learners were analysed by mixed ANOVA per attitude sub-component with a statistical significance level at p <0.05. For each test the within-subject variable was time (pre-and post-test) and the between-subjects variable was condition (experimental and control). To determine differences in development between the experimental and control group, and thus the effectiveness of the training course, interaction effects between time and condition were investigated. Further analysis of the effectiveness of the course was done by post-hoc paired t-tests to detect statistical significant differences between pre-and post-test scores for both conditions separately.

The homogeneity of variances was tested using independent sample t-tests with Levene's tests. Results showed that the assumption of homogeneity of variance was satisfied on all sub-components at a significance level of p = 0.05, except for the post-test regarding the relevance of technology *(P= 0.48).* Because the marginal statistical significance and near equal sample sizes of the two conditions, equal variances were still assumed for further analysis. Normality tests showed some non-normal distributions on pre- and post-tests distributions of the sub-components of the attitude domains. As the sample size was small, this limitation of the non-normality was expected and for the purpose of the study, which was an exploration of the effectiveness of the training program, therefore accepted.

Results of the multiple repeated measures ANOVA's are presented in Table 2 (descriptive statistics) and Table 3 (interaction effects).

Table 2

Descriptive statistics pre- and post-test organized by condition and attitude dimension

		Experimental group *(n =9)*				Control group *(n = 11)*			
		Pre-test		Post-test		Pre-test		Post-test	
		M	SD	M	SD	M	SD	M	SD
Attitude Technology									
	Relevance	4.37	0.70	4.41	0.32	4.42	0.63	4.15	0.72
	Usefulness	3.41	1.01	3.70	0.75	3.76	0.68	3.67	0.65
	Ease of use	2.85	0.92	2.89	0.78	2.91	0.76	3.33	0.86
	Anxiety	2.37	0.99	1.93	1.04	2.15	1.15	2.55	1.17
	Enjoyment	3.47	0.70	3.47	0.72	3.36	0.66	3.27	0.85
	Self-efficacy	2.56	0.67	2.87	0.79	2.45	0.72	2.68	0.77
	Context-dependency	3.36	0.66	3.39	0.69	3.36	0.78	3.61	0.74
	Subjective norm	2.61	0.63	2.75	0.66	3.16	0.90	3.25	0.85
Table 2 (continued)									
Attitude HOTS									
	Relevance	4.25	0.71	4.31	0.63	3.95	0.71	4.05	0.73
	Learners' ability	3.64	0.99	3.84	0.78	3.69	0.59	3.58	0.43
	Self-efficacy	3.33	0.77	3.83	0.50	3.09	0.74	3.14	0.56

* Mean scores attitude sub-components range from: 1 (*totally disagree*) to 5 (*totally agree*).

* * Control group HOTS Relevance *n = 10.*

Table 3

*Interaction effects (time * condition) organized by attitude dimension*

		F	*p*	Partial η2
Attitude Technology	Relevance	1.81	.20	.09
	Usefulness	**6.30**	**.02**	**.26**
	Ease of use	1.52	.23	.08
	Anxiety	**7.08**	**.02**	**.28**
	Enjoyment	0.22	.65	.01
	Self-efficacy	0.24	.63	.01
	Context-dependency	0.52	.48	.03
	Subjective norm	0.04	.85	.00
Attitude HOTS	Relevance	0.05	.82	.00
	Learners' ability	1.41	.25	.07
	Self-efficacy	**7.07**	**.02**	**.28**

* bold values show significant difference in scores between control and experimental group
** significance level at *p* = 0.05

Results per subscale

Relevance technology
The univariate analyses did not show a statistical significant interaction effect of time and condition for the relevance sub-component of the beliefs dimension of the attitude towards technology in classroom, *F*(1, 10) = 1.81, *p* = .20. See figure 10 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group *t*(8) = -.23, *p* = .82, nor for the control group , *t*(10) = 1.70, *p* = .12, meaning that for both conditions the relevance sub-component did not significantly change over time.

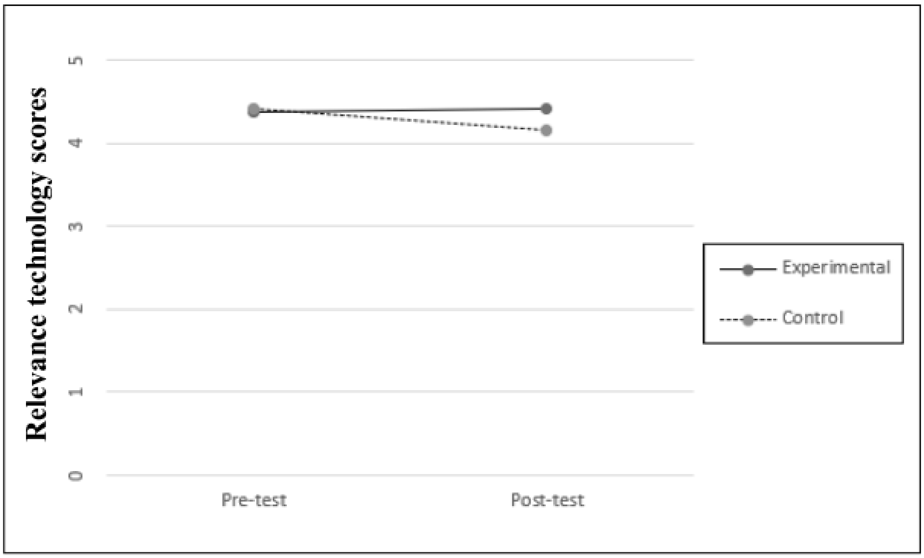


Figure 10. Mean scores pre- and post-test per condition.

Usefulness technology

The univariate analyses showed a statistical significant interaction effect of time and condition for the usefulness sub-component of the beliefs dimension of the attitude towards technology in classroom, $F(1, 10) = 6.30$, $p = .02$, $\eta 2 = .26$. See figure 11 for the interaction plot. The effect size is therefore high (Cohen, 1988) with partial $\eta 2$ of .26, meaning that 26% of the variance in scores for the usefulness sub-component of the beliefs dimension of the attitude towards technology in classroom, was accounted for by the training course. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -2.29$, $p = .05$, nor for the control group , $t(10) = 1.00$, $p = .34$, meaning that however the interaction effect size was high, the usefulness sub-component did not significantly change over time for both conditions.

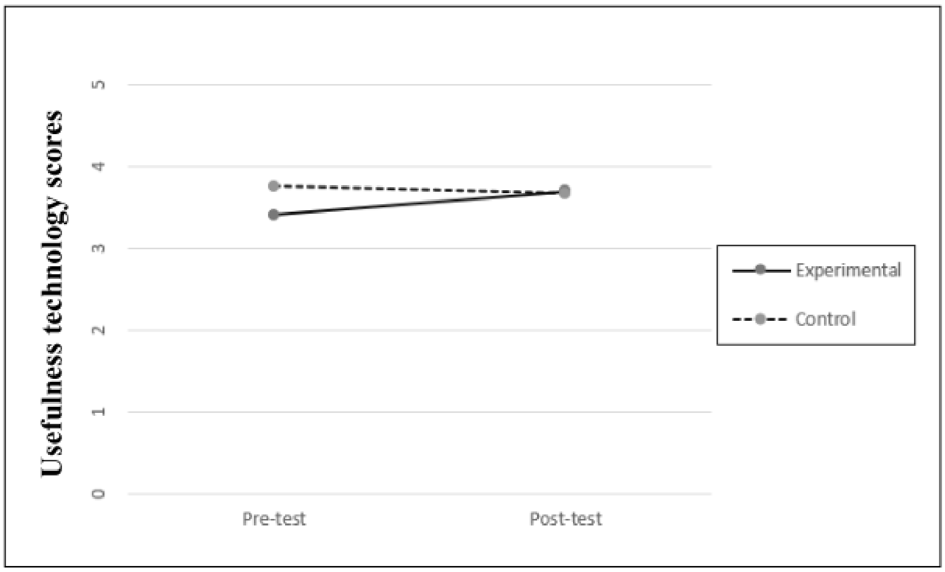


Figure 11. Mean scores pre- and post-test per condition.

Ease of use technology

The univariate analyses did not show a statistical significant interaction effect of time and condition for the ease of use sub-component of the beliefs dimension of the attitude towards technology in classroom, $F(1, 10) = 1.52$, $p = .08$. See figure 12 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.24$, $p = .81$, nor for the control group , $t(10) = -1.67$, $p = .13$, meaning that for both conditions the ease of use sub-component did not significantly change over time.

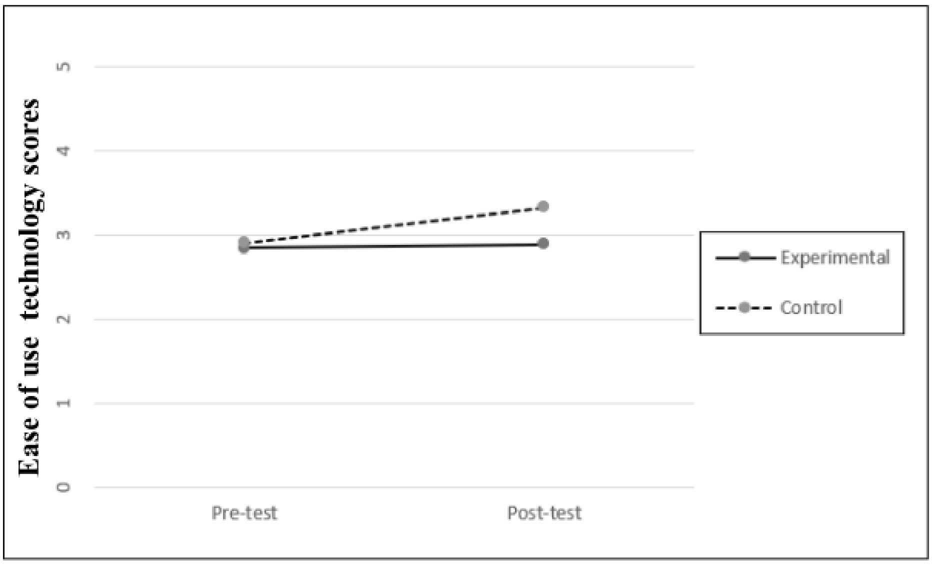


Figure 12. Mean scores pre- and post-test per condition.

Anxiety technology

The univariate analyses showed a statistical significant interaction effect of time and condition for the anxiety sub-component of the affect dimension of the attitude towards technology in classroom, $F(1, 10) = 7.08$, $p = .02$, $\eta 2 = .28$. See figure 13 for the interaction plot. The effect size is therefore high (Cohen, 1988) with partial η2 of .28, meaning that 28% of the variance in scores for the anxiety sub-component of the affect dimension of the attitude towards technology in classroom, was accounted for by the training course. Further analysis using paired t-tests, showed a statistical significant decrease for the experimental group $t(8) = 2.53$, $p = .018$, while for the control group there was no statistical significant change, $t(10) = -1.61$, $p = .14$, this indicates that the training course had a negative effect on the anxiety of primary school teachers towards technology use in classroom.

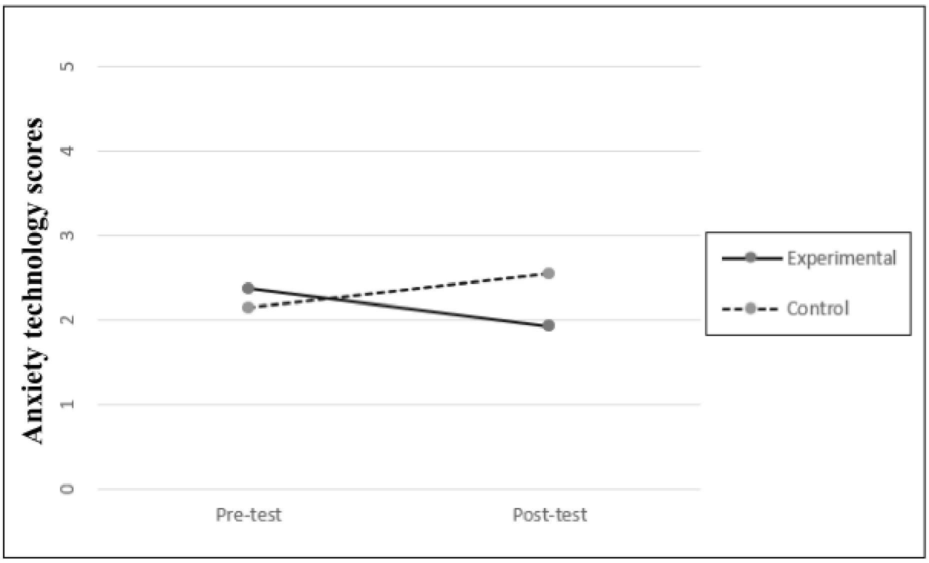


Figure 13. Mean scores pre- and post-test per condition.

Enjoyment technology

The univariate analyses did not show a statistical significant interaction effect of time and condition for the enjoyment sub-component of the affect dimension of the attitude towards technology in classroom, $F(1, 10) = 0.22$, $p = .65$. See figure 14 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = .00$, $p = 1.00$, nor for the control group , $t(10) = .60$, $p = .56$, meaning that for both conditions the enjoyment sub-component did not significantly change over time.

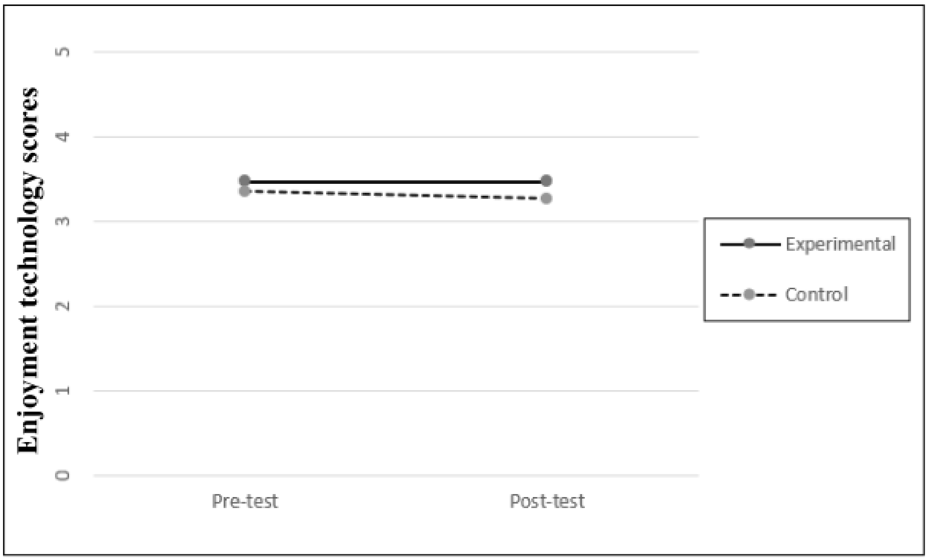


Figure 14. Mean scores pre- and post-test per condition.

Self-efficacy technology

The univariate analyses did not show a statistical significant interaction effect of time and condition for the self-efficacy sub-component of the perceived behavioural control dimension of the attitude towards technology in classroom, $F(1, 10) = 0.24$, $p = .63$. See figure 15 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -2.09$, $p = .07$, nor for the control group , $t(10) = -2.14$, $p = .06$, meaning that for both conditions the self-efficacy sub-component did not significantly change over time.

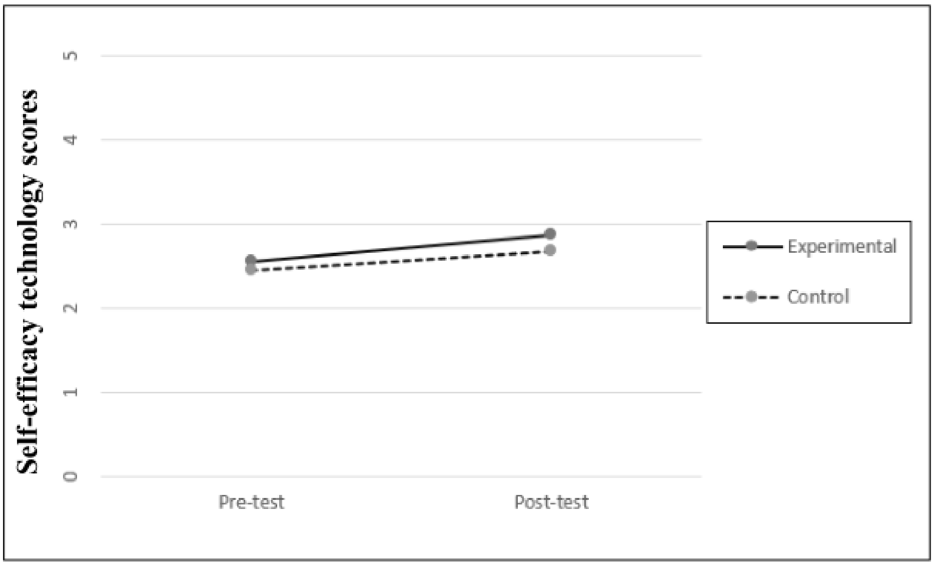


Figure 15. Mean scores pre- and post-test per condition.

Context dependency technology

The univariate analyses did not show a statistical significant interaction effect of time and condition for the context dependency sub-component of the perceived behavioural control dimension of the attitude towards technology in classroom, $F(1, 10) = 0.52$, $p = .48$. See figure 16 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.15$, $p = .088$, nor for the control group , $t(10) = -1.07$, $p = .31$, meaning that for both conditions the context dependency sub-component did not significantly change over time.

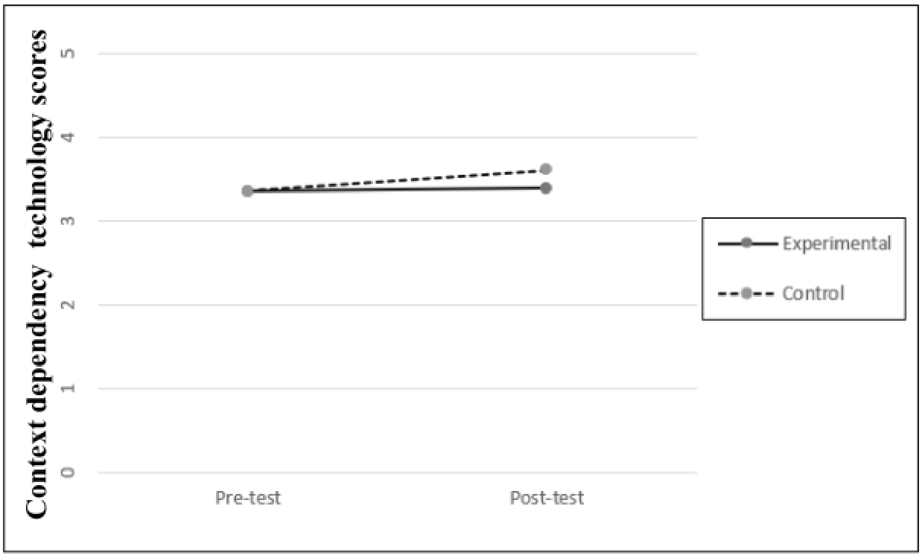


Figure 16. Mean scores pre- and post-test per condition.

Subjective norm technology

The univariate analyses did not show a statistical significant interaction effect of time and condition for the subjective norm sub-component of the social norm dimension of the attitude towards technology in classroom, $F(1, 10) = 0.04$, $p = .85$. See figure 17 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.89$, $p = .40$, nor for the control group, $t(10) = -.50$, $p = .63$, meaning that for both conditions the subjective norm sub-component did not significantly change over time.

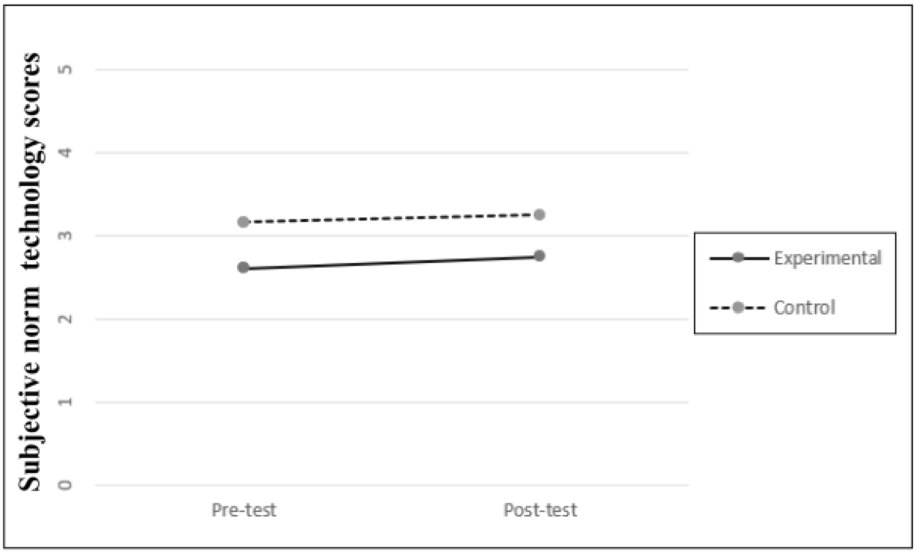


Figure 17. Mean scores pre- and post-test per condition.

Relevance HOTS

The univariate analyses did not show a statistical significant interaction effect of time and condition for the relevance sub-component of the beliefs dimension of the attitude towards the stimulation of HOTS among learners, $F(1, 10) = 0.05$, $p = .82$. See figure 18 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.45$, $p = .67$, nor for the control group, $t(9) = -.67$, $p = .52$, meaning that for both conditions the relevance sub-component did not significantly change over time.

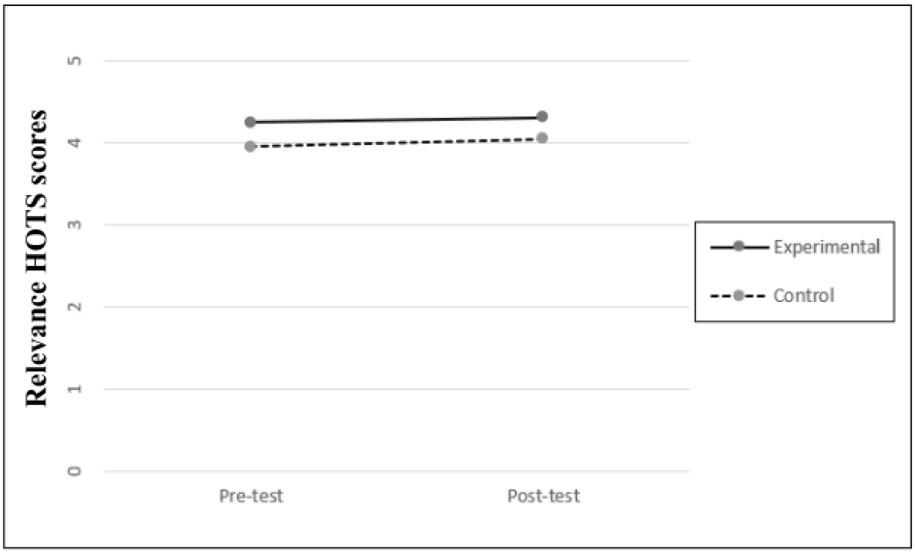


Figure 18. Mean scores pre- and post-test per condition.

