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 2 Concept-guided development of ICT use in 'traditional' and 'innovative' primary schools: what types of ICT use do schools develop?[2]

Introduction

ICT is by many believed to be capable of making a significant, if not indispensable, contribution to education. Among other things the integration of ICT into school practice is expected – and in some studies also found – to lead to more engaging learning activities (Bransford, Brown, & Cocking, 2003; Deany, Ruthven, & Hennessy, 2005; Balanskat, Blamire, & Kefala, 2006) and to more effective education (Kulik, 2003; Webb & Cox, 2004; Li & Ma, 2010). However, in order to be effective ICT needs to be successfully integrated into classroom practice. Researchers find that many ICT innovation projects fail to establish the fully integrated use of ICT which these projects are aimed at, and therefore also fail to realise the expected effects on learning (Smeets, 2005; Ten Brummelhuis, 2006; Voogt, 2008). Most authors find explaining factors for this problematic integration on the level of the school and/or the teacher (e.g. Hew & Brush, 2007; Ertmer, 2005; Tondeur, Cooper, & Newhouse, 2010; Tondeur, van Braak, & Valcke, 2010; Voogt, Almekinders, van den Akker, & Moonen, 2005; Inan & Lowther, 2010). A range of school and teacher characteristics are mentioned as factors in technology integration, from school ICT policy and school leaders to teachers' knowledge of and attitudes towards technology.

Another type of factor influencing the integration of teaching and learning technology is found in the distance between the ICT innovation on the one hand and the school's culture and the innovator's (i.e. teacher's) current practice on the other hand; the shorter

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this distance is, the better chances for successful ICT integration are (Zhao, Pugh, Sheldon, & Byers, 2002). This is consistent with findings indicating that how and with what learning effects ICT resources are used depends on how well they fit in with the established patterns of activity, as ICT resources are always introduced into a pre-existing framework of educational and social activity (Tolmie, 2001). Similarly Niederhauser and Stoddart (2001) find that teachers are inclined to apply technology in a manner that is consistent with their personal perspectives about curriculum and instructional practice. In other words, innovations concerning ICT have a higher chance of succeeding if they start from educational 'desirabilities' (Salomon & Perkins, 1996) rather than from technological possibilities and novelties ('technological push', Ten Brummelhuis & Kuiper, 2008). In this line of reasoning types of ICT use that fit or stay close to the school's educational concept may be more likely to be effective in terms of their contribution to pupils' learning processes and outcomes (Kulik, 2003; Webb & Cox, 2004; Ten Brummelhuis, 2006).

These findings suggest that one of the keys to the successful integration of ICT into educational practices lies in ensuring a good fit between the ICT innovation and the educational concepts underpinning these practices. In other words: the apparent relationship between a school's educational concept and the way ICT is used in its classrooms should be considered when aiming at developing meaningful, effective use of ICT. Research has shown that ICT in general can support a variety of educational concepts (Niederhauser & Stoddart, 2001; Inan, Lowther, Ross, & Strahl, 2010; Higgins & Spitulnik, 2008). ICT-supported learning can for instance be either individual or collaborative and either learner-directed or teacher-directed (Ten Brummelhuis & Kuiper, 2008) and can facilitate the individualisation of learning processes as well as support learning within a learning community (Volman, 2005). So both educational practices with a traditional and an innovative educational concept can be supported by educational technology. The same versatility can be found at the level of particular ICT applications as well. Recent studies on the use of games, for instance, show that games can lead to pupils being more motivated and involved, both in schools where pupils

develop knowledge in an active and exploratory way and in schools which focus on knowledge transmission (Sandford, Ulicsak, Facer, & Rudd, 2007).

