

Chapter 7

Factors affecting teachers' use of ICT after the innovation

In the previous chapter, I discussed the methods used to investigate how teachers at the case-study school were using ICT before and after the introduction of the *DigiSchool Project* promoting the use of ICT for instruction. In this chapter I present the findings of this investigation, i.e. how teachers' computer use changed from before to after the innovation, and I discuss the factors which influenced these changes.

7.1 THE CHANGES IN COMPUTER TASK USAGE

A major focus of the study is to investigate whether changes in teachers' ICT use after the innovation are likely to improve learning, or whether they are simply a case of technological determinism, i.e. using technology in education because of the commonly held perception that technology will be an educational panacea. In Chapter 1 (see Section 1.1.3 on page 9) I discussed the potential of ICT usage to promote meaningful learning. The literature suggests that this potential appears to be greatest when technology is used in ways that allow learners to construct their own knowledge. The literature also shows that the potential of ICT to contribute to meaningful learning is greatest when learners, and not teachers, are using the technology (e.g. Ertmer et al., 2012). This emphasis on learners' use of technology to promote meaningful learning prompted me to report separately on the changes in the tasks for which **teachers** were using computers and the tasks teachers were requiring **learners** to carry out on computer.

7.1.1 Changes in computer tasks carried out by teachers

This section answers Research question 2, restated here for convenience:

Research question 2: To what extent, and in what ways, did teachers' use of technology change after the introduction of the *Digital School Project*?

Figure 67, on the next page, shows changes in the number of teachers carrying out different types of teacher-tasks on computer after the innovation, as reported by teachers in the questionnaire *Teachers' computer use before and after the innovation* (see Appendix AS). The questionnaire asked teachers to indicate, by selecting one of five options ranging from *never* to *about once a day*, how many times, on average, they carried out each of the 19 types of computer tasks before *DigiDays* were introduced at the school, and their current usage after *DigiDays*. The types of computer tasks included in the questionnaire were based on a classification system of ICT usage in education developed by Ward and Parr (2010) and adapted for use in this study (see Table 2 on page 8 in Chapter 1). The classification system used in this study differentiated between teacher and learner use of ICT in education and ranked the range of types of teacher usage and types of learner usage according to potential to contribute to meaningful learning. Although many 'teacher-tasks' will not affect learners at all, and some will have little impact on learners, the types of computer use shown in Figure 67 (see x-axis) are arranged in order of increasing potential to affect learners (see red arrow).

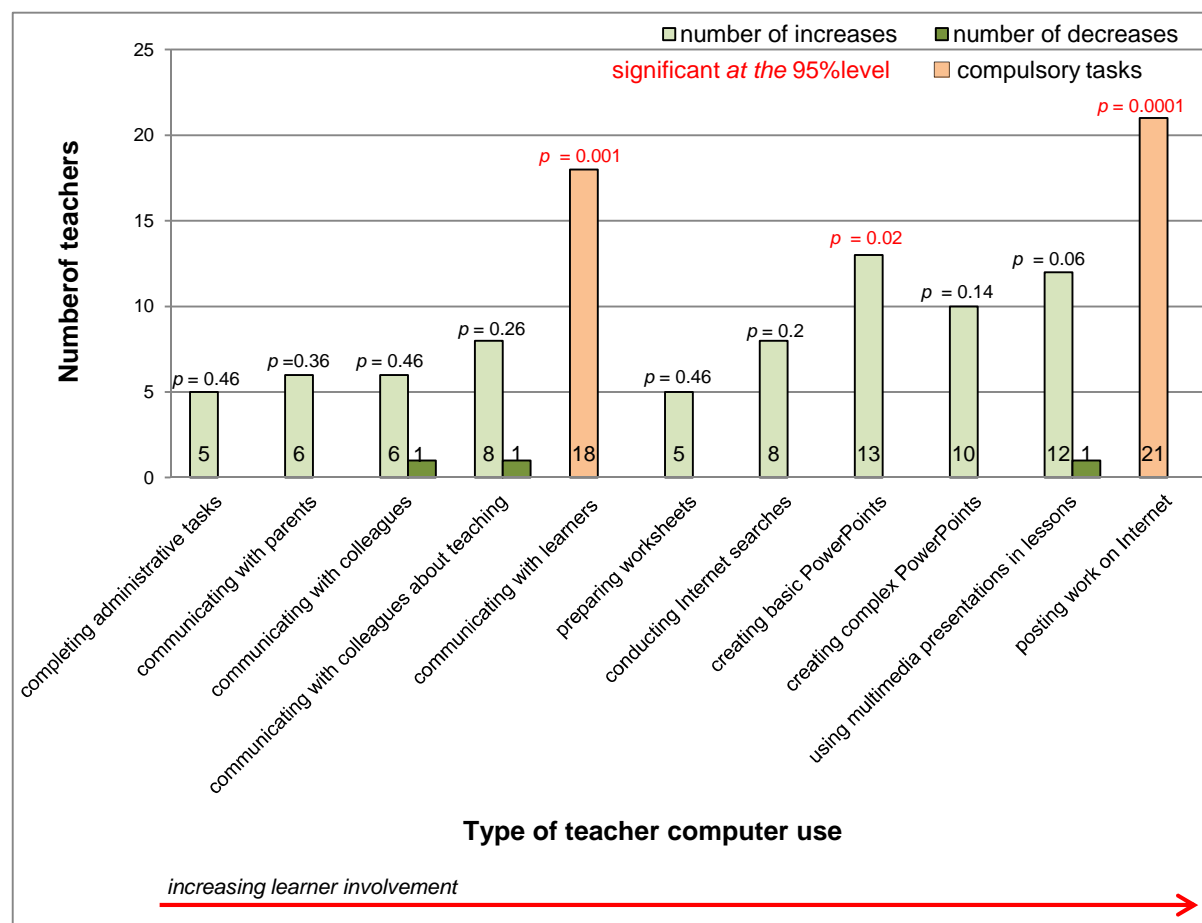


Figure 67. Changes in the number of teachers carrying out different tasks on computer, after the innovation

For some tasks, the number of teachers showing an increase appears large and it is important to know whether these differences are statistically significant – i.e. the likelihood that they occurred by chance. As discussed in the previous chapter, the sign test was carried out to determine the significance of the changes. The p -values calculated using the sign test are shown above the bars in Figure 67. If a value of $p \leq 0.05$ is used to determine significance, three of the tasks in Figure 67 showed statistically significant increases, meaning that these changes are probably not attributable to chance alone. However, the increase in a fourth task (*presenting in lessons*, $p = 0.06$) was very close to significance at this level. The narrow margin between $p = 0.05$ and $p = 0.06$ represents the difference between a 5/100 and a 6/100 chance of a change being significant i.e., having some underlying cause rather than being due to chance alone. Because of this narrow margin, I have also discussed this fourth task.