Learners' ability HOTS

The univariate analyses did not show a statistical significant interaction effect of time and condition for the learners' ability sub-component of the beliefs dimension of the attitude towards the stimulation of HOTS among learners, $F(1, 10) = 1.41$, $p = .25$. See figure 19 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.82$, $p = .44$, nor for the control group, $t(10) = .88$, $p = .40$, meaning that for both conditions the learners' ability sub-component did not significantly change over time.

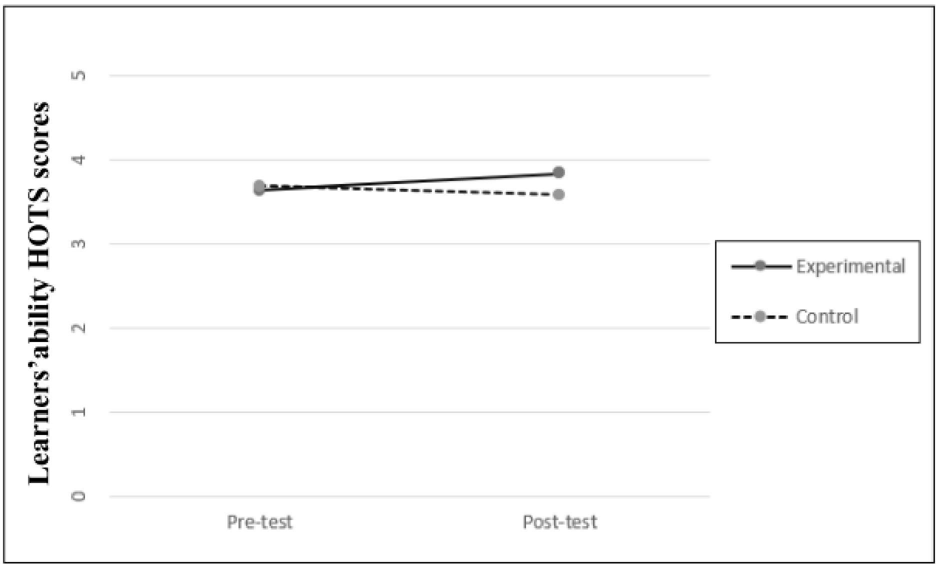


Figure 19. Mean scores pre- and post-test per condition.

Self-efficacy HOTS

The univariate analyses showed a statistical significant interaction effect of time and condition for the self-efficacy sub-component of the perceived behavioural control dimension of the attitude towards the stimulation of HOTS among learners, $F(1, 10) = 7.07$, $p = .02$, η2 = .28. See figure 20 for the interaction plot. The effect size is therefore high (Cohen, 1988) with partial η2 of .28, meaning that 28% of the variance in scores for the self-efficacy sub-component of the perceived behavioural control dimension of the attitude towards the stimulation of HOTS among learners, was accounted for by the training course. Further analysis using paired t-tests, showed a statistical significant increase for the experimental group $t(8) = -3.62$, $p = .004$, while for the control group there was no statistical significant change, $t(10) = -43$, $p = .68$, this indicates that the training course had a positive effect on the self-efficacy of primary school teachers towards the stimulation of HOTS among learners.

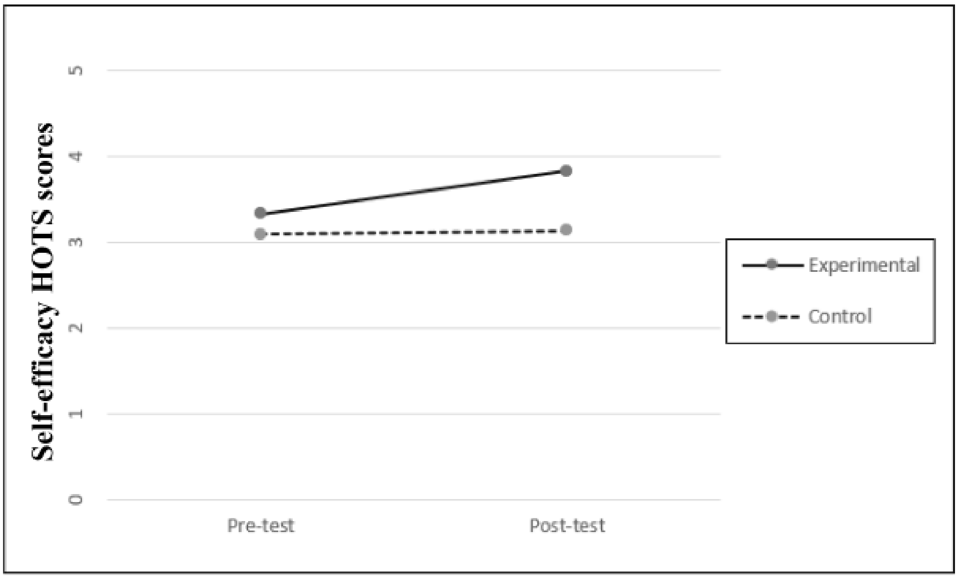


Figure 20. Mean scores pre- and post-test per condition.

Qualitative reflections

At the end of the course teachers in the experimental group were asked to briefly state on paper 1 what they think is the most valuable thing they have learned during the training and 2 what remained unclear. Of the 14 participating teachers, 12 wrote the short reflections.

Learned. Of the teachers, 6 wrote statements related to the attitude sub-component of usefulness of technology in classroom, namely that they had learned that technology is a useful tool for learning or more useful than they initially thought, 5 wrote statements related to the attitude sub-component of ease of use of technology and/or the stimulation of HOTS among learners, namely that they learned an easy way to design lessons with technology and/or aimed at the stimulation of HOTS, 1 wrote a statement related to the attitude sub-component of self-efficacy, namely that he or she learned about his or hers process in designing lessons and how this can be improved and 1 wrote a statement about that he or she learned that there are endless possibilities and he or she should extend his or hers scope. It's not clear if this statement is related to the attitude sub-component of context dependency meaning more possibilities in designing lessons with the technology or aimed at the stimulation of HOTS at the specific school, or endless possibilities for technology in general to be used in education, which will be more related to the attitude sub-component of usefulness of technology.

Unclear. Of the teachers, 5 wrote a question directly related to the attitude sub-component of context dependency. Of these, 4 were about the feasibility for a school to buy technology, and 1 was about possible time constraints. Furthermore, there were also questions that were not directly related to an attitude sub-component which were marked as 'how to' questions. Of these, 2 teachers wrote a question about how to implement the lesson-development scheme that was used in the workshop in their school, 2 teachers wrote a question about how to use a specific part in the scheme, and 1 teacher wrote a question about how specific types of technology can be used.

Discussion

The findings of this study suggest that some attitude dimension sub-components of technology use in classroom, as well as the stimulation of HOTS among learners can positively be influenced by the on- and offline training course used in this study.

Quantitative evidence gathered via surveys (pre-and post-test) indicates a negative effect of the course on the anxiety sub-component of the affect dimension regarding technology use in classroom, meaning that the average teachers' anxiety levels had dropped significantly. Furthermore, the self-efficacy sub-component of the perceived behavioural control dimension of teachers' attitudes toward the stimulation of HOTS showed a significant increase, meaning that teachers on average felt more competent in designing and executing lessons in which the HOTS of learners are stimulated.

Qualitative evidence gathered via short on-paper reflections after the workshop part of the training, partly supported these findings and in addition indicated that there might have been more effects than could be drawn from the quantitative data. Half of the teachers who executed the reflective assignment namely wrote that they had learned that technology is a more useful tool for learning than they initially thought. This thus suggests that there was an effect regarding the usefulness attitude dimension sub-component of technology. When looking at the quantitative data, however, the image is somewhat different. While there was an interaction effect found for the usefulness attitude dimension sub-component of technology, there was no statistically significant change between the pre-and post-test scores per condition. In contrast to the qualitative data, this indicates that the attitudes of teachers regarding this sub-component had not changed. There are thus qualitative indications of a possible effect on the usefulness sub-component, only these could not be supported by quantitative data in this study. Another surprising finding is, while no significant change was found in the quantitative data for the ease-of-use sub-component of the attitude dimension of beliefs regarding technology use in classroom, almost half of the teachers who wrote what they had learned, stated that they learned an easy way to design lessons with technology and/or aimed at the stimulation of HOTS, e.g., *"In this way, learning goals can be quickly concretized and finding digital tools becomes easier".* It is important to consider when looking at the qualitative data that the absence of statements related to other attitude dimension sub-components than the ones described above, might have to do with the type of question that has been asked. Asked is namely, to write what has been 'learned'. Teachers might easier form sentences related to, for instance the usefulness of technology, as something that has been learned. This is namely something you can actually been taught. After the workshop one might state that he learned that technology is a useful tool for learning, because he learned new knowledge about the use of technology in classroom and has seen examples in which the use of technology has added value. That this changed the attitude as well is probably not noticed by the teacher. For other attitude sub-components, it might be more difficult or irrelevant to form sentences about what has been learned, compared to the usefulness sub-component. When looking for example at the anxiety sub-component, it seems not likely that a teacher states that he has 'learned' that his anxiety towards the use of technology decreased. This is mostly not something you learn; it is something that occurs. One could thus have probably not learned about his decrease in anxiety towards the use of technology in classroom, while there was in fact a negative change in anxiety, although unobtrusive and at the attitude level instead of the knowledge level. This might explain why the anxiety sub-component that showed significant changes via the quantitative analysis, does not show changes via the qualitative analysis. Of the reflections of the teachers, some statements about what remained unclear could particularly be related to the context-dependency attitude sub-component of the perceived-behavioural-control dimension regarding the in classroom use of technology, which is supported via the quantitative evidence of this study as there were no significant changes in the scores on this sub-component. Most of the context dependency seems related to the expected costs involved when one would want to start working with technology, as this is what the teachers mainly wrote about.

As stated before, it seems that the relatively short intervention of the study had an effect on 3 attitude dimension sub-components. This is an important result because attitudes are formed by multiple evaluations around an attitude object, which might suggest that changes in attitudes need time to occur (Ajzen, 2001). This would mean that professional development programs with a long duration are needed to have an effect. The results of this study however indicate that that multiple positive evaluations around an attitude object can in fact take place via professional training programs with a short duration that furthermore partly take place online. It would be interesting to see how this holds when this would be investigated with a larger sample size and if the attitude changes would also be apparent on long term. An effective program with a short duration, which could partly take place online would be of high practical value as it would reduce cost for schools for professional development and reduce the time that schools need to invest. The reduced time investment seems especially promising for the development of teachers, as all schools that were asked to participate except, 1 mentioned time-constraints as the primary reason for not being able to participate in the training course. The majority also mentioned that when they would have had time, they would have wanted to participate because they viewed technology use in classroom and the stimulation of HOTS as important topics to receive training on.

Another interesting topic to explore is that while it seems that 3-sub-components of different attitude dimensions can be influenced by the training that is used in this study, it might be that on longer term more sub-components are influenced and that longer term effects might be stronger. This might be possible because when the 3 sub-components of the attitude dimensions are improved, this would mean that the attitude dimensions itself are improved. The overall attitude dimension score is namely an average of the scores on the sub-components (Wijnen et al., in progress). According to the theory of planned behaviour (Ajzen, 2001) this increase might lead to the intention to perform certain behaviour, for example aiming at the stimulation of HOTS more often. This, then, could lead to performing this behaviour. When the teacher performs this behaviour and experiences this as positive regarding for example an increase in learning outcomes, this could lead to further positive evaluations regarding the attitude object. Possibly on other attitude dimension sub-components than the 3 which were influenced by the training of this study. If the new positive evaluations take place it could create a cycle as these positive evaluations on the sub-components would again have an effect on the overall attitude towards an object, which according to the theory of planned behaviour could again lead to the intention to perform certain behaviour, and so forth. First evidence for the existence of this cycle of attitude improvement can be found in the practice causal loop of Howard and Thompson (2016). This causal loop for example states that when a teacher has positive experiences with the use of technology in classroom, in such a way that learning outcomes are improved, this would lead to an increase in the idea that technology supports learning and lead to a change in the beliefs about teaching. This could for example lead to an increased use of technology in learning, or the intention to participate in professional development. This suggestion seems directly related to the usefulness sub-component of the beliefs dimension of the attitudes towards technology use in classroom in the attitude dimension framework of Wijnen et al. (in progress). This sub-component is namely about exactly that idea.

This study was a first exploration of the effects of a relatively short and cost-effective on- and offline training course on the attitudes of primary school teachers. The actual classroom change was therefore not within the scope of this study. It would however be valuable for further research to measure these possible in-classroom changes and thereby particularly investigate if positive changes in the scores on the attitude sub-components will lead to a change in the teaching of teachers and if these changes then will lead to further changes in the attitude sub-components and teaching. This would namely indicate that a cycle of attitude improvement exists. When this would be confirmed, one could further investigate to what extent attitude dimensions and its sub-components need to be influenced via training to start such a cycle. It is furthermore, as stated before, recommended for future research to 1 measure the effects of the course with a larger sample size and at more schools to improve the reliability and the generalizability of the findings, as the sample size of this current study was rather low and necessary statistical assumptions could not be completely met, and 2 investigate which components of the training led to which changes in the attitude dimension sub-components and which not, leading to possible suggestions about how the training can be improved. Currently it is namely not clear if the instructional videos, the workshop, or a combination of both caused the effects and let alone which parts of the videos and/or workshop. Only the training as a whole has been investigated, and while this increased the chances of finding an effect, to improve the training it is important to know what exactly caused the effects. After that it can be investigated if removing or changing ineffective parts would lead to a more effective training.

This study contributed to practice by providing a cost- and time effective training course for the improvement of primary teachers' attitudes towards technology use in classroom and the stimulation of HOTS among learners.

This study contributes to science by providing explorative evidence that the sub-components of the attitudes dimensions as described by Wijnen, Walma van der Molen and Voogt (in progress), can be influenced by a short on- and offline training course containing short video lectures, a workshop and a scheme for the design and development of lessons.

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Appendix A

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Deze vragenlijst gaat over de houding van leerkrachten ten aanzien van het gebruik van technologie in de les en het stimuleren van hogere orde denken bij leerlingen.

Lees eerst onderstaande informatie goed door, voordat je aan de vragen begint.

Eerlijke mening: Het is belangrijk dat je de vragen eerlijk beantwoordt zodat het onderzoek een eerlijk beeld oplevert. Er zijn geen goede of foute antwoorden, het gaat echt om jouw persoonlijke mening. We willen je vragen om de vragenlijst volledig in te vullen omdat onvolledige vragenlijsten niet gebruikt kunnen worden voor het onderzoek.

Anonimiteit: De vragenlijsten worden anoniem verwerkt en niet gekoppeld aan personen. Wel zouden we graag de mogelijkheid hebben om de data van een afzonderlijke school te bekijken. Daarom vragen we je om de naam van de school in te vullen, deze naam wordt uiteindelijk niet genoemd in het onderzoeksverslag. Ook wordt er gevraagd om een code te maken. Deze wordt gebruikt om de eerste en de tweede meting aan elkaar te koppelen.

Over de vragenlijst: Het kan voorkomen dat sommige vragen erg op elkaar lijken. Dat voelt misschien overbodig, maar dat is statistisch gezien noodzakelijk om de vragenlijst betrouwbaar te maken. Daarom verzoeken we je om toch alle vragen in te vullen.

Onderdelen:
Deze vragenlijst bestaat uit de volgende onderdelen:
0. Achtergrondkenmerken
1. Toegang tot technologie
2. Technologie in de les
3. Het stimuleren van hogere-orde denken

Alvast hartelijk dank voor je medewerking!

○ Ik heb de bovenstaande informatie gelezen en ga ermee akkoord dat mijn antwoorden op deze vragenlijst worden gebruikt voor onderzoeksdoeleinden.

Omdat je de vragenlijst uiteindelijk twee keer gaat invullen is het voor het koppelen van de gegevens van de eerste vragenlijst aan de tweede (zonder dat we weten wie je bent) belangrijk een unieke code te maken. Deze code wordt alleen voor de koppeling gebruikt. Kun je daarom hieronder (aan elkaar, zonder spatie) jouw geboortedatum en het nummer van je postcode invullen? Dus bijvoorbeeld 01 januari 1980 en postcode 1234 AB wordt dan : 010119801234

Vul hieronder jouw unieke code in.

UNIVERSITY OF TWENTE.

Op welke school werk je?

Ik ben een...

- Man
- Vrouw

Wat is je leeftijd?

Aan welke groep geef je dit jaar les?

- Groep 1-2
- Groep 3-4
- Groep 5-6
- Groep 7-8
- Anders, namelijk

Wat is je hoogst genoten vooropleiding?

- PABO
- Academische PABO
- HBO
- HBO Master
- Academische Master
- Verkorte lerarenopleiding/ zij-instromer
- Anders

→

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Geef aan in hoeverre jij toegang hebt tot de onderstaande technologische middelen op jouw school om te gebruiken in je lessen.

	1. geen toegang	2.	3.	4.	5. altijd toegang	*weet ik niet*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

Geef aan in hoeverre de onderstaande technologische middelen van voldoende kwaliteit zijn (werken ze naar behoren)

	1. zeer slechte kwaliteit	2.	3.	4.	5. zeer goede kwaliteit	*n.v.t.*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

Geef aan in hoe vaak je de onderstaande technologische middelen in je lessen gebruikt

	1. nooit	2.	3.	4.	5. altijd	*n.v.t.*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

Geef aan in hoeverre je vindt dat de onderstaande technologische middelen van meerwaarde zijn voor het onderwijs.

	1. zeer weinig meerwaarde	2.	3.	4.	5. zeer veel meerwaarde	*n.v.t.*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

→

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BELANGRIJK: De onderstaande vragen gaan over TECHNOLOGIE.

Met technologie bedoelen we in dit onderzoek, digitale leermiddelen (zowel hardware als software) die jij als leerkracht kunt gebruiken als leermiddel om je lessen te verrijken/ondersteunen. Voorbeelden hiervan zijn, hardware: laptops, smartphones, tablets, 3D printers,
educatieve robots (BeeBot, DASH). Software: Office toepassingen, simulatiesoftware, ontwerpsoftware,
programmeersoftware, videobewerkingssoftware.

Geef aan in hoeverre je het eens bent met de volgende stellingen.

	1. helemaal mee oneens	2.	3.	4.	5. helemaal mee eens
Ik ben goed in staat om technologieën te kiezen die de didactische werkvormen in mijn lessen verrijken	○	○	○	○	○
Ik denk dat het erg weinig moeite kost om nieuwe technologie te gebruiken in mijn lessen	○	○	○	○	○
Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van een ICT-coördinator bepalend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Ik heb het gevoel dat op onze school de visie over het inzetten van technologie in het onderwijs helder is	○	○	○	○	○
Ik word nerveus bij het idee dat ik met technologie in mijn lessen moet werken	○	○	○	○	○
De moed zakt me in de schoenen als ik iets nieuws moet doen met technologie in mijn lessen	○	○	○	○	○
Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van lesmaterialen bepalend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Ik ben goed in staat om lessen te geven waarbij technologie, vakinhoud en didactiek op een goede manier zijn geïntegreerd	○	○	○	○	○
Ik denk dat het heel makkelijk is om technologie te gebruiken in mijn lessen	○	○	○	○	○
Ik voel mij gedreven om lessen te geven met technologie	○	○	○	○	○
Ik ben enthousiast over het gebruik van technologie in mijn lessen	○	○	○	○	○
Ik denk dat het erg belangrijk is voor de toekomst van leerlingen dat zij de mogelijkheid hebben om met technologie te leren werken op school	○	○	○	○	○
Voor mij is extra tijd doorslaggevend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Voor mij voelt het gebruik van technologie in mijn lessen als een positieve uitdaging	○	○	○	○	○
Ik denk dat het essentieel is voor leerlingen om met technologie te leren werken, zodat zij goed voorbereid worden op de ontwikkelingen in de samenleving	○	○	○	○	○

Ik denk dat het heel eenvoudig is om nieuwe technologie in te zetten in mijn lessen	○	○	○	○	○
Voor mij is de beschikbaarheid van een scholingsprogramma een voorwaarde om technologie te gebruiken in mijn lessen	○	○	○	○	○
Ik denk dat ik met behulp van technologie de lesinhoud veel makkelijker op een gedifferentieerde manier kan aanbieden	○	○	○	○	○
Ik heb het gevoel dat het inzetten van technologie in de les op onze school wordt gewaardeerd	○	○	○	○	○
Ik ben goed op de hoogte van technologieën die ik kan gebruiken om leerlingen inzicht te geven in de vakken waarin ik lesgeef	○	○	○	○	○
Ik vind het leuk om met technologie te experimenteren in mijn lessen	○	○	○	○	○
Ik denk dat het cruciaal is dat leerlingen de rol van technologie in de maatschappij begrijpen	○	○	○	○	○
Ik denk dat ik met behulp van nieuwe technologie mijn instructie veel meer kan variëren	○	○	○	○	○
Ik heb het gevoel dat in het onderwijs op onze school technologie een belangrijke plaats heeft	○	○	○	○	○
Ik weet precies hoe ik technologieën kan gebruiken om concepten uit verschillende vakken op een andere manier te presenteren aan mijn leerlingen	○	○	○	○	○
Ik ben goed in staat om technologieën te kiezen die de leerprocessen van mijn leerlingen versterken	○	○	○	○	○
Voor mij is de aanwezigheid van technische ondersteuning bepalend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Ik heb het gevoel dat mijn collega's het gebruik van technologie in het onderwijs belangrijk vinden	○	○	○	○	○
Ik denk dat het gebruik van technologie in mijn lessen zeer nuttig is om het dieper leren van leerlingen mogelijk te maken	○	○	○	○	○
Ik voel mij gespannen als ik technologie moet gebruiken in mijn lessen	○	○	○	○	○
Ik ben goed in staat om technologieën te kiezen die de lesinhoud voor de vakken waarin ik lesgeef ondersteunen	○	○	○	○	○
Ik denk dat de leerresultaten van mijn leerlingen aanzienlijk verbeteren door het gebruik van technologie	○	○	○	○	○

→

UNIVERSITY OF TWENTE.

