Concept-guided development of classroom use of ICT

Concept-specific types of ICT use and their integration into teachers' practices

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Chapter 5 Sustainability of technology integration in the classroom in a 'traditional' and an 'innovative' school[5]

Introduction

There is increasing evidence that digital technology (in this study referred to as 'technology') has the potential to improve learning processes and outcomes (cf. Archer, Savage, Sanghera-Sidhu, Wood, Gottardo, & Chen, 2014; Cheung & Slavin, 2013; Lemke, Coughlin, & Reifsneider, 2009; Lewin & McNichol, 2015; Tamim, Bernard, Borokhovski, Abrami, & Schmid, 2011). Yet for technology to have such a positive impact on learning processes it needs to be sustained over a longer period of time (Jerald, 2005). In general, a development, change or innovation in education is not considered sustainably integrated until it remains clearly visible in the school (Datnow, 2005) and is perceived as a part of the teachers' own values (McLauglin & Mitra, 2001). Sustainable change in schools also means an extension of the innovation to 'next generation improvements' and adaptation to the school's changing needs and possibilities (Jerald, 2005). This study focused the sustainability of technology integration in a 'traditional' and an 'innovative' school involved in a project in which teachers developed and implemented technology-rich learning environments in a concept-guided way and on how differences the schools might be explained.

Theoretical background

In order for innovations in education to lead to the intended effects they need to be sustained over a longer period of time (Jerald, 2005). The sustainability of technology innovations in schools has been studied from different angles. One aspect of

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sustainability of an innovation that has received attention in the literature on educational innovations is longevity, i.e. the extent to which an innovation lasts over time (Datnow, 2005). Longevity depends on, among other things, the loyalty of those involved in the innovation, especially after the support that is usually given in the implementation phase is no longer available (e.g. Han & Weiss, 2005; Wagner, Day, James, Kozma, Miller, & Unwin, 2005). Sustaining an innovation however, takes more than just maintaining it beyond the implementation phase. In order to be sustainable, a change also needs to be extended to 'next generation improvements' and, over time, to be adapted to the school's changing needs and possibilities (Jerald, 2005). This 'fine-tuning' of reform elements is needed 'to ensure that they keep working as the environment around them changes' (Jerald, 2005; p. 4).

Promoting sustainable technology integration

Innovations in education do not in and of themselves endure or become institutionalised (e.g. Fullan, 2000; Hargreaves & Fink, 2004; Owston, 2007; Vanderlinde, Aesaert, & van Braak, 2014). Central to many perspectives on sustainable change in education is the cultural character of teaching practices. Gallimore and Ermeling (2012) for instance suggest that for teaching to be sustainably changed the existing routines, settings, and activities need to be addressed, i.e. changed. From a slightly different perspective, and focusing specifically on the integration of new technologies, Zhao, Pugh, Sheldon and Byers (2002) found in their research that technology integration is promoted by a minimal distance between the intended development of the school's technology use and the school's educational culture and practice. This finding suggests that schools have a choice to either change their culture and practice to fit the intended technology-enhanced teaching and learning – as Gallimore and Ermeling (2012) suggest –, or the other way around: to adapt their plans for technology-enhancement to fit the cultural reality into which they will be implemented. Another body of research argues that technology-integration efforts need to start from pedagogical needs rather than technological possibilities (Ertmer & Ottenbreit-Leftwich, 2013; Kampylis et al., 2013; Lewin & McNichol, 2015; Mor & Mogilevsky, 2013; Kirkwood & Price, 2005; Ten

Brummelhuis & Kuiper, 2005). In line with these arguments for an alignment of technology use with the school's educational concept as cultural context we propose a concept-guided approach to the development of technology use. Central to this approach to enhancement of teaching and learning through integration of technology is that the pedagogy or educational concept of the school is taken as the point of departure in finding out what is pedagogically desirable (i.e. what type of teaching and learning is desired) in this particular school, before investigating what technology might promote this. Previous studies have shown that in schools with different educational concepts developing their technology use this way engendered different types of technology use (de Koster, Kuiper, & Volman, 2012), while the extent of integration of the developed technology use in all schools was similar (de Koster, Volman, & Kuiper, submitted). There have not been any studies however, investigating to what extent such a concept-guided approach to technology development would lead to lasting, i.e. sustainably integrated technology use in schools with different educational concepts and how possible differences between school types can be explained.