The two tasks shown in red in Figure 67 were tasks teachers were **required** to carry out for *DigiDays* (*communicating with learners* about administrative matters and *posting work on the Internet*) and might thus not reflect a 'real' uptake of ICT use by teachers. According to the theory of planned behaviour (Ajzen, 1991) (discussed in Chapter 2, pages 45-46) an individual's intentions to carry out a particular behavior are influenced by their underlying beliefs and attitudes towards that behaviour. Where teachers have not adopted ICT use of their own volition, and are only using ICT because they

are required to, behavioural changes are less likely to be sustained since they may not be underpinned by attitudinal changes. The two mandated tasks were:

- Posting work on the Internet.** Twenty-one of the 29 teachers (72%) reported carrying out this type of task more frequently after the innovation, but this highly significant change in ICT use ($p = 0.0001$) is probably due to teachers being required to upload tasks to *Moodle* for learners. While tasks for learners appear to have a high potential to involve learners in meaningful learning, the potential for tasks posted on the Internet to engage learners depends on the nature of the task, as will be explored later in this chapter when I rank 33 tasks posted by teachers on *Moodle* for learners to access. Surprisingly, eight teachers did not report an increase in this task. Three of these eight teachers are heads of departments, who could have delegated the loading of *DigiDays* tasks onto *Moodle* to other teachers within their respective departments. Another two of the eight teachers may not have been assigned the task of uploading *DigiDays* work onto *Moodle* because they are not as comfortable with using technology as other members of their departments.
- Communicating with learners.** The increase in this task reported by 18 of the 29 teachers (62%) was also highly significant ($p = 0.001$) (see Figure 67). However, teachers are mandated to inform learners, via email, when *DigiDays* tasks are accessible on *Moodle* and the date and time by when the completed tasks should be submitted. It would thus be expected that teachers usage of this task this would increase after the innovation. Eleven teachers did not report an increase in their usage. Three of these were heads of departments, who could have assigned this task to other teachers in their departments. Three of the 11 were teachers who were not as comfortable with using technology as other members of their departments, and who may not have been assigned the task of communicating with learners. Another one of these 11 is a member of the executive committee of the school who appears not to be as involved in departmental tasks as are other members of his department. The task of communicating with learners about digital tasks may have fallen to another member of this person's department. It is not clear why the remaining four did not report an increase.

Discounting the two mandated activities and the four administrative teacher-tasks with little to no opportunity for learner involvement leaves five tasks which could involve learners. Four of these tasks involve teachers using computers for finding or preparing resources to use in lessons, and will thus have only a very indirect effect on learners (*preparing worksheets*, *conducting Internet searches*, *creating basic PowerPoint*s, and *creating complex PowerPoint*s). The discussion below focuses on tasks showing significant or close to significant changes.

- Creating PowerPoint**s. Figure 67 includes two tasks involving creating *PowerPoint* presentations. The increase in *creating basic PowerPoint*s is significant ($p = 0.02$), while the increase for *creating complex PowerPoint*s is not ($p = 0.14$). Since the difference between the number of teachers creating basic and complex *PowerPoint* presentations is only three, I will discuss both tasks here. Another reason for considering the change in the number of teachers *creating complex PowerPoint*s, although not statistically significant, is that the latter are considered more likely to promote learning and understanding than basic ones.

A potential benefit of using *PowerPoint* is that displaying visual images which could help learners better understand concepts (as discussed in Chapter 1 pages 10-11). According to the

cognitive theory of multimedia learning (Mayer, 2003) 'complex *PowerPoint*' presentations (any combination of text, music, animations, hyperlinks to external material, etc.) have a greater potential to engage learners than basic *PowerPoints* containing only text, or text and static pictures. *PowerPoints* used simply as an electronic version of 'chalk and talk' are less likely to contribute to constructivist learning. One of the science teachers cited this reason to explain why he doesn't use many *PowerPoint* presentations in his teaching:

No, I don't use PowerPoints a great deal ... my biggest concern is that for many teachers, all that PowerPoint has done is replace the overhead projector. It's doing nothing else. So you've got static slides coming up ... so it's just a different form of bringing up the old overhead. (Teacher 3)

Another potential benefit of using *PowerPoint* is that could improve learners' level of motivation. Research based on the cognitive-affective theory of learning with media (developed by Moreno, 2006) supports the idea that multimedia design features could increase learners' interest in the material to be learned, which could, in turn, promote learning. According to this theory "*motivational factors may mediate learning by affecting the cognitive engagement of the learners*" (Leutner, 2013, p. 1).

Although teachers in my study were presenting more *PowerPoints* in lessons after the innovation, the presentations tended to be basic rather than complex ones. Only 10 of the 29 teachers (34%) reported an increase in *creating complex PowerPoints*, after the innovation, compared to the 13 (45%) with an increase in the number of *basic PowerPoints* they were creating. One of the Life Sciences teachers explained that she used basic rather than complex *PowerPoints*, and from her explanation it can be seen that her *PowerPoints* are not likely to be designed to improve cognitive engagement

I must admit I haven't prepared many. The ones that I have prepared are very simple. I'll just go to Google images and just, you know, put the picture there, and maybe a heading. I haven't sort of gone into major things.

And I thought, well, if I had the same lesson, maybe with PowerPoint and ... videos and clips of music, maybe it wouldn't have been as effective. (Teacher 34)

An Art teacher likened using *PowerPoint* to using *Word* to project documents onto the screen, which suggests she did not understand how *PowerPoint* presentations can be used in her subject to promote meaningful learning:

*No, I **don't** do PowerPoint but what I've done is, you know, if you work on Word? Then I just scroll up and they can see it. It's like having PowerPoint without knowing how to do PowerPoint.* (Teacher 18)

One of the Life Sciences teachers had only just started producing her own basic *PowerPoints*. She explained where she usually got her presentations from:

I tend to rely on that CD that we got with all those hundreds of PowerPoints²⁷ (laughs) or else PowerPoints that kids have done and then I just use ... (Teacher 34)

Like these teachers, other teachers may not be using *PowerPoint* presentations because they do not know how to prepare *PowerPoint* presentations. Or they may be using basic rather than complex *PowerPoints* because they are not aware of the potential benefits of combining different media. A third possible reason might be because their subjects do not lend themselves to making use of this potential benefit which could promote understanding (meaningful learning).

²⁷ This teacher is part of a national network of Life Sciences teachers who share resources. The CD she refers to is a compilation of resources made available at an annual national conference for Life Sciences teachers held in February.