BELANGRIJK: De onderstaande vragen gaan over HET STIMULEREN VAN HOGERE-ORDE DENKEN
Met het stimuleren van hogere-orde denken bij leerlingen bedoelen we het aanbieden van opdrachten, vragen, problemen of dilemma's waarbij kinderen complexe cognitieve denkvaardigheden moeten gebruiken (zoals analyseren, evalueren en creatief denken) om te
komen tot een oplossing, beslissing, voorspelling, oordeel of product. Voorbeelden hiervan zijn
(1) leerlingen zoveel mogelijk oplossingen laten bedenken voor een gegeven probleem, (2) leerlingen een ontwerp laten maken voor een nieuw nog niet bestaand product, (3) leerlingen
voor- en tegenargumenten laten bedenken rondom een stelling om zo een eigen mening te vormen over een bepaald onderwerp.

Geef aan in hoeverre je het eens bent met de volgende stellingen.

	1.helemaal mee oneens	2.	3.	4.	5. helemaal mee eens
Ik denk dat het cruciaal is voor het leren van leerlingen dat zij worden aangezet tot hogere-orde denken	○	○	○	○	○
Ik beschik over genoeg vaardigheden om mijn lessen te verrijken met hogere-orde denkopdrachten	○	○	○	○	○
Ik denk dat we van 'zwakke' leerlingen geen hogere-orde denken moeten verwachten	○	○	○	○	○
Ik denk dat opdrachten die hogere-orde denken vereisen veel geschikter zijn voor 'slimme' leerlingen dan voor 'zwakke' leerlingen	○	○	○	○	○
Ik ben goed in staat vragen te stellen aan mijn leerlingen waarmee hogere-orde denken wordt gestimuleerd	○	○	○	○	○
Ik denk dat 'zwakke' leerlingen opdrachten die hogere-orde denken vereisen niet aan kunnen	○	○	○	○	○
Ik ben goed in staat om zelf opdrachten te maken die mijn leerlingen aanzetten tot hogere-orde denken	○	○	○	○	○
Ik denk dat het voor de ontwikkeling van het denken van leerlingen essentieel is om hogere-orde denken te stimuleren	○	○	○	○	○
Ik denk dat het stimuleren van hogere-orde denken zo belangrijk is, dat alle leerkrachten dit regelmatig moeten doen in hun lessen	○	○	○	○	○
Ik denk dat 'slimme' leerlingen veel beter zijn in hogere-orde denken dan 'zwakke' leerlingen	○	○	○	○	○
Ik denk dat opdrachten die hogere-orde denken vereisen frustrerend zijn voor 'zwakke' leerlingen	○	○	○	○	○
Om de ontwikkeling van het denken van leerlingen te stimuleren, vind ik dat je niet vroeg genoeg kunt beginnen met het aanbieden van opdrachten waarin hogere-orde denken aan bod komt	○	○	○	○	○
Ik ben goed in staat om leerlingen te begeleiden bij het maken van opdrachten waarbij zij aangezet worden tot hogere-orde denken	○	○	○	○	○

Appendix B

De leerling kan (leeronderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om (reden), waarbij de leerling (proces).

1. Wat is het leeronderwerp?

Het leeronderwerp is:…………………………………………

Wat moet de leerling met de leerstof kunnen doen?

Onthouden	Begrijpen	Toepassen	Analyseren	Evalueren	Creëren
Kunnen onthouden van leerstof zonder begrip. Geleerde kennis ophalen door het te herinneren.	Begrijpen en betekenis kunnen geven aan geleerde kennis.	Toepassen van het geleerde in een nieuwe situatie.	Onderzoeken en analyseren van informatie door motieven en oorzaken te identificeren; conclusies te trekken en bewijzen te vinden ter ondersteuning van bevindingen.	Het presenteren en verdedigen van meningen door informatie, ideeën of werk te beoordelen op basis van criteria.	Creëren van nieuwe oplossingen, ideeën, kennis en producten met opgedane kennis door elementen te combineren of alternatieve oplossingen te bedenken.

Lagere orde denkvaardigheden | **Hogere orde denkvaardigheden**

Oppervlakkig leren ← → **Diepgaand leren**

2. Welke leeractiviteit zal de leerling daarbij uitvoeren?

Onthouden		Begrijpen		Toepassen		Analyseren		Evalueren		Creëren	
Benoemen	Vertellen	Aanduiden	Schetsen	Associëren	Overbrengen	Analyseren	Overzien	Aanbevelen	Oordelen	Aanpassen	Testen
Citeren	Navertellen	Demonstreren	Sorteren	Beheersen	Plannen	Beredeneren	- Prioriteren	Bekritiseren	Overtuigen	Bedenken	Toevoegen
Definiëren	Opsommen	Discussiëren	Toelichten	Berekenen	Selecteren	Categoriseren	Relaties	Belang Bepalen	Overwegen	Bewerken	Transformeren
Herhalen	Beschrijven	Vragen	Tonen	Categoriseren	Simuleren	Classificeren	benoemen	Bepalen	Prioriteren	Combineren	Uitbreiden
Herkennen	Aanwijzen	Generaliseren	Uitdrukken	Classificeren	Toelichten	Concluderen	Reorganiseren	Beslissen	Rechtvaardigen	Construeren	Uitvinden
Kiezen	Onderstrepen	Herformuleren	Uitleggen	Demonstreren	Toepassen	Discussiëren	Samenstellen	Betogen	Schatten	Creëren	Veranderen
Kopiëren	Vinden	Herzien	Vergelijken	Experimenteren	Uitvoeren	Focussen	Schatten	Betwisten	Valideren	Experimenteren	Verbeteren
Luisteren	Labelen	Indelen	Vertalen	Gebruik maken	Verbinden	Inspecteren	Selecteren	Bewijzen	Verdedigen	Reviseren	Vereenvoudigen
Memoriseren	Tonen	Interpreteren	Voorbeelden	van	Vertalen	Onderscheiden	Vaststellen	Concluderen	Vergelijken	Herzien	Vervangen
Observeren	Schrijven	Observeren	geven	Gebruiken	Voortbouwen op	Onderzoeken	Verdelen	Debatteren	Verklaren	Innoveren	Visualiseren
Onthouden	…………	Rapporteren	Voorspellen	Identificeren	Vormen	Ontdekken	Vergelijken	Evalueren	Waarderen	Integreren	Voorspellen
Opschrijven	…………	Relateren	…………	Interpreteren	…………	Ontleden	Vinden	Instemmen	Weerleggen	Ontwerpen	Voorstellen
Opzoeken	…………	Samenvatten	…………	Manipuleren	…………	Oorzaak en	Vragen	Interpreteren	…………	Ontwikkelen	…………
Reproduceren	…………	Schatten	…………	Ontwikkelen	…………	gevolg	…………	Kiezen	…………	Oplossen	…………
Selecteren			…………	Organiseren	…………	onderscheiden	…………	Kwalificeren	…………	Produceren	…………
						Ordenen	…………	Mening geven	…………	Samenstellen	…………

3. Welk product zal de leerling maken?

De leerling maakt:……

4. Welke vorm van technologie kan de leerling hierin ondersteunen?

- **3D-printer**
- **Digibord**
- **Tekstverwerker**
  (Bijv.Microsoft Word, Apple Pages, Google Documenten)
- **Spreadsheet programma**
  (Bijv. Microsoft Excel, Apple Numbers, Google Spreadsheets)
- **Presentatiesoftware**
  (Bijv. Microsoft Powerpoint, Prezi, Keynote)
- **Publicatie ontwerp programma** *(Bijv. Microsoft Publisher, Adobe InDesign)*
- **Digitaal tekenprogramma**
  (Bijv. Paint)
- **3D ontwerp programma**
  (Bijv. Thinkercad, Google Sketchup,Doodle3d, Paint3D)
- **Fotobewerking programma**
  (Bijv. Photoshop, Aviary)
- **Programmeerbare robot**
  (Bijv. Ozobot, Beebot, Lego Mindstorms, Mbot)
- **Augmented Reality**
- **Virtual Reality**
  (Bijv. Google Cardboard, Google expeditions)
- **360 graden camera**
- **Video camera**
- **Foto camera**
- **Mindmap software**
  (Bijv. Mindmomo.com, Coggle.it, Mindmapmaker.org)
- **Digitaal prikbord**
  (Bijv. Padlet)
- **Game ontwerper**
- **Mini computer/controller**
  (Bijv. Raspberry Pi, Microbit, Arduino)

- **Website maker**
  (Bijv. Wordpress), school.jouwweb.nl, Mijnwebsite.nl)
- **Elektronica**
  (Bijv. Littlebits)
- **Programmeer programma**
  (Bijv. Scratch, Programmr), Makey Makey)
- **Chatprogramma**
  (Bijv. Skype)
- **Social media**
  (Bijv. Facebook, Instagram, Twitter, Pinterest)
- **Minecraft Education**
- **Videobewerking programma**
  (Bijv. iMovie, Windows foto en film editor)
- **Digitaal Museum**
  (Bijv. Google Art)
- **Time lapse software**
  (Bijv. Lapse It)
- **Chromakey software**
  (Bijv. Greenscreen by Doink, Chroma key studio Pro)
- **Youtube**
- **3D pen**
  (Bijv. Doodle 3d)
- **Zoekmachine**
  (Bijv. Google, Bing, Yahoo, Davindi)
- **Lasersnijder**
- **SMART table**
- **Interactieve vloer**
  (bijv. Active Floor, Wize Floor)
- **Digitale methode software**
- **Interactief foto/video programma** *(bijv. Thinglink)*

- **Infographic programma**
  (Bijv. Piktochart, Easel.ly, Infogr.am)
- **Strip teken programma**
  (Bijv. Strip designer, Pixton, Make Beliefs Comix)
- **Stemrecorder**
  (Bijv. Microsoft Voicerecorder)· **Quiz programma**
  (Bijv. Kahoot, Socrative, Plickers, Blendspace)
- **Woordwolk programma**
  (Bijv. Woordwolk.nl)
- **Enquete programma**
  (Bijv. Miscrosoft forms, Google Forms, Survey Monkey)
- **Schermopname programma**
  (Bijv. Screencast-O-Matic, Windows Gamebar)
- **Mindmap programma**
  (Bijv. Bubble.us, eMindmap, Mindmeister, MindNode)
- **Flitskaarten programma**
  (Bijv. Wozzol, Quizlet)
- **Digibord tools**
  (Bijv. Prowise Presenter, Gynzy)
- **Tijdschrift ontwerp programma**
  (Bijv. Jilster)
- **Online encyclopedie**
  (Bijv. Wikipedia, Wikikids)
- **Stop motion programma**
  (Bijv. Stop Motion Studio)
- **Muurkrant programma**
  (Bijv.Glogster)
- **Tijdlijn programma**
  (Bijv. Timerime, Timeglider)
- **Landkaart software**
  (Bijv. Google Maps, Google Earth)
- ………………

5. Waarvoor gebruikt de leerling deze technologie?

De leerling gebruikt de technologie voor:……………………………………………………………………………………………

6. Wat doet de leerling tijdens de leeractiviteit om het gewenste resultaat te behalen?

De leerling:……

Appendix C

De leerling kan (onderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om(reden) , waarbij de leerling(proces).

Stap 1.1: Beschrijf de belangrijkste leeronderwerpen van de leerlingen van de komende maand. Kies tien onderwerpen die jullie interessant vinden en waar jullie graag mee aan de slag willen. Schrijf deze op de bordjes.

Stap 1.2: Kies één van de tien bordjes met leeronderwerpen.

Stap 2: Kijk naar de taxonomie van Bloom. Bedenk in hoeverre de leerling de leerstof moet beheersen. Dit varieert van enkel het onthouden en reproduceren van de leerstof zonder begrip, tot het zelf kunnen creëren van iets nieuws met of naar aanleiding van de leerstof. Kies het best passende niveau van de taxonomie van Bloom en kies een bijpassende leeractiviteit.

Stap 3: Kies een geschikt product dat de leerling gaat maken.

Stap 4: Kies een vorm van technologie die de leerling in het proces kan ondersteunen.

Stap 5: Leg kort uit waarvoor de leerling die vorm van technologie gaat gebruiken.

Stap 6: Beschrijf hoe de leerling de leeractiviteit uitvoert.

Stap 8: Herhaal stap 2 t/m 7 totdat alle tien de onderwerpen behandeld zijn.

Stap 9: Bekijk de tien gemaakte leerdoelen. Welk leerdoel vinden jullie het beste of het meest interessant? Waarom? Je kunt de leerdoelen bijvoorbeeld beoordelen op de leeropbrengsten, het proces, de denkvaardigheden, de (on)mogelijkheden tot samenwerken, originaliteit, uitvoerbaarheid, efficiëntie, etc.

Stap 10: Bedenk aan de hand van het leerdoel dat jullie het beste of het meest interessant vinden hoe de opdracht eruit komt te zien. Beschrijf welke stappen de leerling moet doorlopen, welke materialen er nodig zijn, hoeveel tijd er voor de opdracht en de subonderdelen beschikbaar is en hoe de leerling ondersteund wordt.

Voorbeelden:

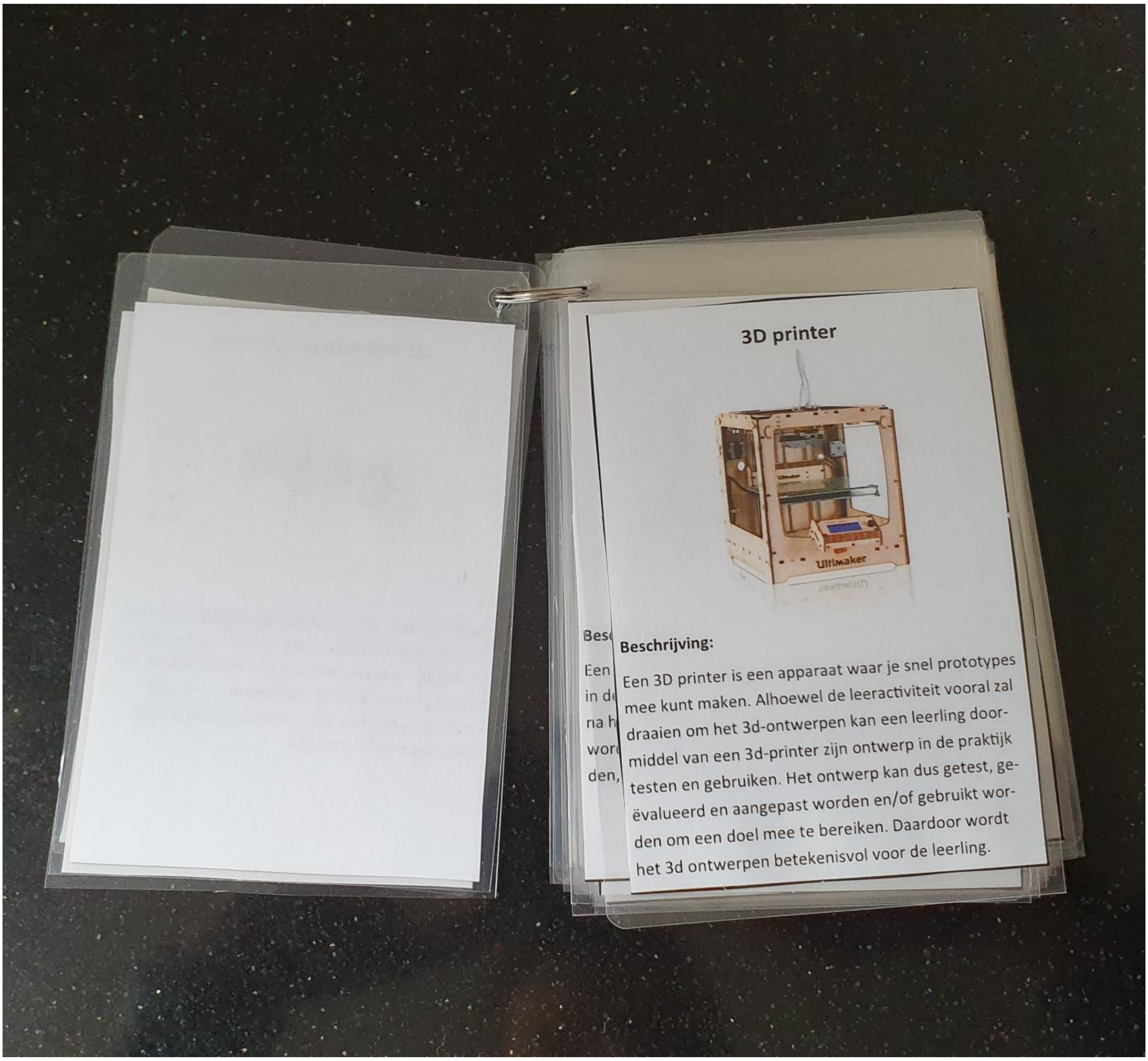
De leerling kan de Mona Lisa, waarderen door een podcast te maken met gebruik van stemopname apparatuur om de podcast terug te kunnen luisteren en te delen met anderen, waarbij de leerling verschillende schilderijen vergelijkt op basis van theorie over schilderkunst en zijn eigen mening.

De leerling kan de menselijke hand verbeteren door een robothand te maken, met gebruik van Lego Mindstorms om op een laagdrempelige manier de werking van een hand na te kunnen doen, waarbij de leerling informatie verzamelt, beoordeeld, combineert, test en alternatieven bedenkt.

Appendix D


Opdracht
Klas
Datum
De leerling kan (leeronderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om (reden), waarbij de leerling (proces).
Leeronderwerp
De leerling kan
Leeractiviteit
Product
door een
te maken
Middel
met gebruik van
Reden
om
Proces
waarbij de leerling

Appendix E


3D printer
Ultimaker
Beschrijving:
Een 3D printer is een apparaat waar je snel prototypes mee kunt maken. Alhoewel de leeractiviteit vooral zal draaien om het 3d-ontwerpen kan een leerling door-middel van een 3d-printer zijn ontwerp in de praktijk testen en gebruiken. Het ontwerp kan dus getest, ge-ëvalueerd en aangepast worden en/of gebruikt wor-den om een doel mee te bereiken. Daardoor wordt het 3d ontwerpen betekenisvol voor de leerling.

Appendix F

Table 4

Scale items of customized instrument with item-codes and corresponding statements in Dutch.*

Scale	Item code	Corresponding statement in Dutch
Technology		
Usefulness	Q11_1	Ik denk dat ik met behulp van technologie de lesinhoud veel makkelijker op een gedifferentieerde manier kan aanbieden
	Q11_2	Ik denk dat de leerresultaten van mijn leerlingen aanzienlijk verbeteren door het gebruik van technologie
	Q11_3	Ik denk dat het gebruik van technologie in mijn lessen zeer nuttig is om het dieper leren van leerlingen mogelijk te maken
	Q11_4	Ik denk dat ik met behulp van nieuwe technologie mijn instructie veel meer kan variëren
Ease of use	Q11_5	Ik denk dat het heel makkelijk is om technologie te gebruiken in mijn lessen
	Q11_6	Ik denk dat het erg weinig moeite kost om nieuwe technologie te gebruiken in mijn lessen
	Q11_7	Ik denk dat het heel eenvoudig is om nieuwe technologie in te zetten in mijn lessen
Relevance	Q11_8	Ik denk dat het essentieel is voor leerlingen om met technologie te leren werken, zodat zij goed voorbereid worden op de ontwikkelingen in de samenleving
	Q11_9	Ik denk dat het cruciaal is dat leerlingen de rol van technologie in de maatschappij begrijpen
	Q11_10	Ik denk dat het erg belangrijk is voor de toekomst van leerlingen dat zij de mogelijkheid hebben om met technologie te leren werken op school
Self-efficacy	Q11_11	Ik ben goed op de hoogte van technologieën die ik kan gebruiken om leerlingen inzicht te geven in de vakken waarin ik lesgeef
	Q11_12	Ik ben goed in staat om technologieën te kiezen die de lesinhoud voor de vakken waarin ik lesgeef ondersteunen
	Q11_13	Ik weet precies hoe ik technologieën kan gebruiken om concepten uit verschillende vakken op een andere manier te presenteren aan mijn leerlingen
	Q11_14	Ik ben goed in staat om technologieën te kiezen die de didactische werkvormen in mijn lessen verrijken
	Q11_15	Ik ben goed in staat om technologieën te kiezen die de leerprocessen van mijn leerlingen versterken
	Q11_16	Ik ben goed in staat om lessen te geven waarbij technologie, vakinhoud en didactiek op een goede manier zijn geïntegreerd
Anxiety	Q11_17	De moed zakt me in de schoenen als ik iets nieuws moet doen met technologie in mijn lessen
	Q11_18	Ik voel mij gespannen als ik technologie moet gebruiken in mijn lessen
	Q11_19	Ik word nerveus bij het idee dat ik met technologie in mijn lessen moet werken
Enjoyment	Q11_20	Ik voel mij gedreven om lessen te geven met technologie
	Q11_21	Ik ben enthousiast over het gebruik van technologie in mijn lessen
	Q11_22	Voor mij voelt het gebruik van technologie in mijn lessen als een positieve uitdaging
	Q11_23	Ik vind het leuk om met technologie te experimenteren in mijn lessen

Subjective norm	Q11_24	Ik heb het gevoel dat in het onderwijs op onze school technologie een belangrijke plaats heeft
	Q11_25	Ik heb het gevoel dat op onze school de visie over het inzetten van technologie in het onderwijs helder is
	Q11_26	Ik heb het gevoel dat het inzetten van technologie in de les op onze school wordt gewaardeerd
	Q11_27	Ik heb het gevoel dat mijn collega's het gebruik van technologie in het onderwijs belangrijk vinden
Context dependency	Q11_28	Voor mij is de aanwezigheid van technische ondersteuning bepalend of ik wel of geen technologie gebruik in mijn lessen
	Q11_29	Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van lesmaterialen bepalend of ik wel of geen technologie gebruik in mijn lessen
	Q11_30	Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van een ICT-coördinator bepalend of ik wel of geen technologie gebruik in mijn lessen
	Q11_31	Voor mij is extra tijd doorslaggevend of ik wel of geen technologie gebruik in mijn lessen
	Q11_32	Voor mij is de beschikbaarheid van een scholingsprogramma een voorwaarde om technologie te gebruiken in mijn lessen
HOTS		
Relevance	Q19_1	Ik denk dat het voor de ontwikkeling van het denken van leerlingen essentieel is om hogere-orde denken te stimuleren
	Q19_2	Om de ontwikkeling van het denken van leerlingen te stimuleren, vind ik dat je niet vroeg genoeg kunt beginnen met het aanbieden van opdrachten waarin hogere-orde denken aan bod komt
	Q19_3	Ik denk dat het cruciaal is voor het leren van leerlingen dat zij worden aangezet tot hogere-orde denken
	Q19__4	Ik denk dat het stimuleren van hogere-orde denken zo belangrijk is, dat alle leerkrachten dit regelmatig moeten doen in hun lessen
Learners' ability	Q19__5	Ik denk dat 'slimme' leerlingen veel beter zijn in hogere-orde denken dan 'zwakke' leerlingen
	Q19__6	Ik denk dat opdrachten die hogere-orde denken vereisen veel geschikter zijn voor 'slimme' leerlingen dan voor 'zwakke' leerlingen
	Q19__7	Ik denk dat opdrachten die hogere-orde denken vereisen frustrerend zijn voor 'zwakke' leerlingen
	Q19__8	Ik denk dat 'zwakke' leerlingen opdrachten die hogere-orde denken vereisen niet aan kunnen
	Q19__9	Ik denk dat we van 'zwakke' leerlingen geen hogere-orde denken moeten verwachten
Self-efficacy	Q19__10	Ik ben goed in staat vragen te stellen aan mijn leerlingen waarmee hogere-orde denken wordt gestimuleerd
	Q19__11	Ik ben goed in staat om leerlingen te begeleiden bij het maken van opdrachten waarbij zij aangezet worden tot hogere-orde denken
	Q19__12	Ik ben goed in staat om zelf opdrachten te maken die mijn leerlingen aanzetten tot hogere-orde denken
	Q19__13	Ik beschik over genoeg vaardigheden om mijn lessen te verrijken met hogere-orde denkopdrachten

* Original instrument is developed by (Wijnen, et al. (in progress).