To our knowledge no attempts have been made so far to describe what types of ICT use result when the ICT use is developed in a concept-guided way, i.e. so that it fits the educational concept underpinning the practice that is to be supported. Therefore, in this study we characterise the types of ICT use resulting from such a concept-guided approach to ICT innovation. This article presents a descriptive multiple-case study of a project of concept-guided development of ICT. In this project teachers at five schools, with support from experienced advisors, designed and implemented ICT-rich learning arrangements in line with their school's educational concept. We explore what types of ICT use this approach leads to. The main research question of this study is:

> *To what extent does concept-guided development of ICT-enhanced learning arrangements in primary schools lead to distinguishable types of ICT use?*

In order to answer this question we first need to explore how the different uses of ICT that result from concept-guided development of ICT use can be characterised.

Method

Participants and setting

Five primary schools, across the Netherlands, were selected to participate in the project that formed the context of this study. The schools were selected from the database of the organisation that supported the schools in designing and integrating ICT-enhanced learning arrangements during this project. Schools in this database typically have a relatively high level of ICT use. Participating schools had to be willing and able to invest a considerable amount of time in the project as the teachers would be actively involved in the process of further enhancing the school's use of ICT.

Two distinguishable types of schools were selected for this project, based on differences in educational concept. The schools were labelled as either 'traditional' or 'innovative'.

The traditional label refers to a fixed curriculum in which standard teaching and learning materials are used, and learning content and activities are directed by the teacher and the materials. 'Innovative' indicates a more open curriculum with a focus on self-regulated learning in which pupils have more input in learning content and activities, and teachers often take on a role as coach.

The two 'traditional' schools and three 'innovative' schools that participated in this project were studied. At each school one or more classes participated. Classes in Dutch primary schools can be homogeneous (one grade per class) or heterogeneous (multi-aged; two or more grade levels per class). The classes involved in the study consisted of 12 to 28 pupils. It was up to the schools to decide which classes would participate in the project.

Procedure

In the course of two school years (2007-2008 and 2008-2009) each school was followed closely in the process of designing and realizing four ICT-enhanced learning arrangements that were to be integrated into their educational practice. A total of seventeen learning arrangements was realised in the course of the project. An overview of the participating schools and the learning arrangements that were developed is shown in Table 1.

Table 1. Overview of participating schools and classes.

School name	*Grades involved in learning arrangements 1 to 4*			
	1	*2*	*3*	*4*
Princess Amalia	5/6	3	6	3
Alma Mater	1/2	2	6	K (age 4-5 yrs)
The Beehive	2/3/4	5/6	3/4 + 5/6	2
Queen Beatrix	4/5/6 (2 classes)	4/5/6	4/5/6 (2 classes)	-
Beech Grove	2/3/4 (4 classes)	2/3/4 (2 classes)	-	-

Note: all the learning arrangements were studied in one class (with one teacher and one or more grades), unless stated otherwise.

The schools developed these learning arrangements in a 'concept-guided' way. A team of teachers at each school was supported in designing and implementing learning arrangements in line with their school's educational concept (teacher-as-designer; e.g. Maher, 1987). Teachers were supported during the project by educational advisors specialised in guiding innovation projects. During the design phase these advisors helped the teachers reflect on their school's educational concept and its ambitions for intensifying its use of ICT in line with this concept. This way we expected the schools' educational concept to be reflected in the resulting learning arrangements. The teacher-as-designer approach was expected to install a sense of ownership in the teachers, which would favourably affect the implementation of the designed learning arrangements (Handelzalts, 2009).

The teachers designed up to four ICT-enhanced learning arrangements and explored which ICT tools – both hardware and software – could support these arrangements in line with their school's ambitions. A learning arrangement would consist of a lesson plan, materials, and goals, and could concern any school subject. For instance, a learning arrangement could be: the use of an interactive whiteboard to show pictures from the internet as visual enhancement of mathematics instruction, aimed at increasing pupils' learning motivation. No specific limitations were set with regard to the ICT tools that were to be used, the duration of the learning arrangement or the type or frequency of ICT-supported activities. The schools were supplied with the necessary ICT tools.