- **Using multimedia presentations in lessons.** Twelve teachers (41%) reported an increase in their **use** of *PowerPoints* in lessons, and the increase approaches significance ($p = 0.06$). This increase is likely to be the result of more teachers having data projectors available in their classrooms. Before the innovation 15 of the 29 teachers (52%) had data projectors in their classrooms. Eighteen months after the innovation started, all but two of the teachers had data projectors. One teacher was due to have her data projector installed in the week after our interview. It is well documented in the literature that the availability of ICT resources affects teachers' use of computers (Becker, 2000; Chigona & Chigona, 2010; Ng & Gunstone, 2003; Vanderlinde et al., 2012). Having data projectors accessible in their classrooms allowed teachers who had not previously been able to present in lessons using computers to do so, either using a newly installed desktop computer (for those who had not previously had one) or using their own laptop. Two teachers, Teacher 15, an Afrikaans teacher, and Teacher 38, a maths teacher, each described how not having a data projector had limited their use of computers for teaching:

I didn't use it. I did not ... because I didn't have the data projector and I ... I sometimes ... well, very seldom, I arranged to take them to a class, either to Teacher 16's class, who had a data projector before I had one ... (Teacher 15)

I only had it [a data projector] from last year. I remember going to another classroom ... to do the Autograph lessons. We used to swap classrooms. So from last year, we've all got projectors now, in our classroom. So we actually don't have an excuse. We've got to use it. (Teacher 38)

This teacher's feeling that teachers were expected to use computers now that data projectors had been installed in classrooms suggests that changes in her computer usage may not have been of her own volition. If this was the case such behaviour might not be sustained.

The availability of data projectors was not the only factor affecting how often teachers presented in lessons. One maths teacher described how not having the data projector readily accessible in her classroom impacted negatively on the number of times she presented in lessons:

*I don't have one **mounted** ... I've got one in a box which is a bit of a pain, 'cause every time I have to take it out the box, set it up on the desk, you know, tune it in and do all the good things.*

... maybe once a month because it is such a pain and then when the next class comes in you've got to get rid of it and pack it away again and then ... and it's got to be packed away securely, you know, it can't just be left lying somewhere. So it's ... from that point of view, logistically it's been a bit of a, you know ... it's a bit of a schlep to do it, so what we sometimes do is ... if two teachers are teaching the same work I sometimes go to my neighbour and say to her "Okay. Can this class combine for the day?" And then we'll do the stuff together. (Teacher 35)

Many of the teacher-tasks shown in Figure 67, while likely to promote teacher productivity, are unlikely to impact directly on the quality of learning. The tasks which are more likely to contribute to meaningful learning are those which more directly involve **learners**, such as whether teachers use *PowerPoint* presentations (whether basic or complex) in lessons. Of the teacher-tasks investigated, the one with the most potential to affect **learning** involves teachers *posting work on the Internet*. However, as pointed out earlier in this section, the potential for ICT tasks to allow learners to construct their own knowledge depends on the nature of the task. Later in this chapter (starting on page 239), I evaluate some of the *DigiDay* tasks posted by teachers on *Moodle* during the first 18 months after the innovation to see whether they are likely to contribute to more meaningful learning.

7.1.2 Changes in tasks carried out by learners using computers

Although many of the computer-based teacher-tasks discussed in the previous section showed increased computer usage, they are unlikely to impact directly on the quality of learning. The tasks which are more likely to contribute to meaningful learning are those which directly involve learners. Figure 68 shows the changes, after the innovation, for eight computer-based 'learner-tasks' set by teachers, as elicited by the questionnaire *Teachers' computer use before and after DigiDays* (see Appendix AS). The types of computer use in Figure 68 are arranged in order of increasing potential to promote meaningful learning, based on the cognitive level required by the task. The tasks therefore range from those which promote learners acquiring knowledge (e.g. *using subject-specific software for accessing content*) to more cognitively demanding tasks which require learners to apply their knowledge or to solve problems (e.g. using simulations). The probability values derived from the sign test used to determine probabilities of statistical significance of the changes are shown above the bars in the figure.

Figure 68 shows that the number of teachers using the eight types of computer-based learner-tasks increased across all the tasks, although four tasks each showed one teacher setting such tasks less often than before the innovation.

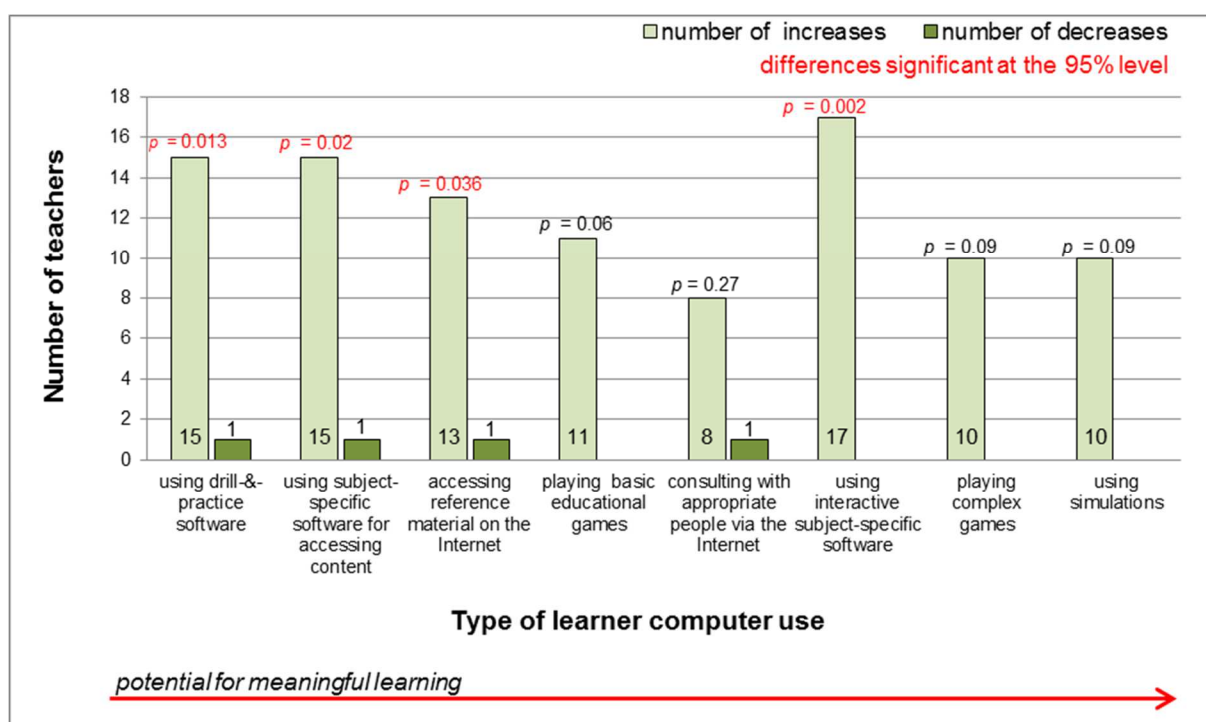


Figure 68. Changes in the number of computer-based learner-tasks, used by teachers after the innovation

Teachers' increased usage of four learner-tasks would be considered significant at the traditional cut-off level of $p \leq 0.05$, suggesting that these changes in usage could be related to factors other than chance alone. However, I consider three other changes to be close enough to this significance level to be worthy of discussion: (*playing basic educational games*, $p = 0.06$; *playing complex games*, $p =$

0.09; and *using simulations*, $p = 0.09$). These p -values suggest odds of less than 10% that the increases were due to chance alone. Only one task did not reach a 10% significance level: *consulting with appropriate people via the Internet* ($p = 0.27$).