Master Thesis

Educational Science and Technology

The impact of an attitude focused on- and offline course on the attitudes of primary school teachers towards technology use and the stimulation of higher-order thinking among learners

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Abstract

When teachers would change their pedagogics and didactics to ways that stimulate learners to use higher-order thinking skills (HOTS) in addition to lower-order thinking skills (LOTS), this would lead to a better memorization and deeper conceptual understanding of content. Technology can support teachers in this by offering the ability to create powerful learning environments with it. As research shows that teachers' attitudes influence behaviour, focussing on the improvement of attitudes in teacher training seems a promising approach. The purpose of this study was therefore to explore the effects of an on-and offline attitude focused training course on the attitudes of teachers towards the use of technology in classroom and the stimulation of HOTS among learners. A quantitative quasi-experimental pre-test-post-test control group design with non-probability convenience and snowball sampling, combined with qualitative post-training reflections, is used. The participating teachers worked at 6 primary schools in the Netherlands. While teachers in the control condition (n = 12) only received the pre-and post-tests, the teachers in the experimental condition (n = 14) received the course in addition. This study provides input for the development of effective attitude focused teacher training programs, explorative evidence for the effectiveness of a relatively short on- and offline training for improving teachers' attitudes and points out directions for future research. Although the sample size in the study was small and not all statistical assumptions were met, the quantitative and qualitative results combined, indicate that regarding technology the teachers' anxiety towards in-classroom use can be decreased, the perceived self-efficacy and ease of use can be increased and regarding HOTS the perceived self-efficacy can be increased by the on-and offline training course of this study.

Keywords: technology, higher-order thinking skills, attitude, primary education, teachers

In history, dramatic educational reforms were expected when new types of technology where introduced. However, these often failed to appear (Spector, 2001). For example, in the 1980s, according to David (1994) technology such as the personal computer was expected to transform education. Still, in the early 1990s there was little use of it in schools.

Nowadays, things have changed. Technology, such as computers, are now widespread in education (Mullis, Martin & Loveless, 2016). The pedagogics and didactics of teachers, however, generally are still the same (Orlando, 2013; Cuban, as cited in Alenezi, 2016).

The primary way of teaching with technology is aimed at the transfer of knowledge, which is generally associated with lower-order thinking skills (LOTS) in Bloom's Taxonomy, namely remembering, understanding and applying (Smeets, 2005; Niederhauser & Lindstrom, 2006). This particularly use of LOTS is problematic because it are the higher-levels, analysing, evaluating and creating, in Bloom's revised hierarchical framework about educational objectives that are associated with higher-order thinking skills (HOTS). When learners use HOTS, this leads to better memorization of information and a deeper conceptual understanding (Jensen, McDaniel, Woodard, Kummer, 2014). This implies that education would improve when learners are stimulated to use HOTS instead of merely LOTS.

Technology can support this by offering the ability to create powerful learning environments with it (Smeets, 2005; Drent and Meelissen, 2008). According to Jonassen (1999) these type of learning environments are connected to the environment outside the school, stimulate cooperation between learners, foster active and independent learning, adapt the curriculum to the needs and capabilities of learners, and facilitate learners in higher-order thinking processes. The use of technology can thus be beneficial for education, only to truly benefit from it, changes in teachers' pedagogy and didactics are needed with a focus on fostering the higher-levels of Bloom's revised taxonomy (Krathwohl, 2002; Adams, 2015).

The need for a different way of educating learners is reinforced by the rapid developing society of today. Because of the rapidity of the developments it is increasingly difficult for the educational system to prepare learners for their life to come, e.g. the professions that learners eventually will have might currently not exist (Dede, 2011). Hence, it is important for the educational system to provide learners with competences and confidence to deal with a complex and uncertain future (Carr & Claxton, 2004). Being able to solve problems, think critical and creative, is crucial in this (Morgan, 1996, as cited in Hopson, Simms & Knezek, 2001; Voogt and Roblin, 2012). The need for the stimulation of HOTS is thus not only induced by the potential learning gains, but also by the importance of the development of these skills, for learners to be able to function well in society.

Changing the way learners are educated can be challenging. Attempts to make changes frequently fail, because they are implemented top down and do not take the attitudes, beliefs, competences and practices of teachers into account, which are strongly influencing an educational change (Voogt & Roblin, 2012; Hermans, Tondeur, van Braak & Valcke, 2008; Niederhauser and Stoddart, 2001; Atkins & Vasu, as cited in Seraji, Ziabari and Rokni, 2017). When they are not addressed, the potential of stimulating HOTS and using technology for improving learning might not be realized.

The teacher should be seen as an agent of the change on its own, instead of merely being variable that needs to be changed. When a change is implemented, what is seen in the classroom, is shaped by a dialog between the beliefs and experience of the teacher and the advocated change (Luttenberg, Imants & van Veen, 2013).

This might explain why there is still little innovative use of technology in schools. Since new technology is introduced, teachers will often use it in ways that fit their beliefs on teaching and learning, instead of changing their pedagogics and didactics to the new possibilities that come available (Admiraal, et al., 2017). To be able to improve teachers' technology use it is thus of high importance to take the teachers beliefs into account.

Especially focussing on teachers' attitudes seems to be a promising approach in this. Regarding the intention of teachers to use technology in their lessons, for instance, attitude namely has a strong influence on teachers' behaviour (Lee, 2010; Kreijns, Vermeulen, Kirschner, van Buuren, & van Acker, 2013; Teo, 2010). The attitude towards something influences the intention to perform a certain behaviour, which on its turn influences the actual behaviour (Ajzen, 1991). This suggests that to improve the actual use of technology in classrooms it might be advantageous to focus on stimulating a positive attitude towards (1) the use of technology in classroom and (2) the stimulation of HOTS within learners, among teachers. This approach has already been found effective regarding science education (Van Aalderen-Smeets & Walma van der Molen, 2015).

The purpose of this study is therefore to develop and test the effects of a teacher training course aimed at the stimulation of positive attitudes towards the use of technology in classroom and the stimulation of HOTS among learners.

1.1 Research design and hypotheses

The main research question of the study is: *What is the impact of an on- and offline course about the use of technology in education and the stimulation of higher-order thinking among learners on primary teachers' attitudes towards (1) technology use in the classroom and, (2) stimulating higher-order thinking among learners?*

To be able to answer this question the following sub-questions are answered: *To what extent can an on-and offline course lead to a change in the attitude of primary school teachers regarding the use of technology in the classroom?*

To what extent can an on- and offline course lead to a change in the attitudes of primary school teachers regarding stimulating HOTS within learners?

It is hypothesized that the course has a positive impact on primary school teachers' attitudes towards (1) technology use in the classroom and (2) stimulating higher-order thinking among learners.

For this study a quantitative quasi-experimental pre-test-post-test control group design with non-probability convenience and snowball sampling, combined with qualitative post-training reflections, is used. See figure 1 for an overview of the research design.

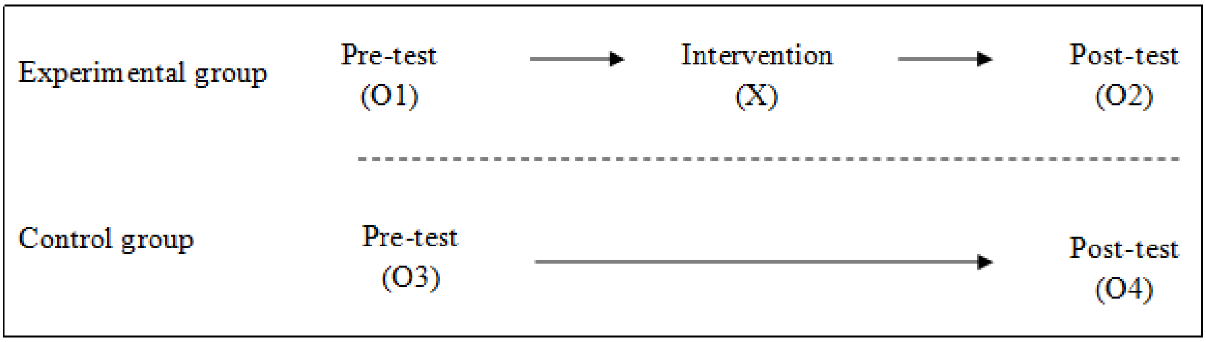

Figure 1. Overview of quasi experimental research design.
Note. O2 is quantitative survey combined with qualitative reflections.

2. Theoretical framework

2.1 Attitude

Throughout literature, in general, attitude can be defined as the psychological tendency of evaluating an object in terms of favourable or unfavourable attribute dimensions such as good or bad, positive or negative and comfortable or uncomfortable (Ajzen & Fishbein, 2000; Ajzen, 2001). An attitude towards an object is formed around multiple evaluations of attributes that a person links to the object. The attitude is a summarization of these evaluations, in which each evaluation contributes with a certain degree to the attitude (Ajzen & Fishbein, 2000). The attitude towards an object influences the intention to perform certain behaviour which on its turn influences the actual behaviour (Ajzen, 1991). Teachers however can hold multiple attitudes towards the evaluative object at the same time. (Ajzen, 2001). For example, Asma, Walma van der Molen, and van Aalderen-Smeets (2011) argue that regarding teaching science teachers might have professional attitudes, as well as personal attitudes which can be contrary to each other. The context determines which attitude is dominant at a certain timepoint (Ajzen, 2001).

According to Wijnen, Walma van der Molen and Voogt (in progress), the attitudes of teachers towards technology use in classroom are formed by evaluations around four dimensions, namely *beliefs*, *affect*, *perceived behavioural control* and *social norm* (figure 2). The evaluations on the dimensions are on their turn formed by evaluations on eight sub-components.

Beliefs is formed around the beliefs teachers have about the *relevance* of using technology for preparing learners for their future lives, the *usefulness* of technology as a tool for learning, and the *ease of use* of technology in teaching. This means that for a teacher to have positive beliefs, the teacher should think technology use in classroom is relevant for the preparation of learners for their future lives in society, is useful as a tool for learning and is easy to use.

Affect is formed around the feelings of *anxiety* regarding using technology in the classroom, and the feelings of *enjoyment* teachers allocate to using technology in classroom. This means that for a teacher to have positive affect towards the use of technology in classroom, the teachers should have low feelings of anxiety and high feelings of enjoyment when using technology in classroom.

Perceived behavioural control is formed around the perceived level of *self-efficacy* of a teacher to use technology in the classroom, and the perceived *context-dependency* to be able to use technology in the classroom. This means that for a teacher to have a positive perceived behavioural control, the teacher should find himself capable of using technology in classroom and independent of external context factors.

Social norm is formed around the *subjective norm* of individuals that are important to a teacher, regarding the use of technology in the classroom. This means that for a teacher to have a positive perceived social norm, the teacher should find individuals important to the teacher positive about the use of technology in classroom.

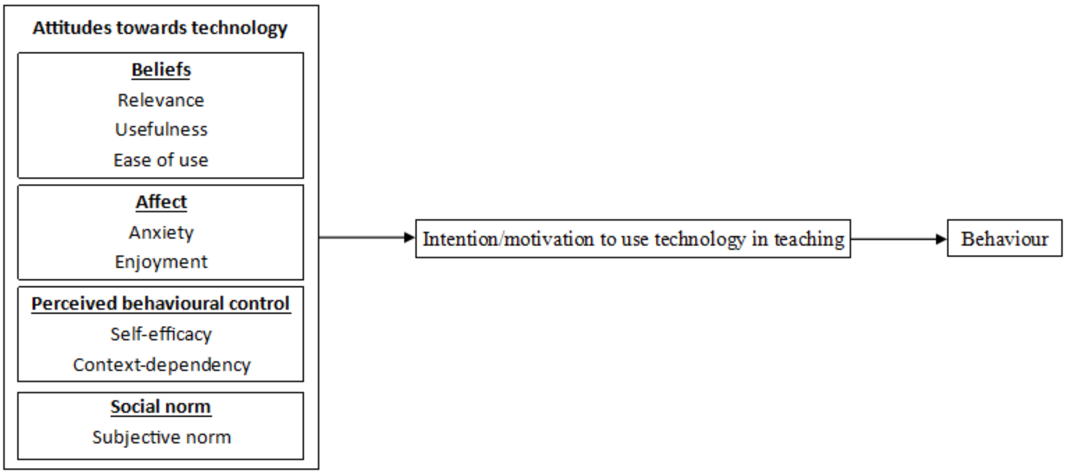

Figure 2. Theoretical framework for primary school teachers' attitudes towards in classroom use of technology (Wijnen et al., in progress).

The attitudes of teachers towards the stimulation of HOTS within learners are formed by evaluations on two dimensions, namely *beliefs*, and *perceived behavioural control* (figure 3). These are formed by evaluations on four sub-components.

Beliefs is formed around the beliefs teachers have about the *relevance* of stimulating HOTS for learning and the future lives of learners, and the *learners' ability* to use HOTS. This means that for a teacher to have positive beliefs, the teacher should think stimulating HOTS is important for the personal development of learners and that all learners are capable of using HOTS.

Perceived behavioural control is formed around the perceived level of *self-efficacy* regarding stimulating HOTS within learners, and *context-dependency* to be able to stimulate HOTS in learners. This means that for a teacher to have a positive perceived behavioural control, the teacher should perceive himself capable of stimulating HOTS within learners, independent of external context factors.

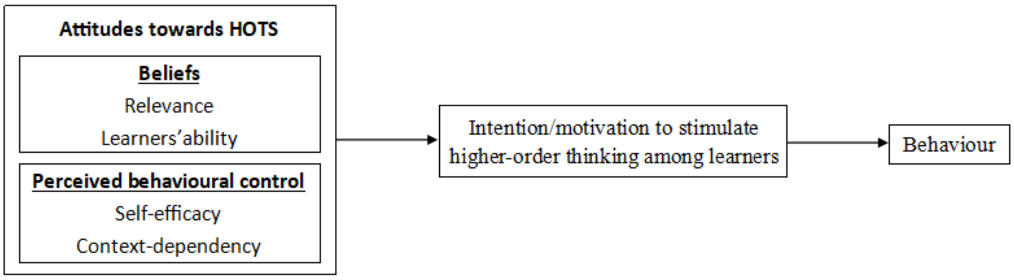

Figure 3. Theoretical framework for primary school teachers' attitudes towards stimulating HOTS among learners (Wijnen et al., in progress).

2.2 HOTS

There are several definitions of HOTS throughout literature (Lewis & Smith, 1993). In this study Bloom's revised taxonomy of educational objectives is used for defining HOTS. According to Polly & Ausband (2009) this taxonomy can be used for identifying and categorizing different thinking skills. Although this taxonomy was originally published in 1956, it was revised by Anderson et al. in 2001. In the revised version the nouns were changed to verbs and the top levels changed positions. While in the original model *evaluation* was placed at the top of the taxonomy and *synthesis* was placed one level lower, now *creating* is placed at the highest level and *evaluating* is placed one level below it. The reasoning for this is that to be able to evaluate one does not necessarily has to be able to create, while to be able to create, meaning: making of a novel product or coherent whole by integrating parts of information, one mostly would have to evaluate the information first (Krathwohl, 2002).

The revised Bloom's Taxonomy can be divided in LOTS and HOTS. LOTS are *remembering* and *understanding*, and HOTS are *analysing*, *evaluating* and *creating* (Zoller, 1993; Crowe, Dirks & Wenderoth, 2008). According to Crowe, Dirks and Wenderoth (2008), it is at the level *applying* of the taxonomy where the transition between LOTS and HOTS happens. *Applying* can therefore be seen as lying in between both. While the taxonomy is seen as a hierarchical framework of which a lower-level of the taxonomy should be mastered before one would be able to perform the processes of a higher-level (Krathwohl, 2002; Anderson et al., as cited in Jensen, McDaniel, Woodard & Kummer, 2014), this hierarchy does not necessary count for HOTS (Crowe, Dirks and Wenderoth, 2008). In other words: to be able to create one does not always need to be able to evaluate, while one has to be able to remember information to be able to understand it. Although this initially contradicts the explanation of Krathwohl (2001) about that *creating* changed places with evaluating in the revised taxonomy because of the hierarchy of the cognitive processes involved, the author also states that the hierarchy is not as strict in the revised version of Bloom's taxonomy as in the original version. This places emphasis on a more flexible hierarchy of the top-level skills of Bloom's revised taxonomy.

In general, when learners use HOTS this will lead to deeper conceptual understanding as well as an increase in the memorization of the information (Jensen, et al. 2014).

2.3 Technology

When new technology is introduced, often new possibilities for educating learners become available. It is however important to state that it is not the technology that has added value for education, it is the change in pedagogics and didactics made possible by the new technology, that can be beneficial (Tay, 2016; Fullan, & Langworthy, 2014; Venezky, 2002; OECD, 2015).

This is important to note, because it implies that when new technology is adopted by a teacher, and there are few or no changes in the pedagogics and didactics of the teacher, the added value of the new technology will be low as it is used as a substitute of the old (Puentedura, 2013). It also implies that older technology, that might be used in education for a long time, can be used in an innovative way by changing pedagogics and didactics. Therefore, in this study, no distinction between old and new technology is made and technology is defined as all electronic technology that is- or can be used in education.

3. Method

3.1 Participants

The participants within this study consisted of 5 male and 21 female primary education teachers between the ages of 23 and 64, from six schools in the eastern part of the Netherlands. There were 14 teachers from 1 school in the experimental condition and 12 teachers from 5 schools in the control condition. The teachers worked with learners from all educational levels in the Dutch primary education, with expected ages between 4 and 12 years old. School leaders from 26 schools were approached and asked for participation in the study. Of the schools, teachers from 1 school were willing to participate in the course and fill in two questionnaires, which was the experimental condition and teachers from 5 schools were willing to only fill in two questionnaires, which was the control condition. The other 20 schools in general expressed that they recognised the importance of the topics from the study, only could not participate because of time constraints and a high workload. There were 4 teachers in the experimental condition, who did not complete the post-test and 2 teachers in the control condition who did not complete the post-test for unknown reasons as can be seen in figure 4.

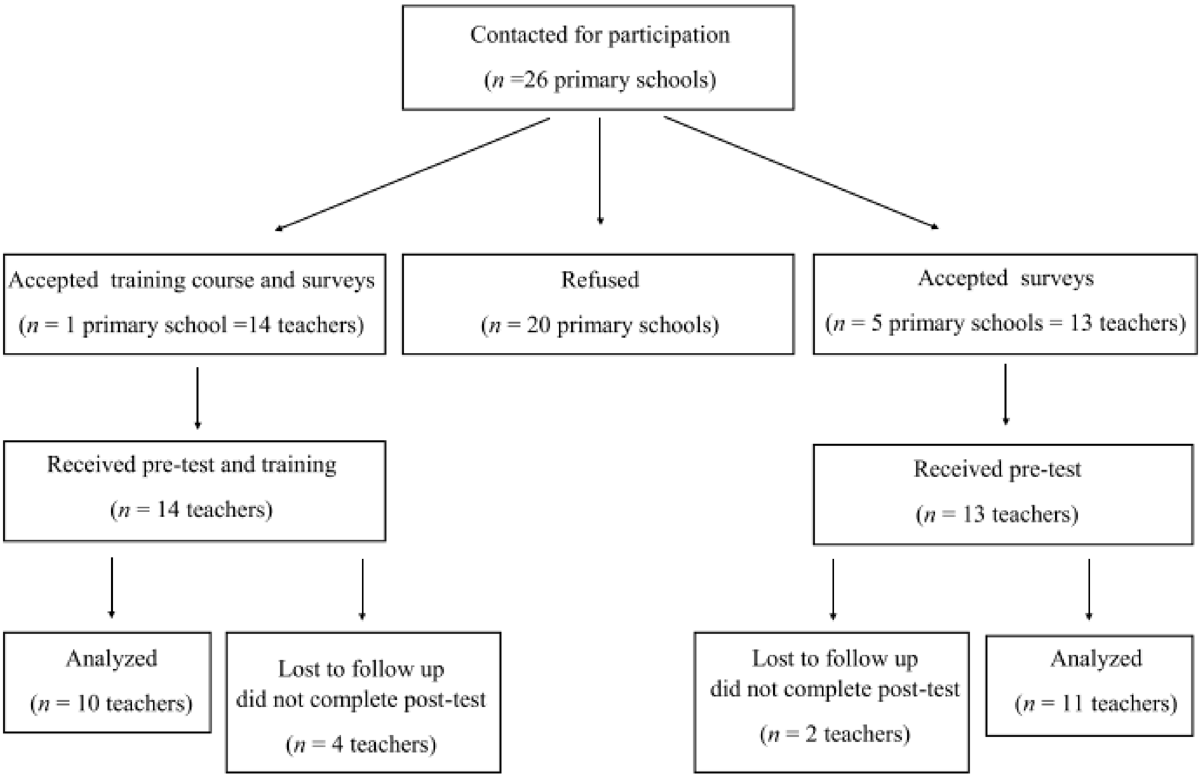

Figure 4. Flow of participants trough stages of the study.

3.2 Instruments

To measure the primary teachers' attitudes towards the use of technology in the classroom and towards the stimulation of HOTS among learners, a customized instrument of Wijnen, Walma van der Molen and Voogt (in progress) is used as the pre- and post-test.

The main difference between the original instrument and the customized instrument is, that the original instrument was developed to measure the attitudes towards *newer* technology, and the customized instrument (Appendix A) was designed to measure the attitude of teachers towards technology in general. For this, texts were adjusted by removing words such as 'new', and a list with examples of types of new technology is supplemented with other types of technology. The essence of the questions however remained the same and in the same order and was therefore expected to be equally reliable.

The customized instrument exists of four parts that measure different constructs (1= *background characteristics*, 2= *Pedagogical beliefs,* 3= *Attitude towards technology*, 4= *Attitude towards stimulating HOTS*. Each part mainly consists of multiple statements to which teachers can indicate their level of agreement via a five-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). All tests were distributed and executed online. The items of the attitude scales were automatically randomized by the software (Qualtrics), for both attitude objects.