Instruments and data collection

In this descriptive multiple-case study (Stake, 1994; Yin, 2008), each school represented one case, while the learning arrangements were studied as sub cases. A wide range of qualitative methods of data collection was used to provide rich data for descriptions of each learning arrangement.

During the design phase of each learning arrangement the researchers asked the teachers involved to explicitly state their intentions and expectations with regard to the learning arrangement and the ICT tools that were used in it. These so called 'working hypotheses' were used as a source of data. During the implementation phase the main sources of data in most learning arrangements consisted of lesson observations and teacher interviews. The other research instruments that were used included pupil interviews, learner reports, teacher diaries, pupil diaries, and document analysis (e.g. of teachers' planning documents or software manuals). Because of the great variety of learning arrangements, the research instruments that were used and the frequency with which they were used varied from sub case to sub case, depending on the specific nature of the arrangement (e.g. number of classes involved, pupils' age, duration of the arrangement, individual or group activities, stationary or mobile activities).

In order to analyse the extent to which distinguishable types of ICT use were developed, the ICT use was operationalised in terms of:

a. ICT tools available to and used by teachers and/or pupils
b. Goals with which these tools were (meant to be) used
c. Activities performed with these tools (by whom and how the tools were used)

The descriptions with regard to the ICT tools that were available and/or used and the activities in which they were used were based on teacher interviews and lesson observations; in some cases this information was also derived from pupil interviews, pupil and teacher diaries and/or documents like a manual for the software that was used in the learning arrangement.

The goals with which the ICT tools were meant to be used were deduced from the teachers' intentions and expectations explicated in the working hypotheses during the design phase. Teacher interviews during the implementation of each learning arrangement allowed us to gain more insight into the goals as initially formulated by the teachers.

Two teams of researchers collected the data. One team investigated two schools, the other team investigated three schools. Both teams reported to each other regularly on

decisions relating to each sub case study, thus clarifying the procedure they followed. This enabled us to audit the research procedures of the separate (sub) case studies (Halpern, 1983).

Data analysis

The data of each sub case study were first processed and interpreted by the research team investigating the sub case. The various types of data collected were used for triangulation to establish a rich and comprehensive description of the different learning arrangements and the use of ICT within the arrangements. Member checking with the teams of teachers involved was used to verify – and if necessary correct – these initial analyses. In a second round of analysis these verified descriptions of the learning arrangements were used to analyse the types of ICT use that were realised as part of the arrangements, using content analysis (Huberman & Miles, 1994). For this purpose a matrix was constructed combining the school concepts with the variables of ICT use that were mentioned in the previous paragraph, i.e: the ICT tools that were available and used, the goals with which they were used, and the activities in which they were used. After thus analyzing the ICT use per sub case, a cross case analysis per school type enabled us to find patterns in the ICT use related to the school types.

Results

For each school type we first give a short description of the participating schools and their educational concepts. Then, we describe the ICT use that was designed and realised in the schools during the project. In Tables 2 and 3 we give some examples for each school type of the ICT use in terms of the tools that were used, with which goals, and in what kinds of activities. We further characterise patterns in ICT use that were found across the learning arrangements in each school type.

Results: schools with a traditional approach to the curriculum

The 'traditional' schools and their educational concepts

The Princess Amalia Primary School (also referred to as school A1) is a growing school in a new suburban neighbourhood. The Alma Mater Primary School (school A2) is a relatively small school in a rural town.

In both schools educational goals are largely pursued through the use of teaching and learning materials with a more or less fixed content. Learning gains are monitored with tests designed for these materials as well as national, standardised tests. Most instruction is given to the whole class, following a more or less strict time schedule, dictated by the teaching materials and the tests that are used. After instruction, pupils mostly work individually or in pairs on assignments (exercises) directly linked to the subject matter. Additionally, remedial instruction is given in smaller groups, informed by test results. Pupils' activities are mainly determined by the teacher. Sometimes pupils are free to choose who they want to work with. At the Princess Amalia School pupils do much of their work independently, following an individual weekly work plan. This work plan is made by the teacher, yet the pupil is to a large extent free to decide when to work on which assignment. At the Alma Mater School the teacher gives daily assignments to the whole class. Here the teacher determines when the pupils work on which assignment.