One seemingly anomalous result requires consideration: Two of the tasks in Figure 68 (*using drill-and-practice software* and *using subject-specific software for accessing content*) show identical frequency of change, yet yield different p -values. The difference in the values for these two tasks is probably due to the different number of teachers who showed no change from before to after the innovation in each case, which affected the sign test calculation (see discussion on zero differences on page 225 in Chapter 6). There were more zero differences for the task with the higher probability value (and lower significance) – *using subject-specific software for accessing content* – than for the other task (*using drill-and-practice software*).

The changes shown in Figure 68 suggest that the innovation impacted positively on the number of computer-based tasks teachers were setting for learners. However, many of the increases shown in Figure 68 are likely to be due to teachers being required to set computer-based tasks for learners to complete on *DigiDays*, and not because the teachers had changed their beliefs and attitudes towards using computers for instruction, and thus their 'real' computer usage. Furthermore, increased usage of learner-tasks does not automatically imply a benefit for learning. To investigate the potential of the learner-tasks to promote meaningful learning requires a closer look at the computer-based tasks teachers were setting for *DigiDays*.

Scoring the *DigiDays* tasks according to potential to promote meaningful learning

Based on my interviews with teachers, observations of activities on *DigiDays*, and analysis of hard copies of tasks teachers had provided me with, I had a record of 33 *DigiDays* tasks set for learners over the first 18 months after the innovation. I wanted to rank the tasks according to their potential to promote meaningful learning, to see whether, after the innovation, teachers were using computers in ways that benefited learning. In Chapter 6 (starting on page 227), I described the development of the tool I used for ranking computer-based tasks based on the effect of using computers for the task and the pedagogical design implied in the task. Because of the correlation between the pedagogical design implied in the task and the cognitive level of that task (as discussed on pages 229-230 in Chapter 6), it is important to identify the appropriate cognitive level of task to be able to assign the correct score for the pedagogical design implied in the task. Although the scoring tool appeared simple to use, I encountered a number of difficulties when using the rubric to evaluate the 33 *DigiDays* tasks I had recorded:

- **The difficulty of deciding whether 'creating' a digital product (e.g. a movie clip) can be classified automatically as a 'synthesis' activity.** It was important to decide whether tasks which involve creating a digital product automatically qualify as a synthesis activity, because this has implications for whether the task promotes the construction of knowledge, which in turn influences the score for pedagogical design implied in the task. In their revision of Bloom's taxonomy of educational objectives Anderson et al. (2001) renamed the category 'Synthesis' as 'Create'. They also reversed the order of the two highest categories so that 'Create' became the highest level of cognitive activity. These authors, however, retained Bloom's original idea that making a new product involves "*mentally reorganising some elements of parts into a pattern or*

structure not clearly present before" (Anderson et al., 2001, p.84). Thus the 'product' Anderson et al. referred to is a mental one rather than a physical one. The Valentine's Day card task (Task 21), in which learners were required to use computers to produce a card and some learners created a movie clip, raised the question of whether creating something using technology automatically qualifies as a synthesis activity, which the tool implies promotes learners constructing their own knowledge. I initially saw it as 'creation', suggesting a higher-order cognitive skill and I wanted to assign it the highest score possible for pedagogical design implied in the task. However, to qualify as 'synthesis' an activity must involve the integration or reorganisation or rearrangement of ideas into a new cognitive whole (Bloom et al., 1956). Task 21 was not considered to be a synthesis activity. Rather, it was scored as not going beyond the reception learning for pedagogical design implied in the task, because it contributed very little in terms of learning the subject.

- **The potentially misleading term 'comprehension exercise'.** A number of tasks were described by teachers as "*comprehensions*" (e.g. Tasks 3 and 4 in Table 34), yet simply involved learners reading a text and then selecting relevant information from the text to answer questions. This does not qualify as the 'comprehension' cognitive level of Bloom, so the term 'comprehension' can be misleading when tasks are ranked. Task 25 presented a similar problem. Although this task involved learners watching a video, they ended up answering questions based on the lyrics of a song. The term 'comprehension' to describe these task was misleading, as they were simply knowledge tasks involving recognising and recounting information and therefore unlikely to go beyond reception learning. I thus named these tasks "*answering questions*" (see Column 2, Table 34) rather than 'comprehension' tasks and assigned them the lowest score for pedagogical design implied in the task.
- **Teachers' beliefs about what constitutes an 'interactive' task.** At its lowest level technical interactivity involves clicking on menus and objects. Sims (1997, p. 158) believes that low levels of technical interactivity "*may not be adequate or relevant to facilitate the acquisition of knowledge or the development of new skills and understanding*". Higher levels of technical interactivity involve learners engaging mentally in the task or receiving feedback from the computer application that leads them to reflect on their choices, thus facilitating their construction of knowledge (Nunes & McPherson, 2007). Teacher 40 described Task 14 as "*interactive ... sort of like a multiple choice-type response*", a description endorsed by Teacher 3 who described this task as an "*electronic, interactive worksheet*". Closer examination of the task, however, revealed that all learners had to do was select an option from a drop-down list and click on it. There was no mental engagement required or feedback offered learners on whether they had selected the correct option. The only 'interaction' was therefore learners clicking on their choice. Using computers for this task therefore offered little benefit as the task could just as well have been completed on paper, and the task was allocated the lowest score (1) for the effect of using technology (see Table 34).
- **Difficulties with classifying tasks as true 'analysis' tasks, and the implications thereof for scoring the pedagogical design implied in the task.** As for the previous two difficulties described, teachers' descriptions of what *DigiDays* tasks involved did not always match the cognitive activity actually required by the task, and hence the pedagogical design implied in the design. The cognitive activity associated with 'analysis' involves separating concepts into

constituent parts so that different structures which comprise it can be understood (Bloom et al., 1956). For example, Task 16, which Teacher 29 described as “*analytical. They had to analyse the information given*” was found to involve learners accessing information and then answering questions using that information. It was thus inappropriate to allocate the task a score of 3 for pedagogical design because it did not seem to promote constructivism. However, depending on how learners did the task, the task could have permitted more than just reception learning. Learners who were sufficiently motivated by the topic and who probed more deeply could have constructed their own knowledge. Task 16 was thus scored a level 2 for the pedagogical design implied in the task.