3.3 Description of the course and materials

The on- and offline course developed in this study aimed at stimulating positive evaluations on the dimensions of primary school teachers' attitudes towards technology use in classroom, and stimulating higher order thinking within learners.

As mentioned, the attitudes towards technology use in classroom are formed around evaluations on four dimensions, namely *beliefs*, *affect*, *perceived behavioural control* and *social norm*. The attitudes towards the stimulation of HOTS within learners are formed around two dimensions, namely *beliefs* and *perceived behavioural control* (Wijnen, Walma van der Molen & Voogt, in progress). To stimulate positive evaluations, this implied that the sub-components of the attitude dimensions needed to be addressed in the design of the attitude focused course, meaning that the design aimed at positively influencing the sub-components, as positive evaluations on the sub-components would lead to positive evaluations on the attitude dimensions.

Objectives. To address all sub-components, the course was designed with the objectives as shown in table 1.

Table 1

Objectives for the attitude focused teacher training course

At the end of the course the teacher should…		
Technology	1	…believe technology use in classroom is relevant for the preparation of learners for their future lives in society
	2	…believe technology is a useful tool for learning
	3	…believe technology is easy to use
	4	…have low feelings of anxiety when using technology in classroom
	5	…have high feelings of enjoyment when using technology in classroom
	6	…find himself capable of using technology in classroom

Table 1 (continued)

	7	…find himself independent from external context factors to be able to use technology in classroom
	8	…think that for the teacher important individuals are positive about the use of technology in classroom
HOTS	9	…believe that the stimulation of HOTS is important for the personal development of learners
	10	…believe that all learners are capable of using HOTS
	11	…perceive himself capable of stimulating HOTS within learners
	12	…perceive himself independent from external context factors to be able to stimulate HOTS within learners

The objectives were expected to be addressed by the use of online instructional videos, and an offline workshop in which teachers could use a newly developed scheme to collaboratively discuss and develop lessons. Instructional videos and a short reflection assignment, aimed at addressing objective 1, 2, 3, 9, and 10. The workshop aimed at addressing objective 2, 3, 4, 5, 6, 7, 8, 11, and 12.

Expected effects instructional videos. Expected was that if teachers would watch and reflect on videos about why technology use in classroom is important for the preparation of learners for their future lives in society, why and how technology is a useful tool for learning, why the stimulation of HOTS is important for the personal development of learners and that every learner is capable of using HOTS, this would lead to changes in the attitude domain of *beliefs*. Teachers would namely receive new knowledge, which they briefly reflect on and could integrate in their existing knowledge and beliefs about teaching. This process of integrating is further stimulated by the workshop part of the course.

Expected effects workshop. Expected was that the offline workshop part of this study would lead to changes in the teachers' attitude sub-components *affect*, *perceived behavioural control* and *social norm,* as described by Wijnen, Walma van der Molen and Voogt (in progress). This was expected because in the workshop the teachers collaboratively design and discuss when learners need to use HOTS and how this can be stimulated. Further, they explore the possibilities of the use of technology in their education in such a way that it contributes to the learning goals. In the process teachers were expected to reflect on their current practice of teaching and think of how the newly gained knowledge from the instructional videos in the e-learning part, can be integrated in their lessons. During the designing of lessons, teachers had the opportunity to repeatedly discover and discuss how lessons can be aimed at stimulating HOTS, how this would lead to deeper learning and how technology can support in this. Beside contributing to the belief that stimulating HOTS is important and technology is a useful tool for learning, teachers might have been able to gain more self-confidence in designing such lessons. In the collaborative activity teachers were expected to actively process and generate new knowledge together with colleagues. This is important because active learning and generating new knowledge are associated with deeper learning and because teachers are learning together, they can learn from each other and can support each other's ideas, which might lead to an increase in self efficacy and the perceived social norm (Johnson & Johnson, 2008; Prince, 2004; Timperley, 2008) .

Description instructional videos. The online e-learning part of this study was written and spoken in Dutch and mainly consisted of 3 instructional videos about (video 1) why and how technology is a useful tool for learning, which had a play time of 2:36 minutes, (video 2) why technology is important for the future lives of learners in society, which had a play time of 4:25 minutes and (video 3) why the stimulation of HOTS among learners is important and how a teacher can do this, which had a play time of 6:40 minutes. All videos contained a male voice over which was complemented with images, animations and videos, as can be seen in figure 5. The videos were stored on Youtube.com and could be played embedded in the e-learning or on the website of Youtube by clicking the title of the video. The videos were hidden on Youtube, which means that they could only be seen via a direct link and were unable to be found on Youtube via the search box by the control group.

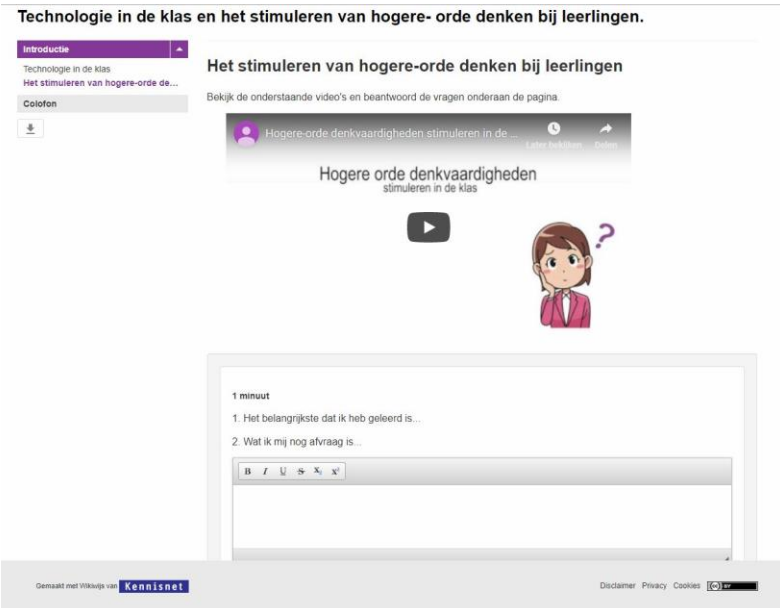

Figure 5. Video 3 as displayed in the e-learning on Wikiwijs.nl

The e-learning started with a page that informed the teachers about the educational objectives of the e-learning which were (1) at the end of the lesson you can tell how technology can be used in classroom in such a way that it has added value and (2) at the end of the lesson you can tell why it is important to stimulate higher-order thinking among learners and how this as a teacher can be done in the classroom. Furthermore, the page informed the teachers about that the e-learning was meant as preparation for the workshop and explained the structure of the e-learning (figure 6).

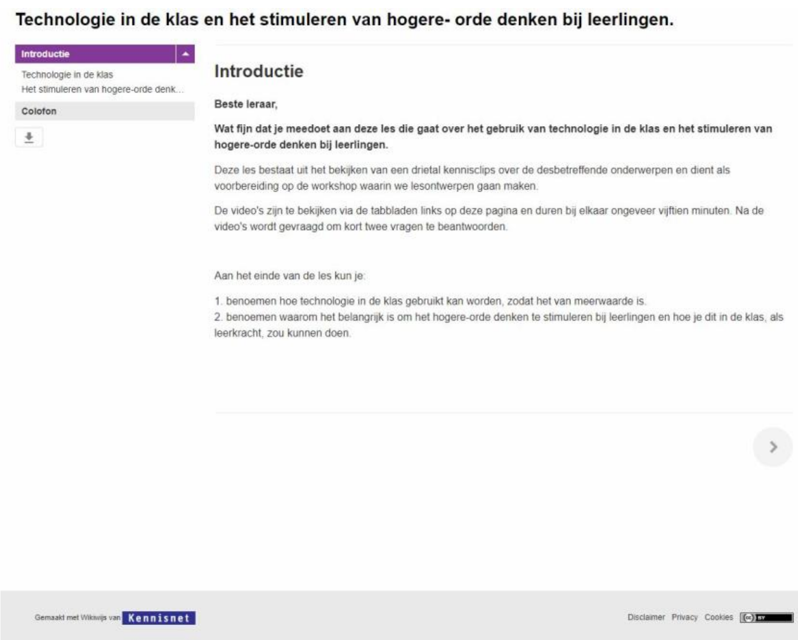

Figure 6. Welcome page as displayed in the e-learning on Wikiwijs.nl

The instructional videos were placed in two tabs. The two videos about technology were placed in the upper tab and the video about HOTS were placed in the tab below. In each tab there was a short assignment asking the teacher to write in one minute about what was the most important thing that the teacher has learned and about what remained unclear for the teacher (figure 7).

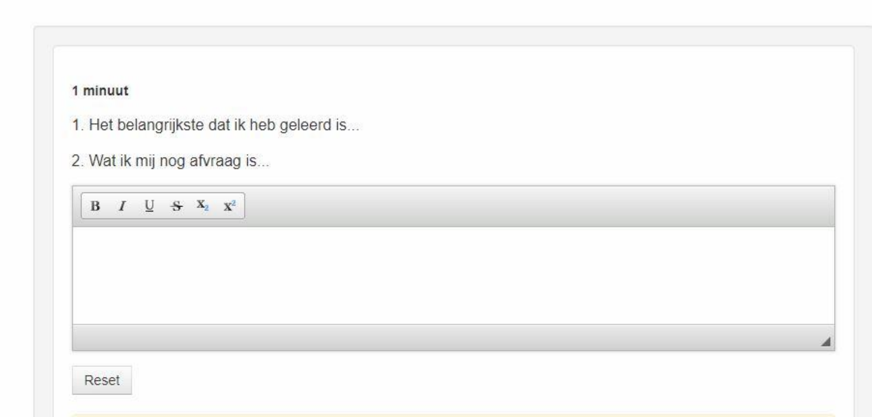

Figure 7. Short reflective assignment as displayed in the e-learning on Wikiwijs.nl

Description workshop. The one-hour workshop was held in a regular classroom of the higher grades in the participating school. After a short introduction about the objectives and the procedure of the workshop, a 30-minute lecture was held by the researcher in which the e-learning was summarized and the A1 sized scheme with which the teachers can develop lessons was introduced. After that the teachers formed small groups based on teaching the same age group of learners for the assignment of collaboratively designing lessons by the use of the scheme and other supporting materials. The supporting materials were a A4 sized sheet in which the steps of the scheme were explained, a A4 sized sheet of paper that displayed a board on which the teachers could write their lesson objectives and a collection of A5 sized cards that briefly explained the types of technology that were named in the scheme (appendix E). Teachers designed and discussed lessons for approximately 25 minutes and the researcher walked between the groups and asked questions about for example the progress and if there were uncertainties about the assignment or the lessons they were designing. When necessary the researcher assisted teachers in the use of the scheme by giving examples and asking questions. The workshop ended with a recap of the workshop and the same one-minute reflective assignment as in the e-learning, only this time on paper and with an actual duration of about five minutes, giving everyone the opportunity to finish the assignment.

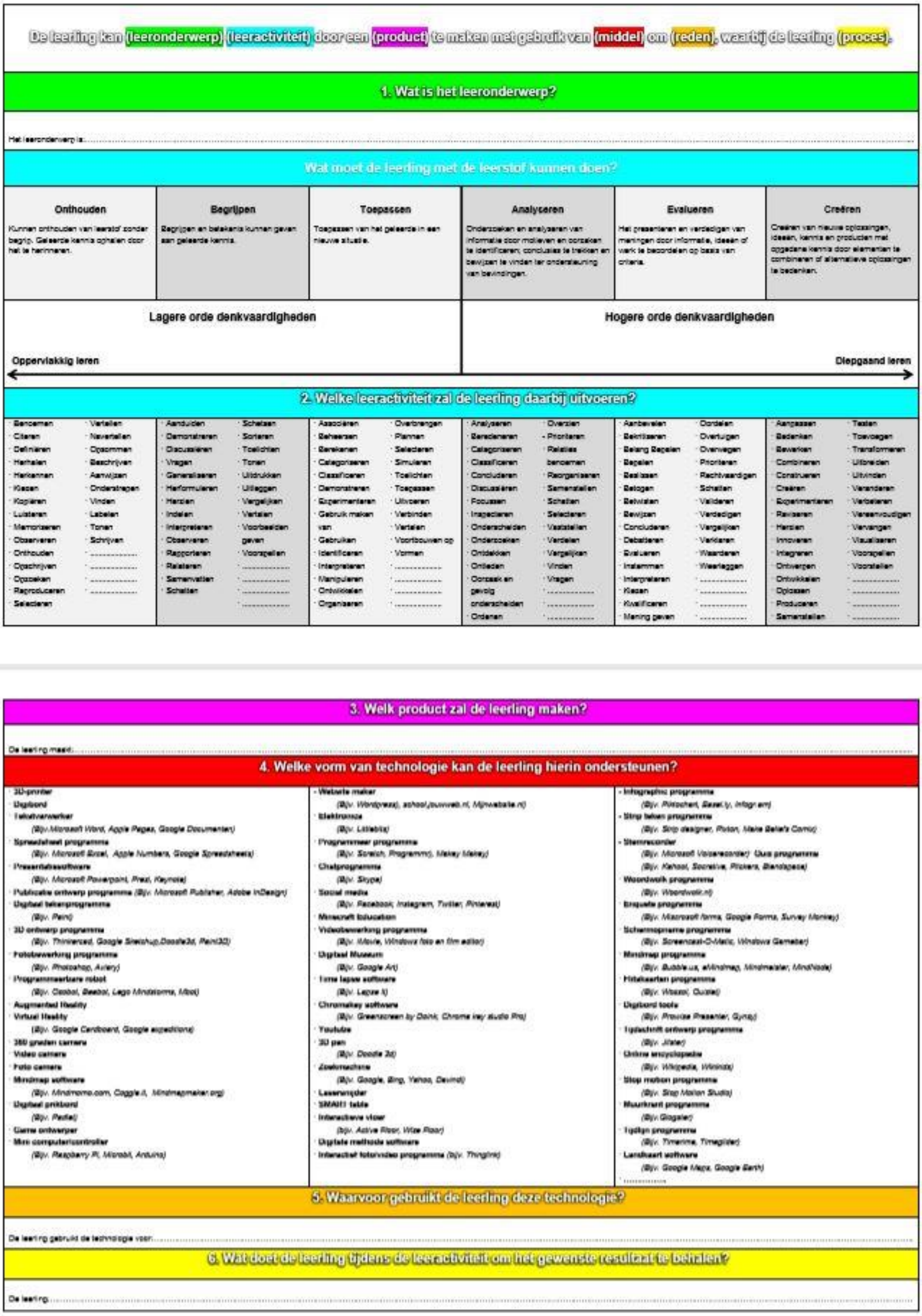

Figure 8. Scheme for designing of lessons with HOTS and technology.

Scheme. The scheme that the teachers used for designing lessons (figure 8 and larger view in appendix B) displayed a ‘fill in the blanks’ sentence at the top. The ‘blanks’ existed of words that should be replaced by the teachers by answering the questions in the colours that correspond with the colours in the to be filled in sentence. Furthermore, the colours correspond to the sheet that explains the steps that the teachers need to take to answer the questions (appendix C). The scheme is used from the top to the bottom. First the scheme asks what the subject matter is that needs to be learned, second what the learner should be able to do with the subject matter, to what level the learner needs to learn and what learning activity therefore is applicable, third which product the learner will make, which is the output, fourth which type of technology could assist the learner in making this product, fifth what the learner will use this type of technology for, and sixth what the learner needs to do during the process to reach the learning objective. When all ‘blanks’ are filled in on the answer board (appendix D) a learning objective is displayed.

Procedure

The ethics commission of the University of Twente was asked for approval of this study. School leaders were approached via email and/or telephone and asked to participate with their school in the study. Next, they were asked if they knew other schools that might be willing to participate. Together with the school leaders, teachers were selected and asked to participate in the course. For the control condition in addition to the school leaders, individual teachers were approached as well and asked for participation in the study. Next, they were asked if they knew other teachers that might be willing to participate. School leaders and teachers were informed with the purpose of the study and confirmed their participation through informed consent.

It was expected that the teachers within a school would have interaction about the treatment and would therefore be able to influence each other. Therefore, all the participating teachers from a school were assigned to the same condition. Teachers from one school received the training and teachers from five schools received no training. All participating teachers from the experimental condition received a link for pre-test via the school leader. All participating teachers from the control group received a link for the pre-test directly via their school email address. Teachers were notified that the tests were anonymous and background characteristics were being collected. When the teachers in the experimental condition received the pre-test and the online course via the school leader, they could plan their own time to go through it at their own pace in a timeframe of a week. One week later, in the second week, the teachers in the experimental condition participated in the workshop at their school. The third week the participating teachers received nothing and had the opportunity to execute the lessons that were designed in the workshop. This was suggested at the end of the workshop. It is however not measured if this was actually done. At the end of the third week the participating teachers received the post-test via the school leader. The participants in the control condition received the post-test at the same time via their email address, while having received nothing in the period between the pre- and post-test. At the end of the test participants were thanked for their participation and provided with the opportunity to share contact details to receive the final anonymized report of the study. An overview of the planning of the activities per condition is given in figure 9.

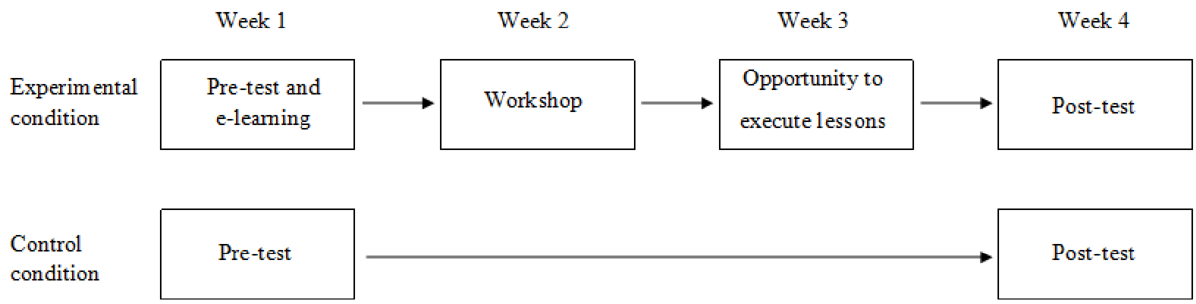

Figure 9. Overview of the planning of the activities per condition.

Data analysis

The quantitative data from the teacher surveys was analysed by the use of SPSS v. 25.0 software. First was analysed if the data fulfilled the statistical assumptions needed for further analysis. Second Cronbach's alpha was calculated to measure the reliability of the scales. Third to establish an effect of the training course, multiple mixed ANOVA were run to compare pre-and post-test scores on the attitude sub-component scales between the two conditions. Fourth T-tests were run to investigate pre-and post-test scores on the attitude sub-component scales for statistical significant differences per condition. The qualitative data (teacher written reflective notes) was analysed by extracting, sorting and counting the same self-reported learning outcomes.

Results

Reliability

As the instrument used for measuring the teachers' attitude sub-components of technology use in classroom and the stimulation of HOTS among learners was still in development by Wijnen et al. (in progress), the instrument was not in advance proven valid and reliable. As the sample size (n = 26) was too small for conducting a factor analysis, Cronbach's Alpha was used instead to measure and establish the internal consistency of the test items expected to load to the different factors, which are the sub-components of the attitude dimensions. Of the 12 factors measured by the instrument that is used in this study, 11 were found sufficient reliable with an internal consistency of Cronbach's alpha ranging from .68, which was found acceptable, to .89, which was found good. One sub-component factor, namely teacher's context dependency regarding the stimulation of HOTS among learners, was unintentionally left out of the questionnaire and could therefore not be measured in this study. For the items expected to belong to this factor consequently no Cronbach's alpha score could be constructed.

The perceived usefulness of technology subscale originally consisted of 4 items (α = .76). Item Q11_3 (Appendix F) was deleted for a higher internal consistency (α = .84). The perceived ease of use of technology subscale consisted of 3 items (α = .71), The perceived relevance of technology subscale consisted of 3 items (α = .84). The perceived self-efficacy regarding technology subscale consisted of 6 items (α = .89). The perceived anxiety regarding technology use subscale consisted of 3 items (α = .86). The perceived enjoyment regarding technology use subscale consisted of 4 items (α = .72). The perceived social influence regarding technology use subscale consisted of 4 items (α = .78). The context dependency regarding technology use subscale originally consisted of 5 items (α = .66). Item Q11_31 was deleted for a higher internal consistency (α = .68). The perceived relevance regarding the stimulation of HOTS subscale consisted of 4 items (α = .86). The perceived learners' capability regarding HOTS subscale consisted of 5 items (α = .84). The perceived self-efficacy regarding the stimulation of HOTS subscale consisted of 4 items (α = .88).

The effects of the on- and offline training course for primary school teachers on the attitude domains regarding in classroom use of technology and the stimulation of HOTS among learners were analysed by mixed ANOVA per attitude sub-component with a statistical significance level at $p < 0.05$. For each test the within-subject variable was time (pre-and post-test) and the between-subjects variable was condition (experimental and control). To determine differences in development between the experimental and control group, and thus the effectiveness of the training course, interaction effects between time and condition were investigated. Further analysis of the effectiveness of the course was done by post-hoc paired t-tests to detect statistical significant differences between pre-and post-test scores for both conditions separately.

The homogeneity of variances was tested using independent sample t-tests with Levene's tests. Results showed that the assumption of homogeneity of variance was satisfied on all sub-components at a significance level of p = 0.05, except for the post-test regarding the relevance of technology *(P= 0.48).* Because the marginal statistical significance and near equal sample sizes of the two conditions, equal variances were still assumed for further analysis. Normality tests showed some non-normal distributions on pre- and post-tests distributions of the sub-components of the attitude domains. As the sample size was small, this limitation of the non-normality was expected and for the purpose of the study, which was an exploration of the effectiveness of the training program, therefore accepted.

Results of the multiple repeated measures ANOVA's are presented in Table 2 (descriptive statistics) and Table 3 (interaction effects).

Table 2

Descriptive statistics pre- and post-test organized by condition and attitude dimension

		Experimental group *(n =9)*				Control group *(n = 11)*			
		Pre-test		Post-test		Pre-test		Post-test	
		M	SD	M	SD	M	SD	M	SD
Attitude Technology									
	Relevance	4.37	0.70	4.41	0.32	4.42	0.63	4.15	0.72
	Usefulness	3.41	1.01	3.70	0.75	3.76	0.68	3.67	0.65
	Ease of use	2.85	0.92	2.89	0.78	2.91	0.76	3.33	0.86
	Anxiety	2.37	0.99	1.93	1.04	2.15	1.15	2.55	1.17
	Enjoyment	3.47	0.70	3.47	0.72	3.36	0.66	3.27	0.85
	Self-efficacy	2.56	0.67	2.87	0.79	2.45	0.72	2.68	0.77
	Context-dependency	3.36	0.66	3.39	0.69	3.36	0.78	3.61	0.74
	Subjective norm	2.61	0.63	2.75	0.66	3.16	0.90	3.25	0.85

Table 2 (continued)

Attitude HOTS									
	Relevance	4.25	0.71	4.31	0.63	3.95	0.71	4.05	0.73
	Learners' ability	3.64	0.99	3.84	0.78	3.69	0.59	3.58	0.43
	Self-efficacy	3.33	0.77	3.83	0.50	3.09	0.74	3.14	0.56

* Mean scores attitude sub-components range from: 1 (*totally disagree*) to 5 (*totally agree*).