This study

The context for this study is a small-scale two-year project in which teachers at five primary schools in the Netherlands with different educational concepts developed technology-enhanced learning arrangements through a concept-guided approach. The learning arrangements were developed in line with the schools' educational concepts, thus aiming at a profitable fit between the technology use and the school's educational concept (Zhao et al., 2002, de Koster, Kuiper, & Volman, 2012). At each school a team of teachers was supported in designing and implementing up to four technology-supported learning arrangements. In this present study we investigated at two schools whether the learning arrangements that were realised proved to be sustainable after the project ended. One year after the project we went back to one 'traditional' and one 'innovative' school, in order to investigate how much of the technology use that was developed during the project was still visible in the school one year after the project ended (Research question 1). With this first research question we focus on the

dimension of the longevity of the innovations (Datnow, 2005). As the further development and fine-tuning of innovations is also suggested as a dimension of sustainability we investigated if and how the technology use was developed further during this year after the project (Research question 2). With this research question we focus on what we propose to label as the progressive dimension of sustainable technology innovation. Finally we explored: are there any differences in sustainability between the two schools and how may these be explained in relation to the schools' educational concepts? (Research question 3).

Method

Context of this study

Five primary schools participated in the project that formed the context for this longitudinal study. During the two-year project a team of teachers at each school designed, developed and realised up to four technology-enhanced learning arrangements. The teaching and learning practices at all participating schools met the quality standards of the Dutch Inspectorate of Education, as stated in the inspectorate's reports of the schools. The two schools that participated in this present study each realised four learning arrangements during this project. The learning arrangements consisted of a lesson plan, including goals, activities and technological tools, and could concern any school subject and any type of technology use. Brief descriptions of these learning arrangements can be found in the results section. The teachers were coached by educational consultants with expertise concerning various processes of educational innovation who worked for an educational consultancy organisation. Each school was coached by a different consultant. At the start of the development process the consultant would support the teachers in reflecting on their school's educational concept and on ways in which technology could be used to support this concept. Based on this reflection the teachers designed up to four technology-enhanced learning arrangements, supported by their consultant throughout the project. These consultants were instructed to prioritise the teachers' sense of ownership in designing the learning arrangements.

The researchers were not involved in the design phase of the project, in order to minimise researcher bias.

The teacher-as-designer approach was expected to further promote the implementation and integration of the designed learning arrangements by installing a sense of ownership in the teachers (Handelzalts, 2009; Ketelaar, Beijaard, den Brok, & Boshuizen, 2013; Maher, 1987). The project focused on the level of the classroom, although schools were free to involve the whole school in the innovations.

Setting

The five primary schools that participated in this project were labeled as either 'traditional' or 'innovative'. These labels only referred to the schools' views of learning and teaching in general, not to their ICT use before or during their participation in the project. At each school two or more teachers participated over a period of two school years. The grade levels of their classes varied from second to sixth grade. In this study we describe the cases of the 'traditional' school, here referred to as the Princess Amalia School, and the 'innovative' school, referred to as the Beehive School. The other schools had either left the project before it was ended or could no longer participate because of organisational changes in the meantime. Typical for the 'traditional' schools in this project was that educational goals were largely pursued through the use of teaching and learning materials with a more or less fixed content. Most instruction was given to the whole class, following a rather strict time schedule, dictated by the teaching materials and the standardised tests that were used. After instruction, pupils mostly worked individually or in pairs on assignments or exercises directly linked to the textbook content. Remedial instruction was given in smaller groups, informed by test results. In general, pupils' activities were mainly determined by the teacher.

The Beehive School was labelled 'innovative' in this project. At the 'innovative' schools the teachers typically aimed at making learning attractive and engaging for pupils by giving them control over their learning process and by inquiry learning activities. The classes were deliberately multi-aged, in order to give pupils the opportunity to learn with and from each other. Subject matter at the Beehive School was

mainly taught in the form of workshops, as a regular part of the school day. Standard teaching and learning materials were primarily used as a general source of content and exercises. Enabling pupils to choose activities that fit their dominant intelligence(s) (Gardner, 1999) was expected to make education more meaningful to students.
The learning arrangements of the traditional Princess Amalia School are referred to as A1-A4, and those of the innovative Beehive School as B1-B4.