ICT use at the 'traditional' schools

Both schools designed and realised four learning arrangements in the course of the two-year project, so that a total of eight different learning arrangements could be studied at the 'traditional schools'. At both schools all learning arrangements were studied in one class per arrangement. All primary grades, from kindergarten to grade 6, were represented in the arrangements studied. Table 2 contains some examples of the ICT tools, the goals and the activities of the learning arrangements at these schools.

Table 2. Examples of learning arrangements at the 'traditional' schools.

	ICT tools	Working hypotheses	Activities
A1-3	Exercise and testing software for reading comprehension Laptop and desktop computers in classroom	Make exercises more engaging, resulting in higher grades, in particular for lower achieving pupils. Digital tests save teachers' time.	Individual exercises + tests. Exercises: 15–20 min, twice every 5 weeks, according to workplan. Tests: once every 5 weeks. Grade 6.
A1-4	Internet Word processing software Presentation software Laptop and desktop computers in classroom	Pupils develop web skills: searching, reading search results, and comprehending information. Pupils memorise the information found on the internet. Pupils learn from each other	Assignments (on cards) in world orientation: web searching, and processing and presenting this information, in pairs. Approx.1 hour, three to four times a week. Two sessions of instruction on web skills by teacher. Grade3.
A2-4	Digital picture books, both ready-made and self-made Interactive whiteboard	Use of digital picture books will increase pupils' vocabulary more effectively	'Reading' digital picture books, both with whole-class (teacher-directed) and independently, both in small groups and individually. Kindergarten (ages 4–5 years).

Most learning arrangements at both schools involved instruction and learning with standard teaching and learning materials. The tools that were used included software programs (mainly practice software; to a lesser extent also word processing and presentation software), interactive whiteboards and the internet. Observations, teacher

interviews, and analysis of software manuals showed that these tools were mainly used to support the teaching and learning materials. The schools either used existing software developed by educational publishers – in three out of four learning arrangements at both schools – or modified existing materials for the interactive whiteboard (learning arrangements A1-2, A2-3 and 4). For instance where language instruction at the Princess Amalia School was previously given with the help of the traditional blackboard, and exercises done individually by the pupils in their exercise book, the teacher now scans exercises from the book and together with the pupils does some exercises on the IWB, as part of the instruction (A1-2). A similar example we find at the Alma Mater School (A2-3). After the whole-class instruction pupils continue to do the exercises in their book (A1-2) or on the computer (A2-3). Both from lesson outlines and observations we conclude that at these schools the ICT tools that are to be used by the pupils are determined beforehand by the teacher.

The teachers' working hypotheses reveal that with the increased application of ICT the schools generally aimed at the following goals:

- Making their instruction more engaging or motivating to pupils (all arrangements, A2-2 and 4 to a lesser extent)
- Catering for differences in pupils' learning abilities (A1-1, and 3; A2-2)
- Maintaining or increasing learning achievements, especially for low-achieving pupils (all arrangements)
- Offering more efficient teaching and learning, leaving the teacher more time for other tasks (A1-1, 2, 3, A2-2, 3, 4)
- Giving pupils a more active role in their learning (A1-1; A1-2; A1-4; A2-1; A2-4).