* * Control group HOTS Relevance $n = 10$.

Table 3

*Interaction effects (time * condition) organized by attitude dimension*

		F	*p*	Partial η2
Attitude Technology	Relevance	1.81	.20	.09
	Usefulness	**6.30**	**.02**	**.26**
	Ease of use	1.52	.23	.08
	Anxiety	**7.08**	**.02**	**.28**
	Enjoyment	0.22	.65	.01
	Self-efficacy	0.24	.63	.01
	Context-dependency	0.52	.48	.03
	Subjective norm	0.04	.85	.00
Attitude HOTS	Relevance	0.05	.82	.00
	Learners' ability	1.41	.25	.07
	Self-efficacy	**7.07**	**.02**	**.28**

* bold values show significant difference in scores between control and experimental group

** significance level at $p = 0.05$

4.2 Results per subscale

Relevance technology. The univariate analyses did not show a statistical significant interaction effect of time and condition for the relevance sub-component of the beliefs dimension of the attitude towards technology in classroom, $F(1, 10) = 1.81$, $p = .20$. See figure 10 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.23$, $p = .82$, nor for the control group , $t(10) = 1.70$, $p = .12$, meaning that for both conditions the relevance sub-component did not significantly change over time.

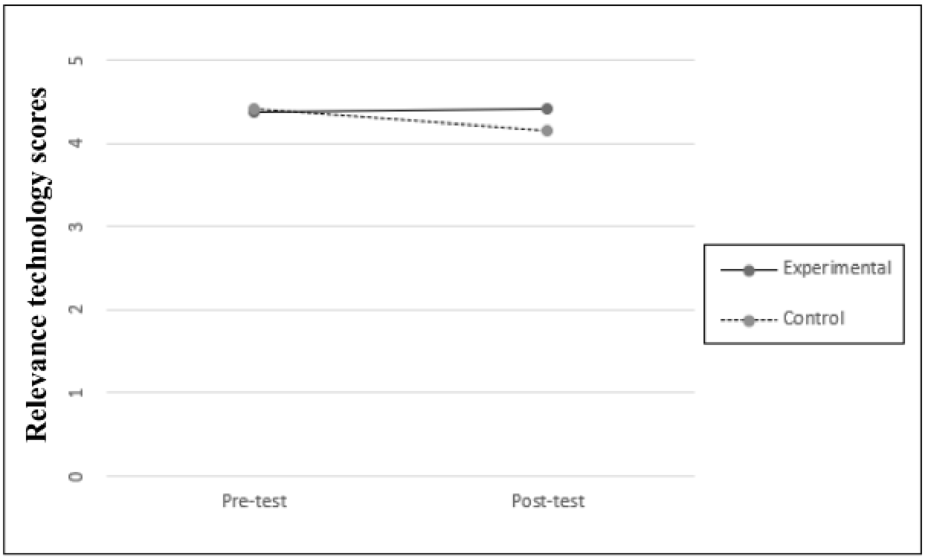

Figure 10. Mean scores pre- and post-test per condition.

Usefulness technology. The univariate analyses showed a statistical significant interaction effect of time and condition for the usefulness sub-component of the beliefs dimension of the attitude towards technology in classroom, $F(1, 10) = 6.30$, $p = .02$, $\eta 2 = .26$. See figure 11 for the interaction plot. The effect size is therefore high (Cohen, 1988) with partial $\eta 2$ of .26, meaning that 26% of the variance in scores for the usefulness sub-component of the beliefs dimension of the attitude towards technology in classroom, was accounted for by the training course. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -2.29$, $p = .05$, nor for the control group , $t(10) = 1.00$, $p = .34$, meaning that however the interaction effect size was high, the usefulness sub-component did not significantly change over time for both conditions.

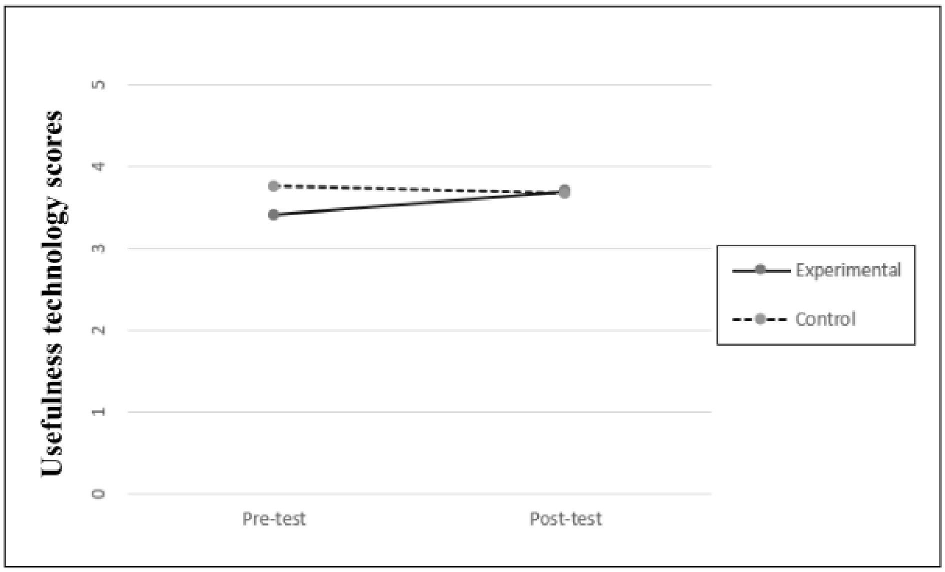

Figure 11. Mean scores pre- and post-test per condition.

Ease of use technology. The univariate analyses did not show a statistical significant interaction effect of time and condition for the ease of use sub-component of the beliefs dimension of the attitude towards technology in classroom, $F(1, 10) = 1.52$, $p = .08$. See figure 12 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.24$, $p = .81$, nor for the control group , $t(10) = -1.67$, $p = .13$, meaning that for both conditions the ease of use sub-component did not significantly change over time.

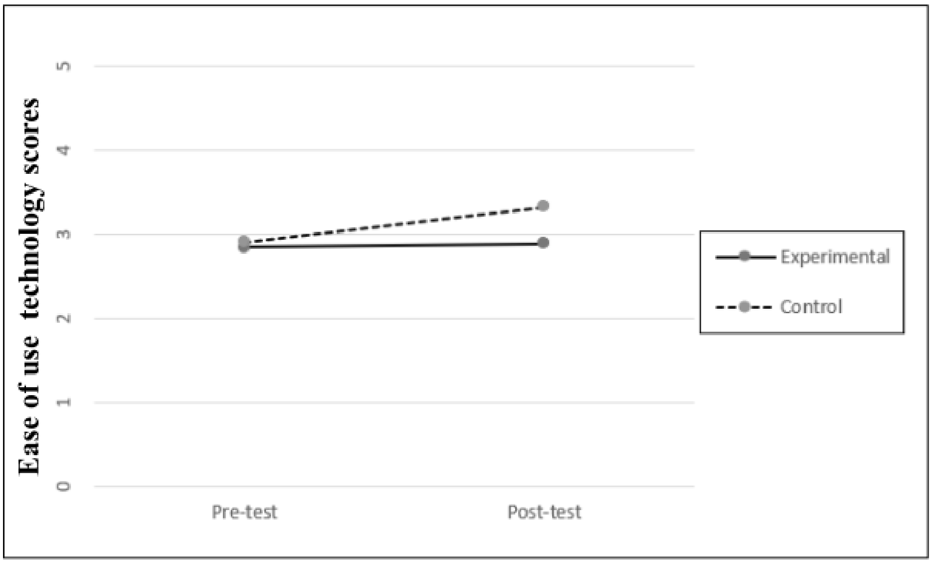

Figure 12. Mean scores pre- and post-test per condition.

Anxiety technology. The univariate analyses showed a statistical significant interaction effect of time and condition for the anxiety sub-component of the affect dimension of the attitude towards technology in classroom, $F(1, 10) = 7.08$, $p = .02$, $\eta 2 = .28$. See figure 13 for the interaction plot. The effect size is therefore high (Cohen, 1988) with partial η2 of .28, meaning that 28% of the variance in scores for the anxiety sub-component of the affect dimension of the attitude towards technology in classroom, was accounted for by the training course. Further analysis using paired t-tests, showed a statistical significant decrease for the experimental group $t(8) = 2.53$, $p = .018$, while for the control group there was no statistical significant change, $t(10) = -1.61$, $p = .14$, this indicates that the training course had a negative effect on the anxiety of primary school teachers towards technology use in classroom.

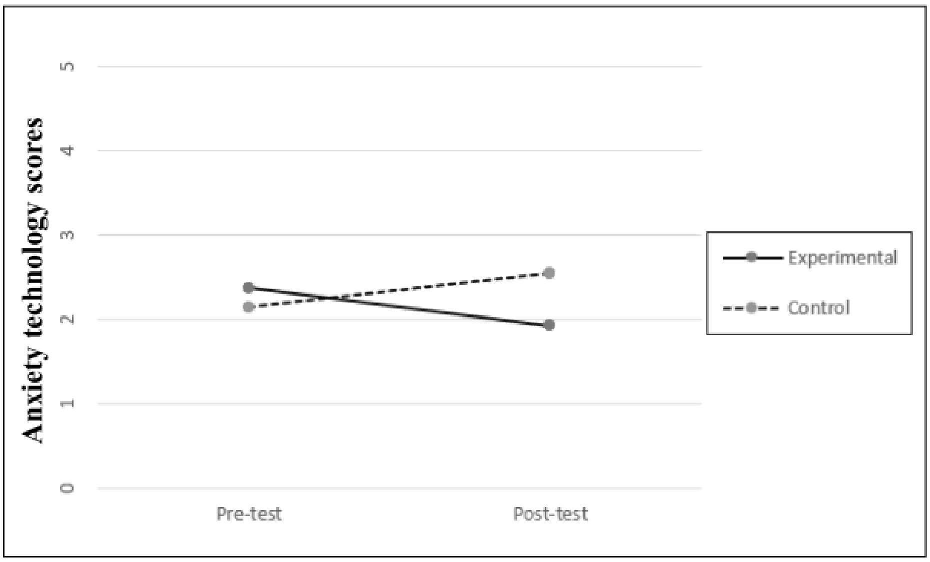

Figure 13. Mean scores pre- and post-test per condition.

Enjoyment technology. The univariate analyses did not show a statistical significant interaction effect of time and condition for the enjoyment sub-component of the affect dimension of the attitude towards technology in classroom, $F(1, 10) = 0.22$, $p = .65$. See figure 14 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = .00$, $p = 1.00$, nor for the control group , $t(10) = .60$, $p = .56$, meaning that for both conditions the enjoyment sub-component did not significantly change over time.

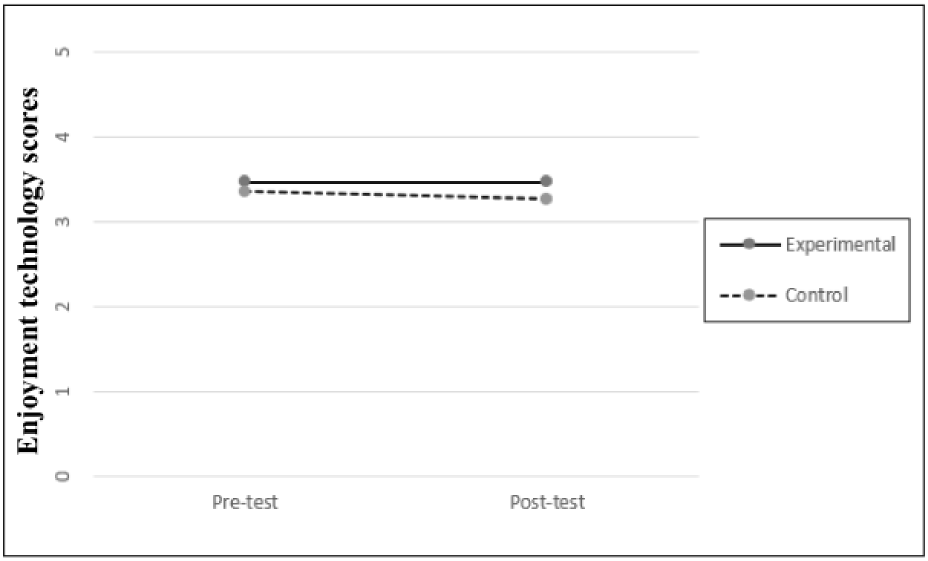

Figure 14. Mean scores pre- and post-test per condition.

Self-efficacy technology. The univariate analyses did not show a statistical significant interaction effect of time and condition for the self-efficacy sub-component of the perceived behavioural control dimension of the attitude towards technology in classroom, $F(1, 10) = 0.24$, $p = .63$. See figure 15 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -2.09$, $p = .07$, nor for the control group , $t(10) = -2.14$, $p = .06$, meaning that for both conditions the self-efficacy sub-component did not significantly change over time.

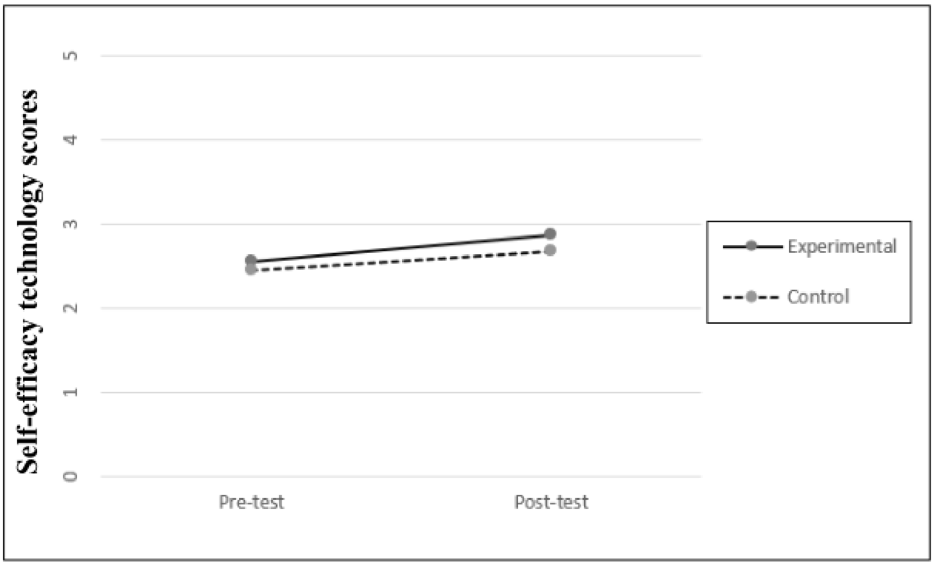

Figure 15. Mean scores pre- and post-test per condition.

Context dependency technology. The univariate analyses did not show a statistical significant interaction effect of time and condition for the context dependency sub-component of the perceived behavioural control dimension of the attitude towards technology in classroom, $F(1, 10) = 0.52$, $p = .48$. See figure 16 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.15$, $p = .088$, nor for the control group , $t(10) = -1.07$, $p = .31$, meaning that for both conditions the context dependency sub-component did not significantly change over time.

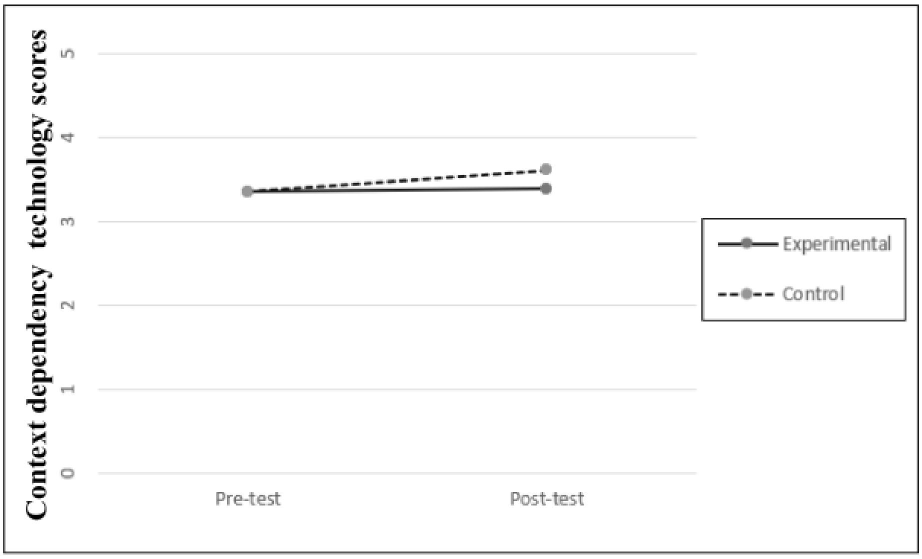

Figure 16. Mean scores pre- and post-test per condition.

Subjective norm technology. The univariate analyses did not show a statistical significant interaction effect of time and condition for the subjective norm sub-component of the social norm dimension of the attitude towards technology in classroom, $F(1, 10) = 0.04$, $p = .85$. See figure 17 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.89$, $p = .40$, nor for the control group, $t(10) = -.50$, $p = .63$, meaning that for both conditions the subjective norm sub-component did not significantly change over time.

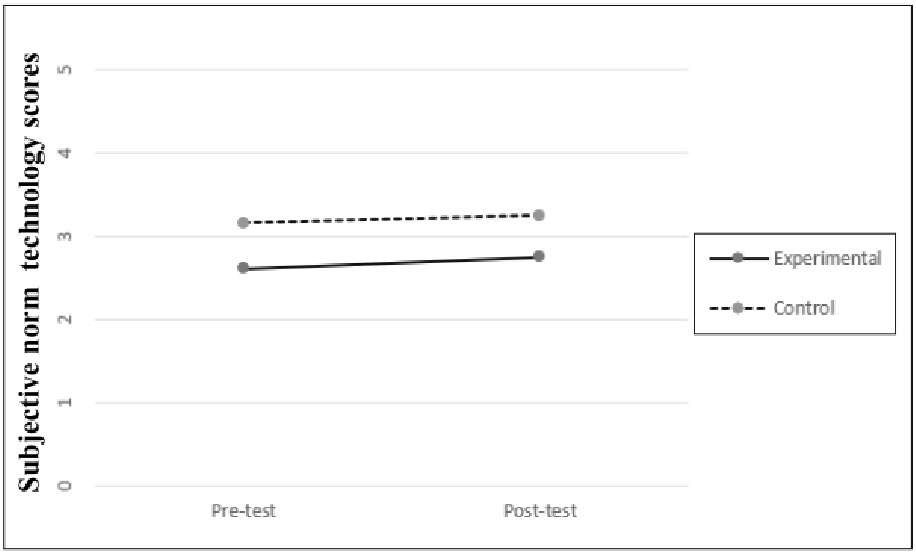

Figure 17. Mean scores pre- and post-test per condition.

Relevance HOTS. The univariate analyses did not show a statistical significant interaction effect of time and condition for the relevance sub-component of the beliefs dimension of the attitude towards the stimulation of HOTS among learners, $F(1, 10) = 0.05$, $p = .82$. See figure 18 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.45$, $p = .67$, nor for the control group, $t(9) = -.67$, $p = .52$, meaning that for both conditions the relevance sub-component did not significantly change over time.

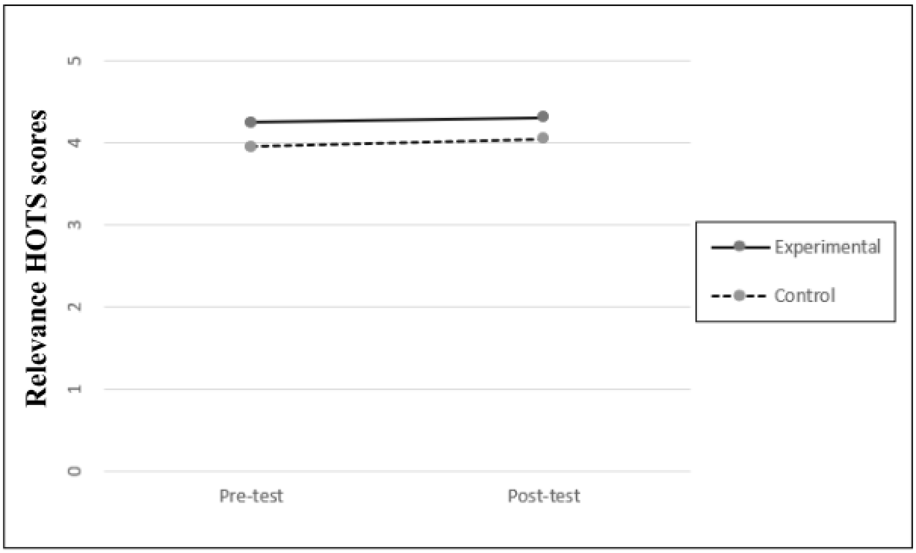

Figure 18. Mean scores pre- and post-test per condition.

Learners' ability HOTS. The univariate analyses did not show a statistical significant interaction effect of time and condition for the learners' ability sub-component of the beliefs dimension of the attitude towards the stimulation of HOTS among learners, $F(1, 10) = 1.41$, $p = .25$. See figure 19 for the interaction plot. Further analysis using paired t-tests, showed no statistical significant change for the experimental group $t(8) = -.82$, $p = .44$, nor for the control group, $t(10) = .88$, $p = .40$, meaning that for both conditions the learners' ability sub-component did not significantly change over time.