Design, instruments and data collection

This multiple case study focused on the cases of these two schools and consisted of two measurements, one at the end of the project (M1) and one a year later (M2). The main source of data were in-depth semi-structured focus group interviews with three teachers at each of the schools, held at both measurements. The focus groups at both schools and both measurements consisted of three teachers who were actively involved in the project by participating in the development and/or realisation of the learning arrangements. In the interviews we focused on the dimensions longevity and progressive innovation that were derived from the literature on sustainability of technology use. The topics in the interview protocol therefore included:

a) The technology use that had been developed during the project
b) Its longevity (is it still visible in the school)
c) Its progressiveness (has it been further developed; e.g. fine-tuned or 'next generation improvements').

Table 1 shows which learning arrangements the teachers in the interviews had been most actively involved in and which grades they were teaching at the time of M1 and M2. The teachers who had carried out the first learning arrangements (A1 and B1) had both left the project before the end of the project and did therefore not participate in the focus group interviews.

Table 1. Composition of focus groups per school: learning arrangement(s) and grades per teacher

	Princess Amalia School		Beehive School	
	Learning arrangement	Grade(s)	Learning arrangement	Grade(s)
Teacher 1	A2 + A4	3 + 4	B2 + B3	5 + 6
Teacher 2	A3	6	B4	1 + 2
Teacher 3	A3	4 + 5	B3	3 + 4

The teachers' accounts in the focus group interviews were checked against descriptive data concerning the use of technology in the learning arrangements throughout the project, collected through individual interviews with teachers, videotaped whole-lesson classroom observations and registration of technology use by teachers and pupils (logs, registration forms). These data were focused on what technology was used, how it was used and with which goals. The learning arrangements are described briefly in Table 2 and 3. They have been analysed and described more elaborately in our previous studies (de Koster, Kuiper, & Volman, 2012; de Koster, Volman, & Kuiper, 2013).

Analysis

The focus group interviews were transcribed and subjected to content analysis (Huberman & Miles, 1994). We analysed all fragments from both measurements that concerned the topics mentioned above, using the labels 'longevity' and 'progressive integration'. The label 'longevity' was assigned to fragments that indicated that a technology use was still visible (Research question 1). The construct of longevity was made more specific by analyzing whether all the central elements of the technology use in each learning arrangement were still visible, i.e. whether the same tools were still used and in the same way, aiming at the same goals as initially intended. Information on tools and their initial use and goals was derived from the descriptions of the learning arrangements and in particular the teachers' intentions and expectations of the learning arrangements described therein (de Koster, Kuiper, & Volman, 2012). The label 'progressive integration' was used to answer Research question 2: if and how the

technology use that was still visible a year after the project was developed further during the year after the project ended. Fragments that indicated that the technology use in the learning arrangements had been developed further in order to improve it in any way were labelled as 'progressive integration' (M2). In order to find differences between the schools with regard to the sustainability of their technology use we compared the found sustainability in terms of longevity and progressiveness. Next we used grounded theory (Glaser & Strauss, 1999) to analyse the focus group interviews again in order to explore possible explanations of the differences that were found (Research question 3).

Results

The results for the 'traditional' school are discussed first, followed by the results for the 'innovative' school. In each section we first give a brief characterisation of the technology-rich learning arrangements that were developed and realised at this school during the project and then compare (within-case) what was still in use by the end of the project (M1) with what was still in use a year after the project ended (M2) (research question 1) and discuss whether or not the developed technology use showed any further development (research question 2). Finally we compare the findings of the two schools and look at possible explanations for any differences found.

Sustainable integration of technology use at the 'traditional' school

During the course of the project four relatively simple learning arrangements with one or two tools per arrangement were realised at the Princess Amalia School. Table 2 gives a brief description of the technology use as designed and realised during the project, including the goals they aimed at, and what was still in use by the end of the project and one year later (longevity).

Table 2. Longevity of technology use at the Princess Amalia School. M1 and M2 compared

Code	*As designed and initially realized*	*Goals*	*Still in use by end of project (M1)*	*Still in use a year later (M2)*
A1	Individual exercises and tests with mathematics exercise and test software, on desktop computers in the classroom; grade 5 and 6	Make exercises more engaging, resulting in higher grades. Facilitate more independent work by pupils and differentiation by teacher.	Exercises are still used, tests have been abandoned	Software has been abandoned completely
A2	Interactive classroom instruction on writing and spelling on IWB; some pupils are asked to do an exercise designed by the teacher on the IWB; grade 3	More active engagement and motivation of pupils during instruction, resulting in higher grades.	The interactive use of IWB in writing and spelling instruction is limited	The interactive use of IWB in writing and spelling instruction is very limited.
A3	Individual exercises and tests with reading comprehension exercise and test software on laptop and desktop computers in the classroom; grade 6	Make exercises more engaging, resulting in higher grades, in particular for lower achieving pupils. Digital tests save teachers' time.	Exercises and tests are still used	Exercises and tests are still used