Based on interviews with teachers we conclude that engaging or motivating their pupils is the 'traditional' schools' main aim of the use of ICT. They expect the variation in instructional and exercise formats facilitated by ICT to contribute to pupils' motivation. For instance a teacher at the Princess Amalia School says, when describing the expected effects of the use of the IWB in arrangement A1-2: 'I think it will […] be more fun than

the blackboard, because of the interactivity and sometimes because of the tricks and the things that you show.' Similarly a teacher at the Alma Mater School says, referring to pupils doing assignments on laptop computers instead of in their exercise books: 'They are very motivated. They find it a lot of fun when they do it on the laptop'.
Teachers also use ICT to support differentiation, aimed at pupils' cognitive abilities and pace of learning. Enhancing learning achievements through ICT at the traditional schools is mainly focused on knowledge acquisition and basic skills. Finally, active and self-directed learning is primarily aimed at for the purpose of time efficient learning and teaching. It is mainly designed in terms of doing exercises and assignments on the computer with less assistance from the teacher. Other purposes, like self-directed learning as a skill in itself, are not mentioned by the teachers.

Whole-class instruction and doing exercises (individually or in pairs) are the most prominent ICT-supported learning activities in these schools, as the lesson outlines and classroom observations show. The 'drill-and-practice' software that was used at these schools is typically used in such a way that the teacher stays in control of the learning process. Both the teacher and the software determine which exercises the pupils do and when they do them. In some cases the pupils have some freedom in deciding which exercises they want to do. The internet is used sparsely at these schools. When it is used, assignments in the teaching and learning materials specify which information has to be searched by the pupils (A1-4 and A2-1). Teacher interviews and analysis of the manuals of learning materials show that how pupils search the internet is either prescribed (A2-1) or to an extent up to the pupils to decide (A1-4). The same goes for the use of word processing and presentation tools. Classroom observations suggest that there was a slight shift towards more independent work by pupils, mostly in the form of carrying out learning activities with less assistance from the teacher. Teachers confirm this in some of the interviews, for instance at the Alma Mater School, where the teacher used to prescribe exactly which exercises the pupils had to do: 'They have a bit of freedom in it. With math too. I don't say: you have to do these exercises. They can choose from five exercises. And with reading as well.'

In all we conclude that both schools designed relatively transparent, straightforward learning arrangements that stayed close to their general didactical principles and curriculum. A limited number of ICT tools was used in each learning arrangement. In general, the ICT tools in both schools were largely used to support learning with standard teaching and learning materials, with mostly fixed learning content and a strongly teacher-directed approach with a little more independent work by pupils.

Results: schools with an innovative approach to the curriculum

The' innovative' schools and their educational concepts

The Beehive Primary School (B1) is a relatively new school in a still growing suburban area. It has a team of mainly young teachers and its educational concept is still being developed. The creed that 'learning can and should be fun', i.e. meaningful and engaging, plays a major role in this school. Teachers aim to enhance pupils' sense of involvement and engagement in educational activities, e.g. by letting pupils formulate their own learning goals. Many of the educational activities are organised around the general themes of 'people and society' and 'science and technology'.

The Queen Beatrix Primary School (B2) is located in a small rural village. Before joining this project the school already had the intention to make learning more attractive for pupils, among other things by giving them more control over their learning and by using inquiry projects as learning activities. Science and social sciences are taught in multidisciplinary projects revolving around a certain theme.

The Beech Grove Primary School (B3) is located in a suburban area. The school has recently converted to a new educational concept which puts much emphasis on learning by doing and exploring, giving pupils a lot of freedom to put forward the subjects and questions they wish to explore. Pupils guide and monitor their own learning with the use of a personal portfolio, supported by the teacher.

At all three schools groups are multi-aged, to give pupils the opportunity to learn with and from each other. Standard teaching and learning materials at the innovative schools are mainly used as a general source of content and exercises. At the Beehive School and

the Queen Beatrix School an exception is made for Dutch language and mathematics lessons, for which the curriculum is more strictly prescribed. At the Beech Grove School standard teaching and learning materials are seldom used for any subject.
At the Beehive School and the Queen Beatrix School, after group instruction pupils work on weekly tasks, independently and both individually and in small groups. At the Beech Grove School all subjects are offered mostly in the form of mixed-group workshops from which the pupils can choose. At the Beehive School some of the learning activities take place in the form of such workshops. At the Beehive School and the Beech Grove School the concept of multiple intelligence (Gardner 1999) plays a significant role. Enabling pupils to choose activities that fit their intelligence(s) is expected to make education more meaningful to them.