After much consideration, and inter-score checking and discussion with a ‘validator’ experienced in both pedagogy and computer-usage for education, the 33 tasks are ranked in Table 34, over the next four pages, according to their potential to promote meaningful learning. To obtain the ranking order, the 33 tasks were first ranked according to the total score, as a measure of the overall potential for that task to contribute to meaningful learning. For tasks with equal total scores, the tasks were then organised according to scores for the *Effect of using ICT*, which seemed logical since teachers were required to design computer-based tasks for *DigiDays*.

Table 34. Some *DigiDays* tasks from the first two years of the innovation

	Type of learner task	Subject	Grade	Description of task**	Effect of using ICT (3)	Design of task (3)	Total score (6)
1	Completing a crossword puzzle.	English	8	<i>I know with our Grade 8s ... we said they had to do a crossword. (Teacher 2)</i>	1	1	2
2	Completing a worksheet.	Afrikaans	11	<i>I gave them an exercise where they had to fill in the correct pronouns. (Teacher 15)</i>	1	1	2
3	Answering questions.	English	12*	<i>So for me it was ... it was quite Word-based, you know? Lots of copy and paste, lots of just uploading a comprehension that I would have already done ... on the computer. (Teacher 22)</i>	1	1	2
4	Answering questions.	Afrikaans	12*	<i>It was simply a comprehension ... an hour long test ... a comprehension and a language activity that they had to complete (Teacher 17)</i>	1	1	2
5	Checking test using memo.	Art	12*	<i>They had a class test and we went through ... I gave them a memo and told them to check and resubmit and just make the changes. That was our very, very first one. (Teacher 19)</i>	1	2	3
6	Answering questions.	English	11*	<i>The Grade 11's did ... if I remember correctly they had to do questions on The Crucible. (Teacher 23)</i> Learners were required to interpret information from the book to answer the questions.	1	2	3
7	Accessing information to make an informative poster.	Natural Science	8*	<i>... I took one of the projects which we'd used in the past here, which was design a poster for an element ... and the preparation that I did before the task was that ... the kids randomly drew numbers ... they didn't know that that was the atomic number of the element which they were going to be...and the task then followed from the number that you've drawn, look up on the periodic table, find out what the element is and then I drew up a Word document that went with that that said "These are the requirements of this exercise". (Teacher 33)</i>	2	1	3
8	Accessing information to answer questions on coral reef formation.	Geography	11	Learners had to search for information on the Internet to complete a worksheet on coral reef formation:	2	1	3
9	Mini-webquest.	English	11	<i>I set for my Grade 11s, for one of their DigiDays ... I sent them on a webquest. (Teacher 25)</i>	2	1	3
10	Accessing information to answer questions.	History	11	<i>... I set questions on Rasputin. We were doing ... the Russian revolution. I think I set questions on ... on Rasputin and they had to go into various websites and basically answer the questions. (Teacher 30)</i>	2	1	3
11	Following step-by-step instructions on how to draw graph in Excel.	Physical Science	11*	<i>They had to use Excel to ... plot graphs. They had to plot ... the graph on the computer ... rather than hand-draw it. So we gave them a point-to-point format of how to go about taking the data from the table and putting it into a graph. (Teacher 39)</i>	2	1	3

*First *DigiDays* tasks set for that grade in that subject.

**Descriptions in italics were supplied by teachers during interviews while descriptions not in italics are my descriptions based on hard copies of *DigiDays* tasks supplied by the teachers.

	Type of learner task	Subject	Grade	Description of task**	Effect of using ICT (3)	Design of task (3)	Total score (6)
12	Accessing reference material for a travel brochure on biomes.	Life Sciences	10	<i>... for instance we did a Grade 10 brochure. It's actually up on the board there (indicates the notice board in the foyer of the Biology building) and they did such a good job. I was actually so amazed ... I think it's extended some of them, because now they've had to go and find out how to do a brochure ... take all that information about a biome and put it into the criteria that we asked for. (Teacher 34)</i>	2	1	3
13	Drawing up an accounting journal in Excel or Word.	Accounting	10	Involves the algorithmic application of transactions as a debit or a credit in the trial balance sheet. <i>... the Grade 10s, they had to ... draw up or create their own transactions. And then post those transactions ... they had to design a ... journal ... CPJs, CRJs, then they had to post those into those journals and then they had to draw up their own trial balance ... so design their own trial balance, as well. They could have done it in Excel or Word ... depending on which one they were more comfortable with. (Teacher)</i>	2	1	3
14	Answering an online chemistry worksheet	Physical Science	12*	Learners had to match chemical formulae to their correct schematic structure by analysing the schematic diagrams. <i>.... we've then found ... electronic worksheets that normally would ... would have been normal worksheets and stuff like that. There was one big one on organic chemistry which was a lovely electronic interactive worksheet, so ... so we have had to do that. It's very good. (Teacher 3)</i>	1	3	4
15	Analysing an unseen poem.	English	12	<i>With the matrices I set an unseen poem ... the type of thing that would be required of them, you know, in preparation for finals ... (Teacher 23)</i>	1	3	4
16	Accessing reference material for a character study.	History	9*	<i>Our section ... it had to do with dictatorships and one of the people we highlighted was Idi Amin. So I had given them information on Idi Amin and they had to do an analysis of the personality. They had to do a little bit of research on him. It was very basic. It was analytical. They had to analyse the information given. There was a character study and then there were just some basic questions to see that they'd understood the material. (Teacher 29)</i>	2	2	4
17	Filling in a table to design a menu for a balanced meal	Life Orientation	8*	<i>... they were doing nutrition, so they had to set a menu for a family restaurant ... we gave them ... certain criteria, I can't remember the exact details but it was for a family of a certain amount [sic], and it had to be a nutritional meal ... with three options, I think, for starters, main course or desert ... something like that ... that they had to set. Obviously we had done all the background work in class and then they just had to come up with the menu. I think we asked them to do it in Word. I think we just ... I think we gave them the layout ... we drew up a table, gave them the layout and just said "Fill it out", just 'cause it was the first one for Grade 8s. (Teacher 32)</i>	2	2	4
18	Producing a table from class notes.	Art	8*	<i>... they were busy, literally, looking at different art works and art movements²⁸and linking them together. So they had to use the notes that they actually had from class, and then identify ... identify the [art] movement that they went into, and they had to identify the ... artist who created them, and then they had to go make a table of the style and techniques, and I think their subject matter or something. (Teacher 18)</i>	2	2	4
19	Accessing reference material to create a worksheet	English	8	<i>We've got a little disadvantaged partner school down the road. And they [her learners] were creating worksheets. They had to find a little passage and then write questions on that passage and I showed them how to do crosswords and word searches and all that on the Internet. (Teacher 21)</i>	2	2	4

*First *DigiDays* tasks set for that grade in that subject.