A4	Assignments (on cards) in social studies, involving web searching, processing and presenting information, in pairs; grade 3	Pupils develop web skills: searching, reading search results, comprehending information. Pupils memorize the information found on the web. Pupils learn from each other.	Focus on developing web skills persists	Focus on developing web skills persists and has spread to higher grades

Note: IWB = interactive whiteboard

Longevity at the 'traditional' school

The use of the math practice software in arrangement A1 was still visible at the end of the second project year, but was abandoned after the project. It had not met the teachers' expectations and had not been replaced by other software.

M2 T2: [The software] we eventually didn't buy because it just didn't add enough value. […]
T1: In [the software] the tests just didn't work properly, not like we had hoped.
T3: And also the extra enrichment… that did not add so much either. […]

The use of the interactive whiteboard (IWB) to support language instruction lessons (A2) continued, yet the interactive features that had formed the core of the initial learning arrangement had been abandoned. In the language lessons only scanned exercises from the workbook were still being used.

M2 T1: I don't do those things with the [IWB] software anymore. What I did then, scanning a language lesson, typing phrases and making parts disappear… […] this in green and that in red, having the children come up to the board…

T2: You still use it, but not…

T1 … you know, things that made them think: 'wow, I didn't know that was possible!' It's still possible, I just don't do it anymore.

The teachers mentioned time constraints as the main reason for this.

M2 T2: […] we had as a goal to make a few lessons together. So that I would know too, because [T1] knows it, that I would know too what's possible and how to do it.

T1: But still, if you would know it now, do you have time to make lessons? I wouldn't know when. At night, right? That's the only moment…

The teachers also claimed that no extra time was created for helping other teachers develop an interactive use of the board.

M2 T2: […] we had set our personal goals on: we're at least going to make sure we have prepared a few lessons, so that I also know…, and then we can also show these lessons to the others […] So then you share your knowledge and then the other teachers can move on from there. But the time isn't created for it, so it sort of stands still.

In the M1 interview the teachers mentioned plans to eventually reinstate the interactive use of the IWB, for instance by designing some interactive lessons together. This had not yet been realised a year later and no concrete plans were mentioned to change this. The use of the reading software (A3) was continued as intended, since it functioned well and was appreciated by both teachers and students. The school had invested in continuing the licence for the software and it was used in the same way as during the project. The focus on using the internet for school projects (A4) had continued and had spread to all upper grades. The teachers reported that now in all upper grades more attention was paid to the development of students' information skills.

M2 T1: You know what we did then with searching, with Google and all… Well, that‘s been discussed […] with all grades. That they have to learn the searching especially. And now we start with that in grade 3. I had grade 3 back then, but now up to grade 6…

Most of the laptops that were used in this learning arrangement started to fail shortly after the project ended and had been replaced by fixed computer work stations in the school's corridors. At M2 these computers were mainly being used for doing exercises and for science projects, similar to what the laptops had been used for during the project.

In summary, one out of four learning arrangements at the Princess Amalia School (A3) was still used as it had been designed and could therefore be considered sustainable in terms of longevity one year after the project ended. The IWB was partly still being used in language lessons (A2) but this use had been downgraded to a much less interactive form. The interactive features of the IWB had not been replaced with another tool or application. In one arrangement (A4) the main tool (laptops) had to an extent been replaced with another tool (desktop computers) and had spread to higher grades. Arrangements A2 and A3 could therefore be seen as partially sustainable in terms of longevity. One arrangement had been abandoned completely (A1) and was therefore seen as not sustainable.

Progressive integration at the 'traditional' school

By the end of the project the teachers at the Princess Amalia School expressed the wish to continue with what they had developed and that all classrooms would get an IWB and more laptop computers. They expressed mixed expectations, however, about the further development of technology use and did not mention any specific plans when asked how they were going to continue after the project ended.

M1 T1: I don't think there will be a lot of change anymore. The way we were teaching today, that's what it looks like every day.

T3: I think eventually it will become even more. I mean, we all get more experienced at it. […]

T1: Eventually you'll have a database of information on your computer that will never go away. Many more classes will have it.

T3: So I think it will only be more comprehensive and that it will be more self-evident that we [work with technology].