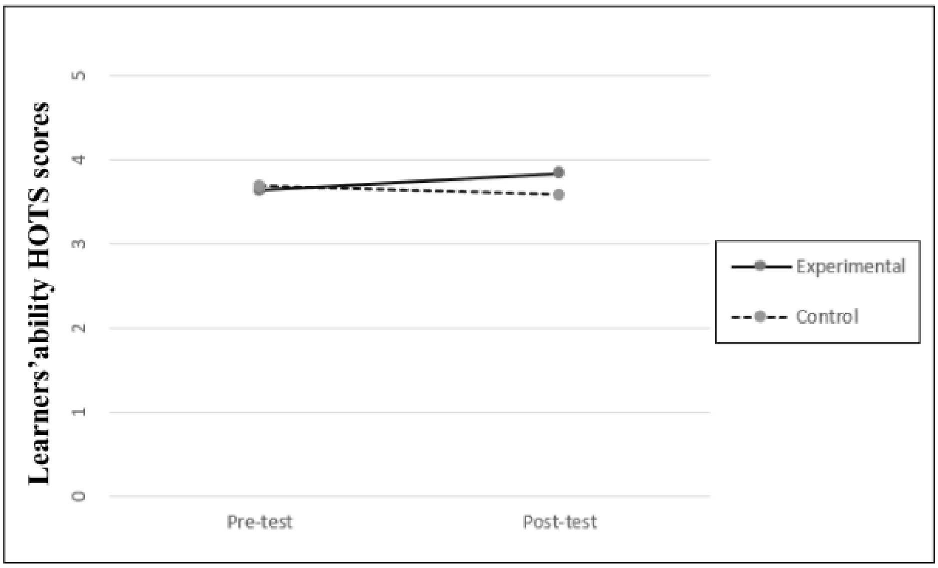

Figure 19. Mean scores pre- and post-test per condition.

Self-efficacy HOTS. The univariate analyses showed a statistical significant interaction effect of time and condition for the self-efficacy sub-component of the perceived behavioural control dimension of the attitude towards the stimulation of HOTS among learners, $F(1, 10) = 7.07$, $p = .02$, η2 = .28. See figure 20 for the interaction plot. The effect size is therefore high (Cohen, 1988) with partial η2 of .28, meaning that 28% of the variance in scores for the self-efficacy sub-component of the perceived behavioural control dimension of the attitude towards the stimulation of HOTS among learners, was accounted for by the training course. Further analysis using paired t-tests, showed a statistical significant increase for the experimental group $t(8) = -3.62$, $p = .004$, while for the control group there was no statistical significant change, $t(10) = -43$, $p = .68$, this indicates that the training course had a positive effect on the self-efficacy of primary school teachers towards the stimulation of HOTS among learners.

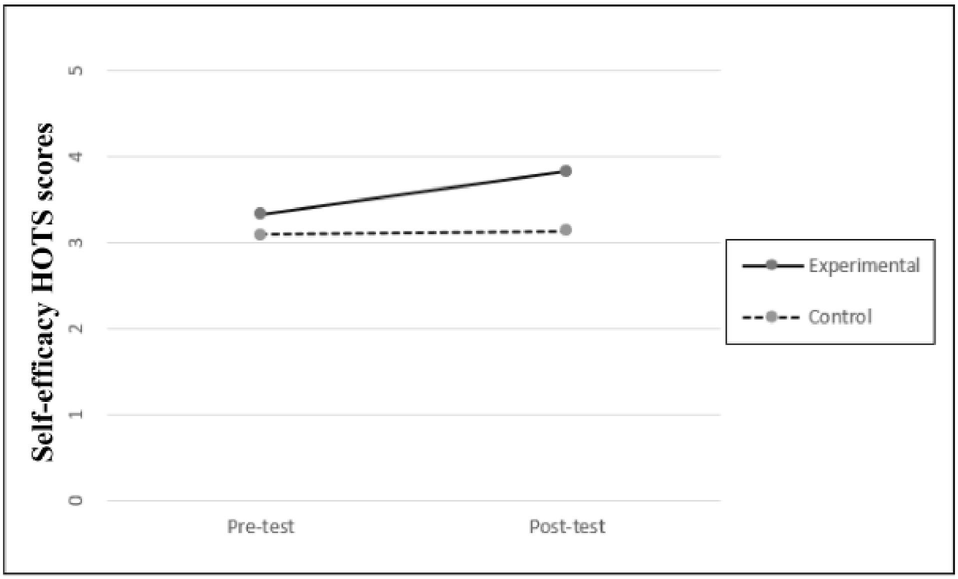

Figure 20. Mean scores pre- and post-test per condition.

4.3 Qualitative reflections. At the end of the course teachers in the experimental group were asked to briefly state on paper 1 what they think is the most valuable thing they have learned during the training and 2 what remained unclear. Of the 14 participating teachers, 12 wrote the short reflections.

Learned. Of the teachers, 6 wrote statements related to the attitude sub-component of usefulness of technology in classroom, namely that they had learned that technology is a useful tool for learning or more useful than they initially thought, 5 wrote statements related to the attitude sub-component of ease of use of technology and/or the stimulation of HOTS among learners, namely that they learned an easy way to design lessons with technology and/or aimed at the stimulation of HOTS, 1 wrote a statement related to the attitude sub-component of self-efficacy, namely that he or she learned about his or hers process in designing lessons and how this can be improved and 1 wrote a statement about that he or she learned that there are endless possibilities and he or she should extend his or hers scope. It's not clear if this statement is related to the attitude sub-component of context dependency meaning more possibilities in designing lessons with the technology or aimed at the stimulation of HOTS at the specific school, or endless possibilities for technology in general to be used in education, which will be more related to the attitude sub-component of usefulness of technology.

Unclear. Of the teachers, 5 wrote a question directly related to the attitude sub-component of context dependency. Of these, 4 were about the feasibility for a school to buy technology, and 1 was about possible time constraints. Furthermore, there were also questions that were not directly related to an attitude sub-component which were marked as 'how to' questions. Of these, 2 teachers wrote a question about how to implement the lesson-development scheme that was used in the workshop in their school, 2 teachers wrote a question about how to use a specific part in the scheme, and 1 teacher wrote a question about how specific types of technology can be used.

5. Discussion

The findings of this study suggest that some attitude dimension sub-components of technology use in classroom, as well as the stimulation of HOTS among learners can positively be influenced by the on- and offline training course used in this study.

Quantitative evidence gathered via surveys (pre-and post-test) indicates a negative effect of the course on the anxiety sub-component of the affect dimension regarding technology use in classroom, meaning that the average teachers' anxiety levels had dropped significantly. Furthermore, the self-efficacy sub-component of the perceived behavioural control dimension of teachers' attitudes toward the stimulation of HOTS showed a significant increase, meaning that teachers on average felt more competent in designing and executing lessons in which the HOTS of learners are stimulated.

Qualitative evidence gathered via short on-paper reflections after the workshop part of the training, partly supported these findings and in addition indicated that there might have been more effects than could be drawn from the quantitative data. Half of the teachers who executed the reflective assignment namely wrote that they had learned that technology is a more useful tool for learning than they initially thought. This thus suggests that there was an effect regarding the usefulness attitude dimension sub-component of technology. When looking at the quantitative data, however, the image is somewhat different. While there was an interaction effect found for the usefulness attitude dimension sub-component of technology, there was no statistically significant change between the pre-and post-test scores per condition. In contrast to the qualitative data, this indicates that the attitudes of teachers regarding this sub-component had not changed. There are thus qualitative indications of a possible effect on the usefulness sub-component, only these could not be supported by quantitative data in this study.

Another surprising finding is, while no significant change was found in the quantitative data for the ease-of-use sub-component of the attitude dimension of beliefs regarding technology use in classroom, almost half of the teachers who wrote what they had learned, stated that they learned an easy way to design lessons with technology and/or aimed at the stimulation of HOTS, e.g., *"In this way, learning goals can be quickly concretized and finding digital tools becomes easier".*

It is important to consider when looking at the qualitative data that the absence of statements related to other attitude dimension sub-components than the ones described above, might have to do with the type of question that has been asked. Asked is namely, to write what has been 'learned'. Teachers might easier form sentences related to, for instance the usefulness of technology, as something that has been learned. This is namely something you can actually been taught. After the workshop one might state that he learned that technology is a useful tool for learning, because he learned new knowledge about the use of technology in classroom and has seen examples in which the use of technology has added value. That this changed the attitude as well is probably not noticed by the teacher. For other attitude sub-components, it might be more difficult or irrelevant to form sentences about what has been learned, compared to the usefulness sub-component. When looking for example at the anxiety sub-component, it seems not likely that a teacher states that he has 'learned' that his anxiety towards the use of technology decreased. This is mostly not something you learn; it is something that occurs. One could thus have probably not learned about his decrease in anxiety towards the use of technology in classroom, while there was in fact a negative change in anxiety, although unobtrusive and at the attitude level instead of the knowledge level. This might explain why the anxiety sub-component that showed significant changes via the quantitative analysis, does not show changes via the qualitative analysis.

Of the reflections of the teachers, some statements about what remained unclear could particularly be related to the context-dependency attitude sub-component of the perceived-behavioural-control dimension regarding the in classroom use of technology, which is supported via the quantitative evidence of this study as there were no significant changes in the scores on this sub-component. Most of the context dependency seems related to the expected costs involved when one would want to start working with technology, as this is what the teachers mainly wrote about.

As stated before, it seems that the relatively short intervention of the study had an effect on 3 attitude dimension sub-components. This is an important result because attitudes are formed by multiple evaluations around an attitude object, which might suggest that changes in attitudes need time to occur (Ajzen, 2001). This would mean that professional development programs with a long duration are needed to have an effect. The results of this study however indicate that that multiple positive evaluations around an attitude object can in fact take place via professional training programs with a short duration that furthermore partly take place online. It would be interesting to see how this holds when this would be investigated with a larger sample size and if the attitude changes would also be apparent on long term. An effective program with a short duration, which could partly take place online would be of high practical value as it would reduce cost for schools for professional development and reduce the time that schools need to invest. The reduced time investment seems especially promising for the development of teachers, as all schools that were asked to participate except, 1 mentioned time-constraints as the primary reason for not being able to participate in the training course. The majority also mentioned that when they would have had time, they would have wanted to participate because they viewed technology use in classroom and the stimulation of HOTS as important topics to receive training on.

Another interesting topic to explore is that while it seems that 3-sub-components of different attitude dimensions can be influenced by the training that is used in this study, it might be that on longer term more sub-components are influenced and that longer term effects might be stronger. This might be possible because when the 3 sub-components of the attitude dimensions are improved, this would mean that the attitude dimensions itself are improved. The overall attitude dimension score is namely an average of the scores on the sub-components (Wijnen et al., in progress). According to the theory of planned behaviour (Ajzen, 2001) this increase might lead to the intention to perform certain behaviour, for example aiming at the stimulation of HOTS more often. This, then, could lead to performing this behaviour. When the teacher performs this behaviour and experiences this as positive regarding for example an increase in learning outcomes, this could lead to further positive evaluations regarding the attitude object. Possibly on other attitude dimension sub-components than the 3 which were influenced by the training of this study. If the new positive evaluations take place it could create a cycle as these positive evaluations on the sub-components would again have an effect on the overall attitude towards an object, which according to the theory of planned behaviour could again lead to the intention to perform certain behaviour, and so forth.

First evidence for the existence of this cycle of attitude improvement can be found in the practice causal loop of Howard and Thompson (2016). This causal loop for example states that when a teacher has positive experiences with the use of technology in classroom, in such a way that learning outcomes are improved, this would lead to an increase in the idea that technology supports learning and lead to a change in the beliefs about teaching. This could for example lead to an increased use of technology in learning, or the intention to participate in professional development. This suggestion seems directly related to the usefulness sub-component of the beliefs dimension of the attitudes towards technology use in classroom in the attitude dimension framework of Wijnen et al. (in progress). This sub-component is namely about exactly that idea.

This study was a first exploration of the effects of a relatively short and cost-effective on- and offline training course on the attitudes of primary school teachers. The actual classroom change was therefore not within the scope of this study. It would however be valuable for further research to measure these possible in-classroom changes and thereby particularly investigate if positive changes in the scores on the attitude sub-components will lead to a change in the teaching of teachers and if these changes then will lead to further changes in the attitude sub-components and teaching. This would namely indicate that a cycle of attitude improvement exists. When this would be confirmed, one could further investigate to what extent attitude dimensions and its sub-components need to be influenced via training to start such a cycle. It is furthermore, as stated before, recommended for future research to 1 measure the effects of the course with a larger sample size and at more schools to improve the reliability and the generalizability of the findings, as the sample size of this current study was rather low and necessary statistical assumptions could not be completely met, and 2 investigate which components of the training led to which changes in the attitude dimension sub-components and which not, leading to possible suggestions about how the training can be improved. Currently it is namely not clear if the instructional videos, the workshop, or a combination of both caused the effects and let alone which parts of the videos and/or workshop. Only the training as a whole has been investigated, and while this increased the chances of finding an effect, to improve the training it is important to know what exactly caused the effects. After that it can be investigated if removing or changing ineffective parts would lead to a more effective training.

This study contributed to practice by providing a cost- and time effective training course for the improvement of primary teachers’ attitudes towards technology use in classroom and the stimulation of HOTS among learners.

This study contributes to science by providing explorative evidence that the sub-components of the attitudes dimensions as described by Wijnen, Walma van der Molen and Voogt (in progress), can be influenced by a short on- and offline training course containing short video lectures, a workshop and a scheme for the design and development of lessons.

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Appendix A

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Deze vragenlijst gaat over de houding van leerkrachten ten aanzien van het gebruik van technologie in de les en het stimuleren van hogere orde denken bij leerlingen.

Lees eerst onderstaande informatie goed door, voordat je aan de vragen begint.

Eerlijke mening: Het is belangrijk dat je de vragen eerlijk beantwoordt zodat het onderzoek een eerlijk beeld oplevert. Er zijn geen goede of foute antwoorden, het gaat echt om jouw persoonlijke mening. We willen je vragen om de vragenlijst volledig in te vullen omdat onvolledige vragenlijsten niet gebruikt kunnen worden voor het onderzoek.

Anonimiteit: De vragenlijsten worden anoniem verwerkt en niet gekoppeld aan personen. Wel zouden we graag de mogelijkheid hebben om de data van een afzonderlijke school te bekijken. Daarom vragen we je om de naam van de school in te vullen, deze naam wordt uiteindelijk niet genoemd in het onderzoeksverslag. Ook wordt er gevraagd om een code te maken. Deze wordt gebruikt om de eerste en de tweede meting aan elkaar te koppelen.

Over de vragenlijst: Het kan voorkomen dat sommige vragen erg op elkaar lijken. Dat voelt misschien overbodig, maar dat is statistisch gezien noodzakelijk om de vragenlijst betrouwbaar te maken. Daarom verzoeken we je om toch alle vragen in te vullen.

Onderdelen:
Deze vragenlijst bestaat uit de volgende onderdelen:
0. Achtergrondkenmerken
1. Toegang tot technologie
2. Technologie in de les
3. Het stimuleren van hogere-orde denken

Alvast hartelijk dank voor je medewerking!

◯ Ik heb de bovenstaande informatie gelezen en ga ermee akkoord dat mijn antwoorden op deze vragenlijst worden gebruikt voor onderzoeksdoeleinden.

Omdat je de vragenlijst uiteindelijk twee keer gaat invullen is het voor het koppelen van de gegevens van de eerste vragenlijst aan de tweede (zonder dat we weten wie je bent) belangrijk een unieke code te maken. Deze code wordt alleen voor de koppeling gebruikt. Kun je daarom hieronder (aan elkaar, zonder spatie) jouw geboortedatum en het nummer van je postcode invullen? Dus bijvoorbeeld 01 januari 1980 en postcode 1234 AB wordt dan : 010119801234

Vul hieronder jouw unieke code in.

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Op welke school werk je?

Ik ben een...

- ◯ Man
- ◯ Vrouw

Wat is je leeftijd?

Aan welke groep geef je dit jaar les?

- ◯ Groep 1-2
- ◯ Groep 3-4
- ◯ Groep 5-6
- ◯ Groep 7-8
- ◯ Anders, namelijk

Wat is je hoogst genoten vooropleiding?

- ◯ PABO
- ◯ Academische PABO
- ◯ HBO
- ◯ HBO Master
- ◯ Academische Master
- ◯ Verkorte lerarenopleiding/ zij-instromer
- ◯ Anders

→

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Geef aan in hoeverre jij toegang hebt tot de onderstaande technologische middelen op jouw school om te gebruiken in je lessen.

	1. geen toegang	2.	3.	4.	5. altijd toegang	*weet ik niet*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

Geef aan in hoeverre de onderstaande technologische middelen van voldoende kwaliteit zijn (werken ze naar behoren)

	1. zeer slechte kwaliteit	2.	3.	4.	5. zeer goede kwaliteit	*n.v.t.*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

Geef aan in hoe vaak je de onderstaande technologische middelen in je lessen gebruikt

	1. nooit	2.	3.	4.	5. altijd	*n.v.t.*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

Geef aan in hoeverre je vindt dat de onderstaande technologische middelen van meerwaarde zijn voor het onderwijs.

	1. zeer weinig meerwaarde	2.	3.	4.	5. zeer veel meerwaarde	*n.v.t.*
iPads/tablets	○	○	○	○	○	○
Smartboard	○	○	○	○	○	○
Computers/laptops	○	○	○	○	○	○
Smartphones	○	○	○	○	○	○
Robots (bijv.Beebot of Dash)	○	○	○	○	○	○
3D printer	○	○	○	○	○	○
Digitale camera	○	○	○	○	○	○
Virtual Reality	○	○	○	○	○	○
Ontwerpsoftware	○	○	○	○	○	○
Simulatiesoftware	○	○	○	○	○	○
Webiste maker	○	○	○	○	○	○
Tekstverwerkingssoftware	○	○	○	○	○	○
Videobewerkingssoftware	○	○	○	○	○	○
Internet	○	○	○	○	○	○
Digitale methode software	○	○	○	○	○	○

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BELANGRIJK: De onderstaande vragen gaan over TECHNOLOGIE.

Met technologie bedoelen we in dit onderzoek, digitale leermiddelen (zowel hardware als software) die jij als leerkracht kunt gebruiken als leermiddel om je lessen te verrijken/ondersteunen. Voorbeelden hiervan zijn, hardware: laptops, smartphones, tablets, 3D printers,
educatieve robots (BeeBot, DASH). Software: Office toepassingen, simulatiesoftware, ontwerpsoftware,
programmeersoftware, videobewerkingssoftware.

Geef aan in hoeverre je het eens bent met de volgende stellingen.

	1. helemaal mee oneens	2.	3.	4.	5. helemaal mee eens
Ik ben goed in staat om technologieën te kiezen die de didactische werkvormen in mijn lessen verrijken	○	○	○	○	○
Ik denk dat het erg weinig moeite kost om nieuwe technologie te gebruiken in mijn lessen	○	○	○	○	○
Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van een ICT-coördinator bepalend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Ik heb het gevoel dat op onze school de visie over het inzetten van technologie in het onderwijs helder is	○	○	○	○	○
Ik word nerveus bij het idee dat ik met technologie in mijn lessen moet werken	○	○	○	○	○
De moed zakt me in de schoenen als ik iets nieuws moet doen met technologie in mijn lessen	○	○	○	○	○
Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van lesmaterialen bepalend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Ik ben goed in staat om lessen te geven waarbij technologie, vakinhoud en didactiek op een goede manier zijn geïntegreerd	○	○	○	○	○
Ik denk dat het heel makkelijk is om technologie te gebruiken in mijn lessen	○	○	○	○	○
Ik voel mij gedreven om lessen te geven met technologie	○	○	○	○	○
Ik ben enthousiast over het gebruik van technologie in mijn lessen	○	○	○	○	○
Ik denk dat het erg belangrijk is voor de toekomst van leerlingen dat zij de mogelijkheid hebben om met technologie te leren werken op school	○	○	○	○	○
Voor mij is extra tijd doorslaggevend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Voor mij voelt het gebruik van technologie in mijn lessen als een positieve uitdaging	○	○	○	○	○
Ik denk dat het essentieel is voor leerlingen om met technologie te leren werken, zodat zij goed voorbereid worden op de ontwikkelingen in de samenleving	○	○	○	○	○

Ik denk dat het heel eenvoudig is om nieuwe technologie in te zetten in mijn lessen	○	○	○	○	○
Voor mij is de beschikbaarheid van een scholingsprogramma een voorwaarde om technologie te gebruiken in mijn lessen	○	○	○	○	○
Ik denk dat ik met behulp van technologie de lesinhoud veel makkelijker op een gedifferentieerde manier kan aanbieden	○	○	○	○	○
Ik heb het gevoel dat het inzetten van technologie in de les op onze school wordt gewaardeerd	○	○	○	○	○
Ik ben goed op de hoogte van technologieën die ik kan gebruiken om leerlingen inzicht te geven in de vakken waarin ik lesgeef	○	○	○	○	○
Ik vind het leuk om met technologie te experimenteren in mijn lessen	○	○	○	○	○
Ik denk dat het cruciaal is dat leerlingen de rol van technologie in de maatschappij begrijpen	○	○	○	○	○
Ik denk dat ik met behulp van nieuwe technologie mijn instructie veel meer kan variëren	○	○	○	○	○
Ik heb het gevoel dat in het onderwijs op onze school technologie een belangrijke plaats heeft	○	○	○	○	○
Ik weet precies hoe ik technologieën kan gebruiken om concepten uit verschillende vakken op een andere manier te presenteren aan mijn leerlingen	○	○	○	○	○
Ik ben goed in staat om technologieën te kiezen die de leerprocessen van mijn leerlingen versterken	○	○	○	○	○
Voor mij is de aanwezigheid van technische ondersteuning bepalend of ik wel of geen technologie gebruik in mijn lessen	○	○	○	○	○
Ik heb het gevoel dat mijn collega's het gebruik van technologie in het onderwijs belangrijk vinden	○	○	○	○	○
Ik denk dat het gebruik van technologie in mijn lessen zeer nuttig is om het dieper leren van leerlingen mogelijk te maken	○	○	○	○	○
Ik voel mij gespannen als ik technologie moet gebruiken in mijn lessen	○	○	○	○	○
Ik ben goed in staat om technologieën te kiezen die de lesinhoud voor de vakken waarin ik lesgeef ondersteunen	○	○	○	○	○
Ik denk dat de leerresultaten van mijn leerlingen aanzienlijk verbeteren door het gebruik van technologie	○	○	○	○	○

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BELANGRIJK: De onderstaande vragen gaan over HET STIMULEREN VAN HOGERE-ORDE DENKEN
Met het stimuleren van hogere-orde denken bij leerlingen bedoelen we het aanbieden van opdrachten, vragen, problemen of dilemma's waarbij kinderen complexe cognitieve denkvaardigheden moeten gebruiken (zoals analyseren, evalueren en creatief denken) om te
komen tot een oplossing, beslissing, voorspelling, oordeel of product. Voorbeelden hiervan zijn
(1) leerlingen zoveel mogelijk oplossingen laten bedenken voor een gegeven probleem, (2) leerlingen een ontwerp laten maken voor een nieuw nog niet bestaand product, (3) leerlingen
voor- en tegenargumenten laten bedenken rondom een stelling om zo een eigen mening te vormen over een bepaald onderwerp.

Geef aan in hoeverre je het eens bent met de volgende stellingen.