**Descriptions in italics were supplied by teachers during interviews while descriptions not in italics are my descriptions based on hard copies of *DigiDays* tasks supplied by the teachers.

²⁸ An art movement refers to a particular art style, e.g. Impressionism ("Art Movements - artists, styles, techniques and ideas," 2013)

	Type of learner task	Subject	Grade	Description of task**	Effect of using ICT (3)	Design of task (3)	Total score (6)
20	Answering questions (includes drawing a graph in <i>Excel</i>).	Life Sciences	11	Learners were required to answer 14 questions from their textbook in a <i>Word</i> document, including questions which involved analysing data. The first question required learners to produce graphs which they were instructed to do in <i>Excel</i> and paste into their <i>Word</i> documents.	2	2	4
21	Designing a card.	Afrikaans	9*	<i>... I asked them to create a Valentine's day card ... and some of them created a whole little movie clip, rather than just a ... conventional ... two-dimensional card. (Teacher 16)</i> The main feature of this task is that the learners had to design the card in Afrikaans.	3	1	4
22	Worksheet on typing mathematics in LaTeX ²⁹ .	Mathematics	All grades*	<i>Basically, it was typing a formula sheet into ... using LaTeX and typing ... just typing ... using a computer language to type out mathematics. (Teacher 38)</i>	3	1	4
23	Creating a basic PowerPoint presentation.	Natural Science	8	Learners had to answer questions from their textbook in <i>Microsoft Word</i> and prepare a <i>PowerPoint</i> presentation on an alien plant.	3	1	4
24	Creating a complex PowerPoint presentation where learners had to insert hyperlinks	Natural Science	9	<i>... with their Expo projects they all had to do their presentations on PowerPoint. We got all the kids to do PowerPoint presentations ... as preparation for the end of their projects. And it ... it's been such a delight for me because we've hyperlinked all the ... network sites they've used ... so we can go straight onto it and we can check for plagiarism. (Teacher 39)</i>	3	1	4
25	Answering questions on the lyrics of a song after watching a video.	English	9	<i>I created a comprehension test on a Nickelback ... music video. (Teacher 25)</i>	3	1	4
26	Research task on steroids.	Natural Science	9*	<i>I did a thing on steroids ... All I wanted them to do was that they had to define what steroids are ... and then they had to tabulate it into advantages or reasons why people take steroids or ... no, it was advantages and disadvantages ... what would you gain by taking steroids and what would you lose by taking steroids. And ... then they had to find pictures of advantages and pictures of disadvantages, because the picture just kind of makes the words make sense to them. (Teacher 24)</i> Learners were required to write an essay.	2	3	5
27	Answering questions based on various articles and suggesting solutions.	Geography	11*	Learners had to access articles about flooding in different areas of Johannesburg, analyse why that area was being flooded and then provide solutions to prevent future flooding:	2	3	5

*First *DigiDays* tasks set for that grade in that subject.

**Descriptions in italics were supplied by teachers during interviews while descriptions not in italics are my descriptions based on hard copies of *DigiDays* tasks supplied by the teachers.

²⁹LaTeX is free software used to type technical and scientific documents ("LaTeX – A document preparation system," 2010).

	Type of learner task	Subject	Grade	Description of task**	Effect of using ICT (3)	Design of task (3)	Total score (6)
28	Accessing reference material to devise and conduct interviews on the digital divide.	Computer Applications Technology	11	<i>I ... decided to set the task on the digital divide and I wanted them to do an investigation and asked them basic questions about ... the `different generations and how the digital ... divide has affected them, their own families, within their own family and just outside and then I wanted them to interview their parents and find out how their parents were using technology to get their work done. And also, I asked them what their opinion was about ... people at school ... members of staff, other children, and administrative staff - their impression of their use of technology and they had to give me feedback on that. They had to do it in the form of a report. They ... they had to ... research some information on the Internet about "What is the digital divide?" ... they had to use their textbook to get some more answers but they had to do the research beforehand and then type up their answers. It was a lot more like a report. Well, like short questions, so ... (Teacher 36)</i>	2	3	5
29	Accessing reference material to synthesise an essay on recycling.	Life Sciences	12*	<i>It was a recycling... recycling essay, and we based it on plagiarism and it was just a way of ... we gave them a document on plagiarism, I think ... and how to source, or something ... something related to that ... ja. And it was related to "Is recycling worth it in South Africa?" (Teacher 34)</i>	2	3	5
30	Drawing up an income statement in <i>Excel</i> .	Accounting	12	For this task learners would have to analyse the transactions in the income statement to identify payments and income, and correct any incorrect entries in the income statement. They then had to draw up a trial balance reflecting the information in the income statement, showing debits and credits. Both the income statement and trial balance would need explanatory notes for more complicated transactions to justify why a transaction had been entered in a particular column. <i>Grade 12s ... I gave them ... a big income ... a pre-adjustment trial balance with adjustments. And then they had to draw up an income statement and a balance sheet with notes. (Teacher 14)</i>	2	3	5
31	Analysing an advert (visual literacy exercise).	English	10	Visual literacy involves analysing unfamiliar images to recognize and understand the ideas being portrayed or conveyed.	3	3	6
32	Worksheet on geographic photographs using Google maps.	Geography	8*	<i>So, for the Grade 8s I had just done a ... a section on orthophotographs and ... aerial photographs and all the different types of geographical photographs and so ... I got some screen shots from Google Earth ... as well as Google maps, as well as a scanned-in map and put them all into a questionnaire ... just asking them generally "What is this? Is this an aerial photograph? Is this ... vertical? Is this. ... birds-eye?" ... and then asking them to locate, by looking at the picture and looking at the map, "What are those things?" (Teacher 28)</i>	3	3	6
33	<i>Phet</i> simulations of chemical equations.	Natural Sciences	9	This task consisted of three simulations involving chemical reactions to help learners understand how to write equations and how to balance them.	3	3	6

*First *DigiDays* tasks set for that grade in that subject.

**Descriptions in italics were supplied by teachers during interviews while descriptions not in italics are my descriptions based on hard copies of *DigiDays* tasks supplied by the teachers.

Analysing the potential of the DigiDay tasks to promote meaningful learning

If the enormous expense and effort involved in installing, maintaining and using ICT are to be justifiable, ICT should be used to promote learning in ways which might be more efficiently or effectively done using ICT than not using it.

My aims in analysing the 33 *DigiDays* tasks were two-fold: to see to what extent teachers were setting tasks which took advantage of the potential benefits of using technology, and to see to what extent teachers were designing tasks which could help learners construct their own knowledge (i.e. go beyond the basics of simple reception learning, which could be achieved more easily and cheaply without ICT). I also wanted to explore possible reasons underlying the types of task teachers set, as this could suggest areas where differentiated professional development for teachers could be targeted (i.e. tailored to specific needs) if a school aims to maximize the effective use of ICT for high-level learning outcomes.