The teachers' remarks during the M2 interview however indicate that no new technology-supported learning arrangements were developed after the project and apart from the spreading of A2 and A4 the learning arrangements from the project had not been further developed. Teacher 1 remarked that everything they had been missing before the project had now been realised and further development was not needed.

M2 T3: We haven't started anything new really, after the project. In terms of technology.

T1: Because it's all working. What we've done. That was what we could develop further and now it's all done, that's what I feel.

The teachers were satisfied with what they had developed. Teacher 1 suggested that it would be best to first optimise what they were doing before developing anything new. Sustainability in terms of progressive integration was therefore not found and did not appear to be on the teachers' or the school's agenda.

Sustainable integration of technology use at the 'innovative' school

At the 'innovative' Beehive School we found four quite complex technology-supported learning arrangements, encompassing a great variety of tools. Table 3 gives a brief description of the technology use as designed and realised during the project, along with what was still in use by the end of the project and one year later (longevity).

Table 3. Longevity of technology use at the Beehive School. M1 and M2 compared.

Code	*As designed and initially realized*	*Goals*	*Still in use by end of project (M1)*	*Still in use a year later (M2)*
B1	Pupils use digital cameras to make pictures and video clips around a theme, make presentations with their pictures, their video clips and information from the web, and give presentations on the IWB; grades 2 through 4	The use of self-made digital images makes the theme 'friendship' meaningful and engaging to pupils and facilitates the realization of the intended learning results.	Use of digital cameras and student presentations on IWB is continued in a different context	Use of digital cameras and student presentations on IWB is continued in a different context
B2	Pairs of pupils perform a chemical experiment and record and edit a video of the experiment, and show videos on the IWB to the class; grades 4 through 6	Making a video of their own experiment enables pupils to co-construct and share knowledge. Make learning more engaging.	Making video clips has continued	Making video clips has continued in a different context
B3	Pupils (individual, pairs, small groups) practise multiplication tables through non-digital games, available in a database on school's digital network; teacher makes an instruction film for a game with grade 6 pupils;	Practising multiplication tables independently. Being able to choose games according to intelligence improves meaningfulness to pupils.	Use of database has been suspended	Use of database is still suspended.

	grades 3 through 6			
B4	Pupils (pairs, small groups) photograph groups of objects with digital photo cameras. Teacher prints photographs and pupils use photographs to make multiplication booklets; grade 2	Taking photos of groups of objects and using the photos enables pupils to grasp the basic principles of multiplication tables.	Use of digital cameras for making multiplication booklets has continued	Use of digital cameras for making multiplication booklets has continued

Longevity at the 'innovative' school

During the year after the project ended learning arrangements B1 and B2 had continued, yet in a slightly different context. This will be described further in the next sub section as examples of progressive integration. The teachers indicated at M1 that their appreciation and use of the IWB, which had played a pivotal role in presenting and discussing student products in B1 and B2, had gradually decreased. Although they did not abandon its use altogether they realised that they spent more time doing small group work with the laptop computers than whole-class instruction with the IWB.

M1 T1: For me that's not the first thing that I would miss if it wasn't there. I think it's very useful, I do see its added value, but actually I find the laptops far more important than the IWB.

This continued after the project ended. At M2 Teacher 2 indicated that the presenting function of the IWB had been partially taken over by the laptops. Arrangement B3 had been suspended by the end of the project and had still not yet been realised at M2. The arrangement had been designed to be used in an electronic learning environment (ELE)

that had not been realised yet. At M2 the teachers still expressed the wish to continue with it when the ELE was realised.

M2 T3: [the school board] are involved in this project of… […] about that ELE.
T1: Yeah. [the school's technology supporter] is involved in it, right? It's another pilot that we're participating in. […] So such a database is still… some things are still unpractical at the moment.

Arrangement B4 was still used as it had been designed and realised during the project.

In summary, one out of four learning arrangements at the Beehive School was still used as it had been designed (B4) and was therefore considered sustainable in terms of longevity. Two arrangements had continued in a different context and with a shift from presenting student products on the IWB to presenting on the laptops (B1 and B2). These were therefore considered partially sustained. One arrangement (B3) had been suspended by the end of the project because the ELE for which it had been designed had not yet been realised. This had not changed a year later. Therefore the longevity of this learning arrangement could not be assessed as either sustained, partially sustained or abandoned.