	1.helemaal mee oneens	2.	3.	4.	5. helemaal mee eens
Ik denk dat het cruciaal is voor het leren van leerlingen dat zij worden aangezet tot hogere-orde denken					
Ik beschik over genoeg vaardigheden om mijn lessen te verrijken met hogere-orde denkopdrachten					
Ik denk dat we van 'zwakke' leerlingen geen hogere-orde denken moeten verwachten					
Ik denk dat opdrachten die hogere-orde denken vereisen veel geschikter zijn voor 'slimme' leerlingen dan voor 'zwakke' leerlingen					
Ik ben goed in staat vragen te stellen aan mijn leerlingen waarmee hogere-orde denken wordt gestimuleerd					
Ik denk dat 'zwakke' leerlingen opdrachten die hogere-orde denken vereisen niet aan kunnen					
Ik ben goed in staat om zelf opdrachten te maken die mijn leerlingen aanzetten tot hogere-orde denken					
Ik denk dat het voor de ontwikkeling van het denken van leerlingen essentieel is om hogere-orde denken te stimuleren					
Ik denk dat het stimuleren van hogere-orde denken zo belangrijk is, dat alle leerkrachten dit regelmatig moeten doen in hun lessen					
Ik denk dat 'slimme' leerlingen veel beter zijn in hogere-orde denken dan 'zwakke' leerlingen					
Ik denk dat opdrachten die hogere-orde denken vereisen frustrerend zijn voor 'zwakke' leerlingen					
Om de ontwikkeling van het denken van leerlingen te stimuleren, vind ik dat je niet vroeg genoeg kunt beginnen met het aanbieden van opdrachten waarin hogere-orde denken aan bod komt					
Ik ben goed in staat om leerlingen te begeleiden bij het maken van opdrachten waarbij zij aangezet worden tot hogere-orde denken					

Appendix B

De leerling kan (leeronderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om (reden), waarbij de leerling (proces).

1. Wat is het leeronderwerp?

et leeronderwerp is:..

Wat moet de leerling met de leerstof kunnen doen?

Onthouden	Begrijpen	Toepassen	Analyseren	Evalueren	Creëren
unnen onthouden van leerstof zonder egrip. Geleerde kennis ophalen door t te herinneren.	Begrijpen en betekenis kunnen geven aan geleerde kennis.	Toepassen van het geleerde in een nieuwe situatie.	Onderzoeken en analyseren van informatie door motieven en oorzaken te identificeren; conclusies te trekken en bewijzen te vinden ter ondersteuning van bevindingen.	Het presenteren en verdedigen van meningen door informatie, ideeën of werk te beoordelen op basis van criteria.	Creëren van nieuwe oplossingen, ideeën, kennis en producten met opgedane kennis door elementen te combineren of alternatieve oplossingen te bedenken.

Lagere orde denkvaardigheden | **Hogere orde denkvaardigheden**

Oppervlakkig leren → **Diepgaand leren**

2. Welke leeractiviteit zal de leerling daarbij uitvoeren?

Onthouden		Begrijpen		Toepassen		Analyseren		Evalueren		Creëren	
Benoemen	Vertellen	Aanduiden	Schetsen	Associëren	Overbrengen	Analyseren	Overzien	Aanbevelen	Oordelen	Aanpassen	Testen
Citeren	Navertellen	Demonstreren	Sorteren	Beheersen	Plannen	Beredeneren	- Prioriteren	Bekritiseren	Overtuigen	Bedenken	Toevoegen
Definiëren	Opsommen	Discussiëren	Toelichten	Berekenen	Selecteren	Categoriseren	Relaties benoemen	Belang Bepalen	Overwegen	Bewerken	Transformeren
Herhalen	Beschrijven	Vragen	Tonen	Categoriseren	Simuleren	Classificeren	Reorganiseren	Bepalen	Prioriteren	Combineren	Uitbreiden
Herkennen	Aanwijzen	Generaliseren	Uitdrukken	Classificeren	Toelichten	Concluderen	Samenstellen	Beslissen	Rechtvaardigen	Construeren	Uitvinden
Kiezen	Onderstrepen	Herformuleren	Uitleggen	Demonstreren	Toepassen	Discussiëren	Schatten	Betogen	Schatten	Creëren	Veranderen
Kopiëren	Vinden	Herzien	Vergelijken	Experimenteren	Uitvoeren	Focussen	Selecteren	Betwisten	Valideren	Experimenteren	Verbeteren
Luisteren	Labelen	Indelen	Vertalen	Gebruik maken van	Verbinden	Inspecteren	Vaststellen	Bewijzen	Verdedigen	Reviseren	Vereenvoudigen
Memoriseren	Tonen	Interpreteren	Voorbeelden geven	Gebruiken	Vertalen	Onderscheiden	Verdelen	Concluderen	Vergelijken	Herzien	Vervangen
Observeren	Schrijven	Observeren	Voorspellen	Identificeren	Voortbouwen op	Onderzoeken	Vergelijken	Debatteren	Verklaren	Innoveren	Visualiseren
Onthouden	....	Rapporteren	....	Interpreteren	Vormen	Ontdekken	Vinden	Evalueren	Waarderen	Integreren	Voorspellen
Opschrijven	....	Relateren	....	Manipuleren	....	Ontleden	Vragen	Instemmen	Weerleggen	Ontwerpen	Voorstellen
Opzoeken	....	Samenvatten	....	Ontwikkelen	....	Oorzaak en gevolg onderscheiden	....	Interpreteren	....	Ontwikkelen	....
Reproduceren	....	Schatten	....	Organiseren	....	Ordenen	....	Kiezen	....	Oplossen	....
Selecteren			....		....		....	Kwalificeren	....	Produceren	....
								Mening geven	....	Samenstellen	....

3. Welk product zal de leerling maken?

De leerling maakt:...

4. Welke vorm van technologie kan de leerling hierin ondersteunen?

- **3D-printer**
- **Digibord**
- **Tekstverwerker**
  (Bijv.Microsoft Word, Apple Pages, Google Documenten)
- **Spreadsheet programma**
  (Bijv. Microsoft Excel, Apple Numbers, Google Spreadsheets)
- **Presentatiesoftware**
  (Bijv. Microsoft Powerpoint, Prezi, Keynote)
- **Publicatie ontwerp programma** *(Bijv. Microsoft Publisher, Adobe InDesign)*
- **Digitaal tekenprogramma**
  (Bijv. Paint)
- **3D ontwerp programma**
  (Bijv. Thinkercad, Google Sketchup,Doodle3d, Paint3D)
- **Fotobewerking programma**
  (Bijv. Photoshop, Aviary)
- **Programmeerbare robot**
  (Bijv. Ozobot, Beebot, Lego Mindstorms, Mbot)
- **Augmented Reality**
- **Virtual Reality**
  (Bijv. Google Cardboard, Google expeditions)
- **360 graden camera**
- **Video camera**
- **Foto camera**
- **Mindmap software**
  (Bijv. Mindmomo.com, Coggle.it, Mindmapmaker.org)
- **Digitaal prikbord**
  (Bijv. Padlet)
- **Game ontwerper**
- **Mini computer/controller**
  (Bijv. Raspberry Pi, Microbit, Arduino)

- **Website maker**
  (Bijv. Wordpress), school.jouwweb.nl, Mijnwebsite.nl)
- **Elektronica**
  (Bijv. Littlebits)
- **Programmeer programma**
  (Bijv. Scratch, Programmr), Makey Makey)
- **Chatprogramma**
  (Bijv. Skype)
- **Social media**
  (Bijv. Facebook, Instagram, Twitter, Pinterest)
- **Minecraft Education**
- **Videobewerking programma**
  (Bijv. iMovie, Windows foto en film editor)
- **Digitaal Museum**
  (Bijv. Google Art)
- **Time lapse software**
  (Bijv. Lapse It)
- **Chromakey software**
  (Bijv. Greenscreen by Doink, Chroma key studio Pro)
- **Youtube**
- **3D pen**
  (Bijv. Doodle 3d)
- **Zoekmachine**
  (Bijv. Google, Bing, Yahoo, Davindi)
- **Lasersnijder**
- **SMART table**
- **Interactieve vloer**
  (bijv. Active Floor, Wize Floor)
- **Digitale methode software**
- **Interactief foto/video programma** *(bijv. Thinglink)*

- **Infographic programma**
  (Bijv. Piktochart, Easel.ly, Infogr.am)
- **Strip teken programma**
  (Bijv. Strip designer, Pixton, Make Beliefs Comix)
- **Stemrecorder**
  (Bijv. Microsoft Voicerecorder) · **Quiz programma**
  (Bijv. Kahoot, Socrative, Plickers, Blendspace)
- **Woordwolk programma**
  (Bijv. Woordwolk.nl)
- **Enquete programma**
  (Bijv. Miscrosoft forms, Google Forms, Survey Monkey)
- **Schermopname programma**
  (Bijv. Screencast-O-Matic, Windows Gamebar)
- **Mindmap programma**
  (Bijv. Bubble.us, eMindmap, Mindmeister, MindNode)
- **Flitskaarten programma**
  (Bijv. Wozzol, Quizlet)
- **Digibord tools**
  (Bijv. Prowise Presenter, Gynzy)
- **Tijdschrift ontwerp programma**
  (Bijv. Jilster)
- **Online encyclopedie**
  (Bijv. Wikipedia, Wikikids)
- **Stop motion programma**
  (Bijv. Stop Motion Studio)
- **Muurkrant programma**
  (Bijv.Glogster)
- **Tijdlijn programma**
  (Bijv. Timerime, Timeglider)
- **Landkaart software**
  (Bijv. Google Maps, Google Earth)
- ....

5. Waarvoor gebruikt de leerling deze technologie?

De leerling gebruikt de technologie voor:...

6. Wat doet de leerling tijdens de leeractiviteit om het gewenste resultaat te behalen?

De leerling:...

Appendix C

De leerling kan (onderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om(reden) , waarbij de leerling(proces).

Stap 1.1: Beschrijf de belangrijkste leeronderwerpen van de leerlingen van de komende maand. Kies tien onderwerpen die jullie interessant vinden en waar jullie graag mee aan de slag willen. Schrijf deze op de bordjes.

Stap 1.2: Kies één van de tien bordjes met leeronderwerpen.

Stap 2: Kijk naar de taxonomie van Bloom. Bedenk in hoeverre de leerling de leerstof moet beheersen. Dit varieert van enkel het onthouden en reproduceren van de leerstof zonder begrip, tot het zelf kunnen creëren van iets nieuws met of naar aanleiding van de leerstof. Kies het best passende niveau van de taxonomie van Bloom en kies een bijpassende leeractiviteit.

Stap 3: Kies een geschikt product dat de leerling gaat maken.

Stap 4: Kies een vorm van technologie die de leerling in het proces kan ondersteunen.

Stap 5: Leg kort uit waarvoor de leerling die vorm van technologie gaat gebruiken.

Stap 6: Beschrijf hoe de leerling de leeractiviteit uitvoert.

Stap 8: Herhaal stap 2 t/m 7 totdat alle tien de onderwerpen behandeld zijn.

Stap 9: Bekijk de tien gemaakte leerdoelen. Welk leerdoel vinden jullie het beste of het meest interessant? Waarom? Je kunt de leerdoelen bijvoorbeeld beoordelen op de leeropbrengsten, het proces, de denkvaardigheden, de (on)mogelijkheden tot samenwerken, originaliteit, uitvoerbaarheid, efficiëntie, etc.

Stap 10: Bedenk aan de hand van het leerdoel dat jullie het beste of het meest interessant vinden hoe de opdracht eruit komt te zien. Beschrijf welke stappen de leerling moet doorlopen, welke materialen er nodig zijn, hoeveel tijd er voor de opdracht en de subonderdelen beschikbaar is en hoe de leerling ondersteund wordt.

Voorbeelden:

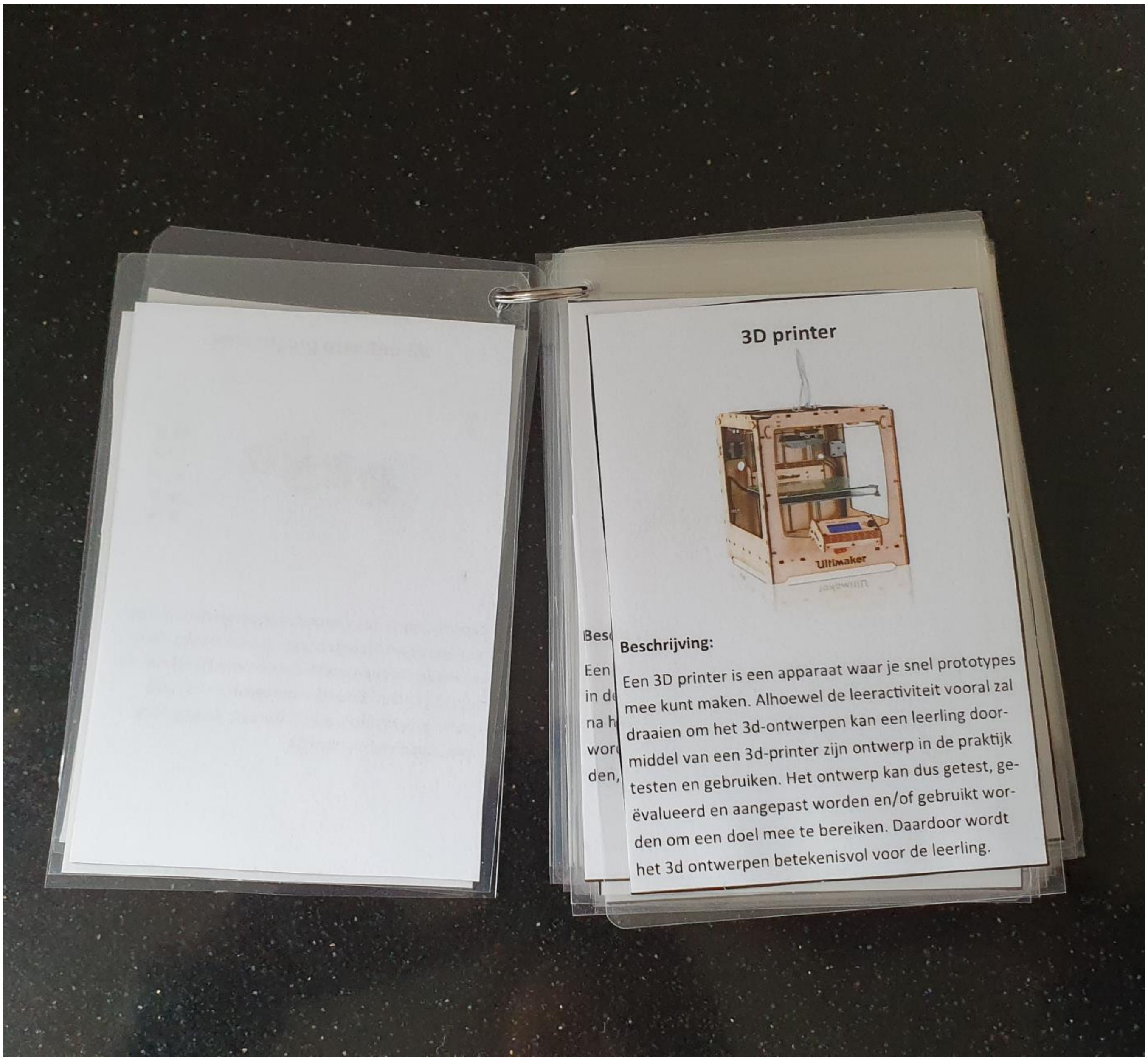
De leerling kan de Mona Lisa, waarderen door een podcast te maken met gebruik van stemopname apparatuur om de podcast terug te kunnen luisteren en te delen met anderen, waarbij de leerling verschillende schilderijen vergelijkt op basis van theorie over schilderkunst en zijn eigen mening.

De leerling kan de menselijke hand verbeteren door een robothand te maken, met gebruik van Lego Mindstorms om op een laagdrempelige manier de werking van een hand na te kunnen doen, waarbij de leerling informatie verzamelt, beoordeeld, combineert, test en alternatieven bedenkt.

Appendix D


Opdracht
Klas
Datum
De leerling kan (leeronderwerp) (leeractiviteit) door een (product) te maken met gebruik van (middel) om (reden), waarbij de leerling (proces).
Leeronderwerp
De leerling kan
Leeractiviteit
Product
door een
te maken
Middel
met gebruik van
Reden
om
Proces
waarbij de leerling

Appendix E


3D printer
Ultimaker
Beschrijving:
Een 3D printer is een apparaat waar je snel prototypes mee kunt maken. Alhoewel de leeractiviteit vooral zal draaien om het 3d-ontwerpen kan een leerling door-middel van een 3d-printer zijn ontwerp in de praktijk testen en gebruiken. Het ontwerp kan dus getest, geëvalueerd en aangepast worden en/of gebruikt worden om een doel mee te bereiken. Daardoor wordt het 3d ontwerpen betekenisvol voor de leerling.

Appendix F

Table 4
Scale items of customized instrument with item-codes and corresponding statements in Dutch.*

Scale	Item code	Corresponding statement in Dutch
Technology		
Usefulness	Q11_1	Ik denk dat ik met behulp van technologie de lesinhoud veel makkelijker op een gedifferentieerde manier kan aanbieden
	Q11_2	Ik denk dat de leerresultaten van mijn leerlingen aanzienlijk verbeteren door het gebruik van technologie
	Q11_3	Ik denk dat het gebruik van technologie in mijn lessen zeer nuttig is om het dieper leren van leerlingen mogelijk te maken
	Q11_4	Ik denk dat ik met behulp van nieuwe technologie mijn instructie veel meer kan variëren
Ease of use	Q11_5	Ik denk dat het heel makkelijk is om technologie te gebruiken in mijn lessen
	Q11_6	Ik denk dat het erg weinig moeite kost om nieuwe technologie te gebruiken in mijn lessen
	Q11_7	Ik denk dat het heel eenvoudig is om nieuwe technologie in te zetten in mijn lessen
Relevance	Q11_8	Ik denk dat het essentieel is voor leerlingen om met technologie te leren werken, zodat zij goed voorbereid worden op de ontwikkelingen in de samenleving
	Q11_9	Ik denk dat het cruciaal is dat leerlingen de rol van technologie in de maatschappij begrijpen
	Q11_10	Ik denk dat het erg belangrijk is voor de toekomst van leerlingen dat zij de mogelijkheid hebben om met technologie te leren werken op school
Self-efficacy	Q11_11	Ik ben goed op de hoogte van technologieën die ik kan gebruiken om leerlingen inzicht te geven in de vakken waarin ik lesgeef
	Q11_12	Ik ben goed in staat om technologieën te kiezen die de lesinhoud voor de vakken waarin ik lesgeef ondersteunen
	Q11_13	Ik weet precies hoe ik technologieën kan gebruiken om concepten uit verschillende vakken op een andere manier te presenteren aan mijn leerlingen
	Q11_14	Ik ben goed in staat om technologieën te kiezen die de didactische werkvormen in mijn lessen verrijken
	Q11_15	Ik ben goed in staat om technologieën te kiezen die de leerprocessen van mijn leerlingen versterken
	Q11_16	Ik ben goed in staat om lessen te geven waarbij technologie, vakinhoud en didactiek op een goede manier zijn geïntegreerd
Anxiety	Q11_17	De moed zakt me in de schoenen als ik iets nieuws moet doen met technologie in mijn lessen
	Q11_18	Ik voel mij gespannen als ik technologie moet gebruiken in mijn lessen

	Q11_19	Ik word nerveus bij het idee dat ik met technologie in mijn lessen moet werken
Enjoyment	Q11_20	Ik voel mij gedreven om lessen te geven met technologie
	Q11_21	Ik ben enthousiast over het gebruik van technologie in mijn lessen
	Q11_22	Voor mij voelt het gebruik van technologie in mijn lessen als een positieve uitdaging
	Q11_23	Ik vind het leuk om met technologie te experimenteren in mijn lessen
Subjective norm	Q11_24	Ik heb het gevoel dat in het onderwijs op onze school technologie een belangrijke plaats heeft
	Q11_25	Ik heb het gevoel dat op onze school de visie over het inzetten van technologie in het onderwijs helder is
	Q11_26	Ik heb het gevoel dat het inzetten van technologie in de les op onze school wordt gewaardeerd
	Q11_27	Ik heb het gevoel dat mijn collega's het gebruik van technologie in het onderwijs belangrijk vinden
Context dependency	Q11_28	Voor mij is de aanwezigheid van technische ondersteuning bepalend of ik wel of geen technologie gebruik in mijn lessen
	Q11_29	Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van lesmaterialen bepalend of ik wel of geen technologie gebruik in mijn lessen
	Q11_30	Voor mij is de aanwezigheid van inhoudelijke ondersteuning in de vorm van een ICT-coördinator bepalend of ik wel of geen technologie gebruik in mijn lessen
	Q11_31	Voor mij is extra tijd doorslaggevend of ik wel of geen technologie gebruik in mijn lessen
	Q11_32	Voor mij is de beschikbaarheid van een scholingsprogramma een voorwaarde om technologie te gebruiken in mijn lessen
HOTS		
Relevance	Q19_1	Ik denk dat het voor de ontwikkeling van het denken van leerlingen essentieel is om hogere-orde denken te stimuleren
	Q19_2	Om de ontwikkeling van het denken van leerlingen te stimuleren, vind ik dat je niet vroeg genoeg kunt beginnen met het aanbieden van opdrachten waarin hogere-orde denken aan bod komt
	Q19_3	Ik denk dat het cruciaal is voor het leren van leerlingen dat zij worden aangezet tot hogere-orde denken
	Q19__4	Ik denk dat het stimuleren van hogere-orde denken zo belangrijk is, dat alle leerkrachten dit regelmatig moeten doen in hun lessen
Learners' ability	Q19__5	Ik denk dat 'slimme' leerlingen veel beter zijn in hogere-orde denken dan 'zwakke' leerlingen
	Q19__6	Ik denk dat opdrachten die hogere-orde denken vereisen veel geschikter zijn voor 'slimme' leerlingen dan voor 'zwakke' leerlingen
	Q19__7	Ik denk dat opdrachten die hogere-orde denken vereisen frustrerend zijn voor 'zwakke' leerlingen

	Q19__8	Ik denk dat 'zwakke' leerlingen opdrachten die hogere-orde denken vereisen niet aan kunnen
	Q19__9	Ik denk dat we van 'zwakke' leerlingen geen hogere-orde denken moeten verwachten
Self-efficacy	Q19__10	Ik ben goed in staat vragen te stellen aan mijn leerlingen waarmee hogere-orde denken wordt gestimuleerd
	Q19__11	Ik ben goed in staat om leerlingen te begeleiden bij het maken van opdrachten waarbij zij aangezet worden tot hogere-orde denken
	Q19__12	Ik ben goed in staat om zelf opdrachten te maken die mijn leerlingen aanzetten tot hogere-orde denken
	Q19__13	Ik beschik over genoeg vaardigheden om mijn lessen te verrijken met hogere-orde denkopdrachten

* Original instrument is developed by (Wijnen, et al. (in progress).