Figure 69 shows the two criteria used to rank the digital tasks — the pedagogical design implied in the task (horizontal continuum) and the effect of using ICT to carry out the task (vertical continuum) — as two intersecting continua on which I have represented the 33 tasks. The 33 tasks were those used during the first 18 months after the innovation had been introduced, which meant that some of the tasks were the first *DigiDays* tasks some teachers had set. The tasks which were the first *DigiDays* tasks set are shown in a different colour (orange) in the scattergram.

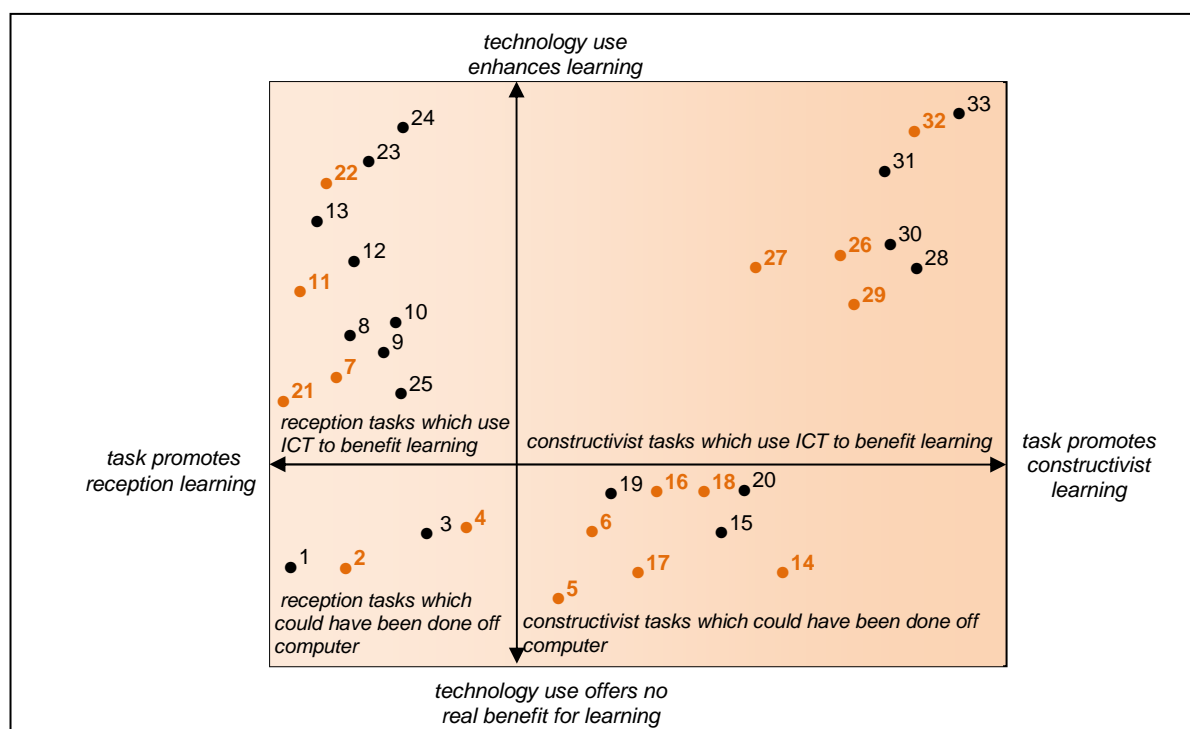


Figure 69. Potential of the *DigiDay* tasks to promote meaningful learning

In Figure 69 the 13 tasks below the horizontal continuum represent tasks which might just as well have been done off computer, while the 20 tasks plotted above the horizontal continuum resulted either in increased efficiency or increased effectiveness of learning (as defined on page 227 in

Chapter 6), the latter being plotted higher up the vertical continuum. The 16 tasks to the left of the vertical continuum do not go beyond reception learning, while the 17 tasks to the right of the vertical continuum go beyond reception and show increasing potential to promote constructivist learning the further right they are plotted.

I first examine **tasks which failed to use the potential benefits of using computers**, i.e. the tasks plotted below the horizontal continuum in Figure 69, in the two bottom quadrants:

- **Reception-learning tasks which could have been done off computer** (bottom left-hand quadrant). A small proportion of the 33 tasks (Tasks 1-4, which made up 12% of the tasks), both failed to take advantage of the benefits of using computers and did not go beyond the reception level of learning. For example, for Task 2 learners were required to supply the pronouns in an Afrikaans worksheet, which did not need to be done on computer and involved cognitive activity only at the knowledge retrieval level. Although reception learning is a necessary part of learning, and an important building block for all higher-level cognitive tasks, some researchers believe that ICT is best used in education when used to support more constructivist pedagogical approaches to instruction (see Drent & Meelissen, 2008; Ertmer et al., 2012; Kozma, 2003; Peeraer & van Petegem, 2012).
- **Constructivist tasks which could have been done off computer.** The nine tasks in the bottom right-hand quadrant could also have been done off computer. Some subject-specific software packages could promote off-computer activities (as discussed in Chapter 5, page 132). However, the design of these tasks would better promote constructivist learning than the tasks in the bottom-left hand quadrant. For example, Task 20 (learners were required to analyse data from their textbook and type up their answers, and plot a graph using Excel according to specifications given by the teacher, such as which variable to plot on which axis), was judged to promoted constructivist learning BUT could have been done off-computer. Learners could have written out their answers and drawn the graph on graph paper. This task could have made better use of computers had learners been required to decide which variables to plot on what axes and/ or been asked to analyse the data from the graph. Some researchers (e.g. Barton, 1997; Frost, 1997) suggest that carrying out activities like drawing graphs on computer saves time, which learners could use for analysing the data. However, in the case of Task 20, learners were only asked to draw the graph, and did not have to analyse it, so the task could just as well have been done off computer.