Progressive integration at the 'innovative' school'

Arrangements B1 and B2 continued in the context of new projects. Students continued to make movie clips. They presented these videos on the IWB and on laptops but also incorporated these clips for instance into a self-designed website.

M2 T1: I organised a pop concert with my pupils last year. And all pupils made a video clip and a song on the computer. And made a photo-shoot and made invitations through some website and a website for their own band. […] What I did back then [the chemical experiments, B2], I continued with our pop concert. Back then the basic idea was that pupils could watch each other's

clips, and also learn to work with Moviemaker, making their own clips. And now I organised it differently and it was more successful. Because now I knew what could go wrong. I'm also a lot less apprehensive about making clips with them, because I just know: we can do it.

The teacher's remark that she 'organised it differently and it was more successful' points at her effort to fine-tune this technology use to make it fit even more with her learning goals, part of the dimension of progressive integration. Another example of progressive integration is seen with regard to arrangement B3. Although it was still suspended at M2, the teachers reported it had led to a spin-off:

M2 T3: Triggered by the instruction film that [T1] made [for one of the exercises in the database] I went a step further last year. Back then she had made it herself with the pupils. I made another instruction film of a different activity. I had the pupils do it all themselves. So I had the pupils write the script, construct a kind of game, film it and edit it as well. So that was basically a sequel to that first film.

The teacher's remark that she 'went a step further' indicates an example of 'next generation improvements', another aspect of progressiveness. So to summarise we found two examples of progressive integration of the developed technology use at this school.

Differences and possible explanations

Differences in sustainability in terms of longevity

The findings with regard to sustainability in terms of longevity of the technology-enhanced learning arrangements and the use of laptops and IWBs presented in 3.1 and 3.2 are summarised in Table 4 in order to make a comparison between the schools.

Table 4. Sustainability in terms of longevity per learning arrangement / tool per school

Princess Amalia School	*Sustained*	*Partially sustained*	*Suspended*	*Abandoned*
A1	-	-	-	X
A2	-	X	-	-
A3	X	-	-	-
A4	-	X	-	-
Beehive School				
B1	-	X	-	-
B2	-	X	-	-
B3	-	-	X	-
B4	X	-	-	-

Table 4 shows that the learning arrangements at the Princess Amalia School were either sustained as designed (one arrangement), partially sustained (two arrangements) or abandoned (one arrangement). Noticeably in one arrangement at the Princess Amalia School that was partially sustained the element that was abandoned was not replaced (interactive use of the IWB in A2), while in another arrangement it was replaced by other technology use (desktop computers to an extent replaced the use of the IWB in A4). At the Beehive School the learning arrangements were either sustained (one instance), partially sustained (two instances) or suspended (one instance). The technology use that was only partially sustained in two arrangements was to an extent replaced with other technology use (the use of laptops to an extent replaced the use of the IWB in B1 and B2). This shows that although at both schools only one arrangement had been sustained as designed and two had been partially sustained the developed technology use seemed the least sustainable in terms of longevity at the Princess Amalia School. Here one of the arrangements had been abandoned completely and in one of the partially sustained arrangements the abandoned element had not been replaced by other technology use while at the Beehive School no arrangements or elements of arrangements had been abandoned without being replaced by other technology use.

Differences in sustainability in terms of progressive integration

Across both schools the sustainability in terms of progressive integration could be described as either progressive (improvements had been made to better serve the intended purpose, e.g. students making videos in different contexts at the Beehive School), static (the technology use was continued as it had been designed) or regressive (the technology use had regressed to a form that seemed to have lost some of its intended purpose, e.g. the less interactive use of the IWB in arrangement A2 at the Princess Amalia School). We use these terms to make a comparison between the schools. The findings with regard to sustainability of the technology use in the learning arrangements in terms of progressive integration presented in 3.1 and 3.2 are summarised in Table 5.

Table 5. Sustainability in terms of progressive integration per learning arrangement per school

Princess Amalia School	*Progressive*	*Static*	*Regressive*
A1	-	-	-
A2	-	-	X
A3	-	X	-
A4	-	X	-
Beehive School			
B1	X	-	-
B2	X	-	-
B3*	(X)	-	-
B4	-	X	-

*although this arrangement was suspended it did lead to a 'next generation' spin-off

This table clearly shows a difference between the two schools. The technology use in the learning arrangements at the Princess Amalia School tended to be either static or even regressive. No examples of progressive integration were found at this school. At the Beehive School we saw two examples of progressive integration and, although it

had been suspended, even arrangement B3 had led to a 'next generation' spin-off. Although the use of the IWB in two learning arrangements had become less intensive these arrangements were labeled as progressive rather than regressive because its use had been replaced by another tool and the use of making videos by students had been developed further. One arrangement had remained unaltered. In summary the technology use at the Beehive School appeared more sustainable in terms of progressive integration than at the Princess Amalia School where not progressive integration was found.