ICT use at the' innovative' schools

A total of ten different 'innovative school learning arrangements' were studied. The Beehive School realised four learning arrangements. The Queen Beatrix School realised three and the Beech Grove School two of the initial four learning arrangements that were designed, mainly because of the complexity of the learning arrangements that these schools designed. The grades involved at the Beehive School ranged from 1 to 6. At the Queen Beatrix School the classes were multi-aged, grades 4, 5 and 6. At the Beech Grove School both learning arrangements were studied in four multi-aged classes, grades 1, 2 and 3. For each school Table 3 shows an example of the ICT tools used in the learning arrangements, and the goals and activities that were involved.

Table 3. Examples of learning arrangements at the 'innovative' schools.

	ICT tools	Working hypotheses	Activities
B1-4	Digital photo camera Printer	Taking photos of groups of objects and using the photos enable pupils to grasp the basic principles of multiplication tables.	Pupils (pairs, small groups) photograph groups of objects. Teacher prints photographs. Pupils use photographs to make multiplication booklets. Grade2.
B2-3	Digital photo cameras Digital video cameras Internet Word processing software Presentation software Desktop & laptop computers Interactive whiteboard	When the teacher pays more attention to the explorative learning process, pupils' learning experiences and presentations improve.	Workshop on web searching. Pupils (individually or in pairs) formulate a research question related to the theme 'the Caribbean' and carry out a small research project, mainly on the Web. Pupils present their results to the class on IWB or on wall posters. Grades4/5/6.
B3-2	Internet Digital microscopes Laptop computers Topographical software Interactive whiteboard	More focus on multiple intelligences will help to make more use of them in relation to ICT.	Workshop on multiple intelligences. Teachers give pro-active guidance on the use of ICT connected to multiple intelligences. Pupils (individually or in pairs) formulate a research question on a subject of their choice and carry out a small research project. Grades1/2/3

Classroom observations, teacher interviews and diaries show that mainly open-ended tools were used in the learning arrangements at the innovative schools; i.e. tools that do not prescribe a certain outcome. The Beehive School designed three learning

arrangements in which the use of visual tools – i.e. tools for producing digital images – played a major role, as part of the school's emphasis on the use of multiple intelligences. The interactive whiteboard too, played a prominent role in this 'visualisation' of learning material. For instance in learning arrangement B1-1 pupils took photographs of each other's facial expressions which were then shown on the IWB and discussed with the class. The internet and software for making presentations were used to a lesser extent.

At the Queen Beatrix School and the Beech Grove School emphasis is put on tools that can be used for explorative activities like the internet and microscopes. Explorative activities were also supported by the use of digital cameras, for instance where pupils would take pictures of old houses when exploring building styles from the past (B2-2). None of the learning arrangements studied at the innovative schools were linked to the use of standard teaching and learning materials.

Pupil and teacher interviews show that pupils were largely free to decide which tools to use for their research projects (Queen Beatrix) or were encouraged to use tools connected to multiple intelligences (Beech Grove), like using the computer for making a cartoon based on a textual description of volcanism on the internet (B3-2). At all three schools pupils frequently gave presentations with the use of an interactive whiteboard, mostly without help or interference from the teacher, as in most cases the pupils operated the IWB themselves and led a classroom discussion afterwards, while the teacher remained in the background.