A possible explanation for differences in sustainability

The main picture that emerges from these findings is that the technology use in the learning arrangements at the 'innovative' Beehive School was somewhat more sustainable in terms of both longevity and progressive integration than at the 'traditional' Princess Amalia School. Possible explanations for these differences were found in the teachers' remarks about further development of their technology use. When discussing how the learning arrangement that had been suspended because the ELE had not been realised yet the teachers' remarks showed a more general ambition at the Beehive School to develop their technology use further.

M2 T2: Now it's all on the network. And when we have [the ELE], then it's just...
T1: Then it's supposed to be a lot easier. Because we want to do a lot more with it than we can do now.
T2: Right. The technological developments are holding us back. Because we're stuck with our network.

This contrasts with the Princess Amalia School where the teachers were satisfied to continue with what they had developed, as mentioned in 3.1. One of the teachers at the Beehive School summarised the continuing development of their technology use as follows.

M2 T1: For us it didn't stop after [the project]. We just continued and still ask ourselves: […] what else can we do with technology in the school?

As examples of developments the teachers at the Beehive School mentioned the school's participation in other technology-related projects, for instance a one-laptop-per-child experiment, and the enrollment of one of the teachers in a worldwide networking programme for innovative teachers. The continuing development of their technology use played an important part in their aspiration to further develop towards an even more student-directed pedagogy by providing students with more opportunities to practice at home and by deepening students' independent learning.

M2 T3: To deepen. So that children can do things even more independently. So that the teacher steps even further away from the IWB, in a way. And coaches more, I think.
T2: Yeah, tailor-made learning, right?
T3: Exactly.
T1: Plus, I still feel that you can't really not keep developing this further. Because this is something we just… This is our society.

Conclusion

In this double longitudinal case study we explored if and how newly developed technology use became sustainably integrated in the classroom practices of a 'traditional' and an 'innovative' primary school one year beyond their participation in an innovation project and how possible differences in sustainability might be explained. The schools were among five schools that participated in a two-year project in which teachers developed their technology use in a concept-guided way. This meant developing technology use that might support and enhance teaching and learning in a way that fitted the school's education concept. Based on focus group interviews with the teachers involved and analysis of the learning arrangements developed in the two schools, sustainability was measured by investigating whether or not the developed

technology use was still visible in the schools' classroom practices one year after the project ended (sustainability in terms of longevity) and if and how the technology use was developed further in the course of this year (sustainability in terms of progressive integration). After analyzing the sustainability at each school separately we zoomed in on differences and their possible explanations.

Sustainability in terms of longevity and progressive integration: differences and possible explanations

Both in terms of longevity and progressive integration the technology use in the learning arrangements at the 'innovative' Beehive School was more sustainable than at the 'traditional' Princess Amalia School. At the 'traditional' school one of the arrangements had been abandoned completely and in one of the partially sustained arrangements the abandoned element had not been replaced by other technology use. At the 'innovative' school one arrangement was suspended and no arrangements or elements of arrangements had been abandoned without being replaced by other technology use serving the same purpose. At both schools only one learning arrangement was sustained as it had been designed. In analyzing the progressiveness of the integration we distinguished between progressive (improvements had been made to better serve the intended purpose), static (the technology use was continued as it had been designed) and regressive integration (the technology use had regressed to a form that seemed to have lost some of its intended purpose). The technology use in the learning arrangements at the 'traditional' school tended to be either static or regressive. No examples of progressive integration were found at this school. At the 'innovative' school two learning arrangements showed progressive integration and the arrangement that had been suspended had led to a 'next generation' spin-off.

A difference between the schools in the teachers' general attitude to further developing the school's technology use is suggested to account for the differences that were found in the sustainability. At the Princess Amalia School the teachers expressed a general satisfaction with what had been accomplished by participating in the project and no specific plans for future development of their technology use were mentioned. At the

Beehive School on the other hand the further development of the technology use that had been developed during the project seemed to be a part of a more general tendency to constantly look for new ways to enhance their teaching and to encorporate technology in this development.