The teachers at the 'innovative' schools expressed as a general expectation of ICT that it will make learning activities and content more meaningful and engaging to pupils. As reflected in the teachers' working hypotheses this effect was expected to be achieved through the following goals:

- Increasing the active construction of learning content by the pupils (B1-1, 2, 4; B2-2, B2-3, B3-1, B3-2)
- Facilitating the production of visual materials and having pupils use these self-made materials as learning materials (B1-1, 2, 4; at B2: all)

- Giving the pupils more opportunities to use multiple intelligences (B1-1 through 4, B2-1, B3-1, B3-2)
- Giving the pupils more opportunities to take their own research questions as the starting point for largely self-directed learning activities (B1-1, 2; at B2 and B3: all).

Although teachers did express the expectation, both in their working hypotheses and in interviews, that pupils would gain knowledge of the school subjects in question, strictly content-related learning goals like memorizing information or increasing vocabulary played only a minor role in these schools' learning arrangements. With regard to learning gains the focus lay on construction of knowledge by producing and discussing visual material and collecting information, mainly on the internet, and the development of skills, like inquiry skills. From the teacher interviews we conclude that at the 'innovative' schools ICT was expected to give pupils more control over the content of their learning activities, for instance by giving pupils the opportunity to formulate their own research questions for their inquiry activities. This is also expected to lead to more motivation in pupils, as illustrated in the following quote of a teacher at the Queen Beatrix School, regarding an inquiry activity on the internet: 'Seeing that children are moved by a subject and then go for it. And at some point you notice that the time is up because they want to do so much. Then you have a good process going on.' The focus on multiple intelligences at the Beehive School and the Beech Grove School and on pupils' input in their inquiry activities at the Queen Beatrix School and the Beech Grove School suggests that the innovative schools mainly use ICT to differentiate between pupils in terms of differences in learning style and interest.

The ICT tools that were used were mainly expected to contribute to creating more engaging learning activities. From teacher interviews and classroom observations in all three schools we conclude that the general assumption was that by experiencing the activities and their content as meaningful, the subject matter of the activities would be learned. As the teacher involved in B1-1 – in which the pupils made pictures of each other's facial expressions – puts it: 'The best thing was, when they were looking back [to the pictures]. For the children it is somehow so impressive to see yourself on a big

screen, on the IWB. Yes, that brings up so much emotion that you think: this is something they will remember. Because they are in it themselves.'
Classroom observations, teacher and pupil interviews and teacher diaries show that in general the pupils had a lot of input in the ICT-supported activities. At the Beehive School the teacher decided which tools were to be used. Here the pupils' input mainly concerned the content of their activities, like choosing which objects they made pictures of with the digital camera.

At the Queen Beatrix School and the Beech Grove School to a large extent pupils decided both about the subject of their inquiry activities and the tools that they used for their inquiries.

We further notice that the innovative schools developed complex learning arrangements, involving a wide variety of ICT-supported activities with which the teachers and pupils often had little previous experience, like putting digital pictures on a weblog. This resulted in a relatively large amount of time spent on experimenting with the tools and dealing with technical and organisational problems, e.g. incompatible software or pupils uploading pictures and forgetting on which laptop computer they saved them. Because of time constraints some of the planned activities were therefore not carried out.

We can conclude that at the 'innovative' schools in this study ICT tools were generally used to support open-ended activities with a lot of input from the pupils, which the teachers expected to promote the meaningfulness of learning activities. Most learning activities were explorative or concerned the use of multiple intelligences, or both. At one innovative school visualisation of content was a main issue. At all 'innovative' schools the control of the learning process within the developed learning arrangements was shared by teacher and pupils. The complexity and novelty of the learning arrangements, made integrating the use of ICT more difficult at these schools than at the 'traditional' schools.

Conclusion and discussion

In this study five primary schools were followed while they were supported in developing their educational use of ICT in line with their educational concept. Two schools were labelled as 'traditional', i.e. with a fixed, textbook and teacher-driven curriculum and learning activities and content that are set by the teacher and the teaching and learning materials. Three schools were labelled as 'innovative', meaning they have a more open curriculum and pupils at these schools have more input in decisions about learning activities and content. The purpose of this study was to characterise the ICT use developed in the five schools, thus answering the question to what extent this concept-guided approach leads to distinguishable types of ICT-use.

The learning arrangements that were designed by the schools with a traditional approach to the curriculum stayed close to the schools' general didactical principles and curriculum. In most learning arrangements only one or two ICT tools were used, mainly supporting the use of standard teaching materials with fixed learning content and a strongly teacher-directed approach. The learning activities focused on making the instruction more engaging for pupils and offering them more opportunities to practise. There was also some tendency to use ICT to enable more independent work by pupils. Integrating the ICT-enhanced learning arrangements into the existing teaching practice was relatively easy at these schools, with only minor technical problems.

At the three schools in this study that were labelled as 'innovative', a wide range of ICT tools was generally used to support open-ended activities with considerable input from the pupils. In this way learning activities were expected to become more meaningful for pupils. Most learning activities were explorative and/or concerned the use of multiple intelligences. At one school visual tools played a significant role, at the other schools the internet and other tools that facilitate explorative activities were used most prominently. The complexity and novelty of the learning arrangements that seemed to be typical of the 'innovative' schools made integrating the enhanced use of ICT at these schools more problematic and time-consuming.

The above leads us to conclude that concept-guided development of ICT-enriched learning arrangements indeed resulted in clearly distinguishable types of ICT use in the two types of schools. The tools that were used, the activities in which they were used and the goals that were expected to be achieved through the learning arrangements, in general reflect the different school concepts that set the school types apart.
Some ICT tools were used in both school types, yet in different ways, in line with the schools' different educational concepts. This concerned mainly the basic hardware tools like (laptop and desktop) computers and the IWB, and in a lesser degree the internet.

The teachers in both school types to an extent also formulated similar goals. In all five schools teachers to some measure expected the ICT-enhanced learning arrangements to increase pupils' motivation, improve learning results, promote self-directed learning, and enable teachers to differentiate more between pupils. Yet the different ways in which the same tools were used in the different school types indicate that the schools hold significantly different expectations with regard to ICT and learning. At the traditional schools enhanced motivation was expected because of the variation in instructional and exercise formats facilitated by ICT, whereas the innovative schools' teachers expected pupils to be more motivated through the enhanced meaningfulness of learning activities enabled by the ICT applications. With regard to learning results the traditional schools focused on knowledge acquisition through ICT, while the innovative schools expected the intensified use of ICT to contribute mainly to the development of skills, like inquiry skills. As for self-directed learning, at the traditional schools this meant in most cases doing exercises and assignments on the computer with less assistance from the teacher, whereas at the innovative schools ICT was expected to give pupils more control over the content of their learning activities, like in inquiry projects. Finally, the traditional schools designed ICT-enhanced learning arrangements that enabled differentiation with respect to learning abilities (cognitive level and learning pace), while at the innovative schools differences in learning style and interest were facilitated by the use of ICT.

One significant difference between the school types was, as stated above, that the traditional schools created learning arrangements that were relatively easy to integrate into their educational practice. For those involved in concept-guided ICT development in innovative schools it is important to note that the more complex learning arrangements designed in these schools may typically take more time and support to develop and implement and ask more motivation and perseverance from teachers.

We conclude this article with some suggestions for further research. In this explorative study only five schools, roughly characterised as either traditional or innovative, were followed in the process of developing and enacting ICT-enriched learning arrangements. This gave us the opportunity to study in detail the learning arrangements that materialised at these schools as a result of concept-guided development of ICT use and to give a detailed characterisation of the ensuing uses of ICT. A more large scale approach could give a view of a wider range of educational concepts and their characteristic uses of ICT, making these results generalisable to a wider range of educational practices. A longitudinal study could also focus on the durability of the accomplished integration.

Finally, the practical implications of the complexity of the ICT-enhanced learning arrangements developed by the innovative schools, and the subsequently more challenging integration of the ICT use warrant further study.