Discussion

We conclude that, based on the teachers' statements in the interviews, the main difference between the schools is found in the teachers' (and possibly the schools') attitude towards technological innovation. For this attitude Van Braak (2001) uses the term 'technological innovativeness', defining it as a positive attitude towards the need to introduce technology and a willingness to realise this introduction of technology in the classroom. This technological innovativeness could of course be expected to be part of the culture of a school that was labelled as 'innovative' on entering this project. Yet it could have been expected from the 'traditional' schools as well, since this school too joined the project with the intention to further its technology use. At the 'traditional' school, however, we found an innovativeness that seemed much more limited, as the teachers' ambitions explicitly focused on optimizing their current technology-enhanced practices rather than on taking their technology use a step further or developing new technology-enhanced learning arrangements.

The lower sustainability at the 'traditional' school might also be attributed to the type of technology use that was developed at this school. What this technology use adds to the teachers' practices seems less essential than at the 'innovative' school.

The regression of technology use that was found at the 'traditional' school, i.e. lessons with the IWB becoming less interactive, could be described as a 'lethal mutation', as described by Brown and Campione (1996). On the other hand this mutation could also be seen as their IWB use becoming more 'traditional' and therefore becoming better suited to the teaching and learning at this school. The teachers' apparent ambivalence regarding the loss of this interactivity, expressing the wish to make the lessons more interactive again yet apparently not 'going the extra mile' to achieve this goal, may show that the intensification of their technology use presented them with a dilemma

between staying true to their school's 'traditional' pedagogical principles and the more 'innovative' affordances of the tool.

We did on the other hand see one 'progressive' development at this school, namely the spreading of some arrangements to other grades. This can be seen either as an aspect of progressive integration (spreading within the school as development of technology use in a quantitative sense) or as a dimension of sustainable technology integration in its own right, as an indication that the technology is becoming more integrated in the school as a whole (Coburn, 2003).

This reflection leads us to add the following to our conclusions about the sustainability of the technology use at these two schools. In terms of progressiveness the 'innovative' school appeared to be focused more on further developing their technology use, which seemed to be part of a larger aim to further develop their teaching and learning practices. At the 'traditional' school the teachers appeared to focus instead on staying close to their tried-and-tested teaching methods rather than on development.

Limitations and further research

With only one school of each school type in this study and a strong reliance on the teachers' accounts of their technology use we can of course only draw very tentative conclusions. It does seem worthwhile to further investigate the possible relationship between school educational concept and technological innovativeness as a basis for better understanding and supporting the sustainable integration of technology in schools with different educational concepts. Also, as the real challenge of sustaining an innovation starts after the support of the innovation project has been withdrawn, these schools should be followed beyond the first year after participation in such a project.

Another limitation of the study was that the analysis of the technology use one year after the project was based solely on the teachers' accounts in the focus group interviews. For future research on the further development of technology use we recommend to use direct measurement of the technology use and to also include more aspects of the school context in the investigation.

Reflecting on our findings we propose to expand the existing models for investigating sustainability of technology use in the classroom. With regard to the aspect of 'longevity' a question that needs to be addressed is whether an innovation that has been abandoned is replaced by something else to support the initial goal of the innovation. With regard to 'progressiveness' we need to investigate whether the innovation is further developed, including fine-tuning and/or next generation improvements, or remains at it is (in this study labeled as static sustainability) or even regresses. The spreading or institutionalisation of technology use within the school could be studied either as another aspect of progressive integration or as an aspect of sustainability in its own right.

With regard to the 'traditional' school in this study it would be worthwhile to investigate whether its technology use stays static over a longer period of time or if there is eventually some further development. Apart from the apparently more limited innovativeness at this school and the seemingly less profound contribution of the type of technology use that it developed there is another factor that may hinder progressive development of technology use in this type of school. There is limited room for curriculum development by teachers in a strongly textbook-driven curriculum, as some remarks of the teachers at the 'traditional' school indicated. In such a pre-structured curriculum there is little time for the teachers to take on the enterprise of continued development of a learning arrangement and of the professional development that is needed to do this. Further studies in this type of school will need to pay attention to all of these concept-specific issues, as well as to the extent to which the integrated technology use actually helps to improve these practices, as this is essentially the goal of innovation.

Despite the limitations of this study these findings raise some poignant questions that need to be addressed in further research in order to 'fine-tune' our understanding of and ability to support the sustainability of technology integration in relation to different educational concepts.