There are a number of possible reasons why some teachers set tasks which failed to use the potential benefits of using computers to improve learning. Knowing these reasons could help professional development planners decide how best to help teachers to utilise the potential of computers to better effect. Firstly, some teachers may have set tasks which failed to use the potential benefits of using computers because the topic of work they were faced with the predicament of having to set a *DigiDays* task when they were covering a section of content not suitable for learners to carry out computer-based work. Secondly, some teachers might have simply needed to find a task to use for *DigiDays*, and may not have had the time to specially design new tasks or to adapt old tasks for to better utilise the advantages of using computers. The following comments refer to Tasks 5 and 6 (see Figure 69), both of which were first *DigiDay* tasks and which failed to utilise the affordances of using technology:

And I can only speak from [sic] my ... subject, okay? We haven't pushed the boundaries. We basically say "Listen, submit this via ..." you know. (Teacher 19 about Task 5)

No, because I would have given it to them anyway, so because of the fact that I had to have something for Moodle, I decided that would be the easiest route to go. (Teacher 23 about Task 6)

The comments above suggest a third possible reason why some teachers set tasks which failed to use the potential benefits of using computers to improve learning – some teachers might not have been convinced that using ICT could benefit learning, and thus may not have seen the relevance of designing special learner-based tasks. Finally, some teachers may have lacked the necessary knowledge to design computer-based tasks which use technology effectively for learning. According to Mishra and Koehler (2006) the use of ICT for teaching requires teachers to combine three types of knowledge – technological knowledge (knowledge of the different types of digital technologies available and how to use them), pedagogical knowledge (generic knowledge about methods of teaching and learning, including knowledge about techniques to be used in the classroom and ways of assessing learner understanding) and content knowledge (knowledge of the subject matter). A lack one or more of these three types of knowledge may contribute to ICT being used in ways in which do not take advantage of the potential benefits of using ICT for learning. In South Africa efforts to get teachers to design their own teaching materials for traditional **paper-based** activities as part of a new curriculum were not successful. In a review of the curriculum implementation process Chisholm et al. (2000) found that it had been unrealistic to expect South African teachers to produce their own lesson materials, e.g. given the extra time this would require. Where teachers are unable to set meaningful paper-based tasks they are likely to find it even more difficult to design their own meaningful **computer-based tasks**.

The tasks in the two quadrants above the horizontal continuum in Figure 69, on page 246, represent ICT learning activities which were judged to benefit learning either by making it more efficient to carry out a task using computers or which used technology in ways which enhanced the potential of the task to benefit learning (plotted further up the vertical continuum).

- **Reception-level tasks which use ICT to benefit learning.** Although the 12 tasks (36%) in the upper left-hand quadrant represent tasks which either make learning more efficient or more effective, they do not go beyond simple reception-learning activities. An example of the former type of technology usage would be requiring learners to search for information on the Internet (e.g. Tasks 7, 8, and 9), which is likely to be more efficient than having to acquire books to look up information. Tasks towards the top end of the technology-usage continuum typically required a specific type of software, for example, *PowerPoint* (see Tasks 23 and 24 in Table 34, on page 242), which required that they be done on computer. However, this group of tasks, while they benefited from being carried out on computer, did not promote learning beyond the reception level. Some teachers may have deliberately set reception-level tasks because this was their goal for that particular task. For example, the Mathematics Department needed learners to practice how to type mathematics equations using a special mathematics software package in preparation for future *DigiDays* tasks. They thus set Task 22 as the first Mathematics *DigiDays* task for all grades. Another possible reason why some teachers set low-level tasks is because these might have been easier to use as a first *DigiDays* task. For example, the teacher who set Task 7 said that he had used a task he had previously required learners to do off computer and

just asked that they do it on computer. Some teachers who designed *DigiDay* tasks having low potential to promote construction of subject knowledge may not have thought carefully about their underlying pedagogical reasons for constructing the tasks. For example, Task 21 (the Valentine's Day task discussed before Table 34, see page 241) allowed learners to produce a decorative finished product, but offered little benefit in terms of subject learning other than potentially improving learners' Afrikaans vocabulary. The fact that some learners produced a movie clip, thereby making it necessary to carry out the task on computer, is purely coincidental as the teacher had not instructed all learners to do that. Squires and McDougall (1994) believe that software which is not underpinned by learning theory cannot be expected to have much educational value (see Chapter 5, page 133). This implies that teachers would have to consider what they wanted to achieve when designing tasks. Finally, some teachers may have been unaware of how to set tasks promoting meaningful learning, suggesting that they lacked the pedagogical knowledge to set tasks which promoted meaningful learning. According to Squires and McDougall (1994) software which promotes off-computer activities could be useful to help learners construct their own knowledge (see Chapter 5, page 132).

- **Constructivist tasks which use technology to benefit learning.** The eight tasks in the upper right-hand quadrant combined the effective use of technology for instruction (as for tasks in the upper left-hand quadrant) with the potential to promote meaningful learning, which the tasks in the upper left-hand quadrant had not achieved. An example of a task which exemplifies using technology for constructivist learning is Task 33. This task, which was based on science simulations (for which ICT was absolutely essential) allowed learners to manipulate the reactants in chemical reactions in ways which helped them to better understand how to balance chemical equations, thus promoting constructivism. The following comment by a Natural Sciences teacher who had seen learners doing Task 33 highlights the benefits of learners carrying out this task on computer:

... ja, I must say I was very impressed, the last time I invigilated [in the computer lab on a DigiDays], with Teacher 40's little DigiDays thing that he'd done for the Grade 9s. I had a quick squiz at it and I thought it was really brilliant, because, you know, chemical equations and chemical bonds and stuff are things that kids really struggle with ... because it is so abstract, you know? And I mean, Teacher 33 and I have tried jelly tots and ... paper clips and ... I don't know what-all else ... but you know if they can just play around a bit on the computer, you know, and it's ... it's almost like a 3-D looking thing and ... I thought it was awesome. I thought that in terms of teaching balancing chemical equations and just chemical bonding, I thought that was just brilliant ... I really, really did and ... just a million times more useful than trying to draw little dots and big dots and small dots and green dots and purple dots on the board. (Teacher 24)

Ertmer et al. (2001) suggest that what constitutes exemplary technology use would depend on the particular educational context within which technology is being integrated. Riel and Becker (2008) believe that teachers who are “(a) more constructivist than other teachers of the same subject and level, and (b) use computers substantially more than other teachers do” could play valuable roles as teacher leaders in the dissemination of appropriate technical and pedagogical skills and knowledge for successful ICT integration (Riel & Becker, 2008, p. 398). Within the context of the case study school, teachers who set exemplary computer-based tasks, i.e. tasks which combine the effective use of technology for instruction and also promote high levels of constructivism (like Task 33) could serve as role models for teachers who are less competent or confident using ICT for learner-tasks.

Looi, Sun, Seow, and Chia (2014, p. 222) point out that teachers' uptake of a **curricular innovation** is influenced by a number of factors including *"differing levels of content readiness, pedagogical orientations, teaching competency, different student profiles, and professional development experiences"*. Analysing the potential of the *DigiDays* tasks to promote meaningful learning shows that different teachers at the case study school were at very different stages of readiness to be able to set effective computer-based tasks. These teachers could have benefited from differentiated support focused on areas in which they needed specific help with designing effective computer-based tasks which better take advantage of the unique benefits of using technology for teaching and learning. This aspect will be explored further in the final chapter of this thesis.

7.1.3 Changes in individual teacher's computer use

Having examined the extent and nature of the changes in teacher's computer use after the innovation, for the 29 teachers as a group, in this section I report on the changes in **individual** teacher's computer usage after the innovation was introduced. The ICT innovation at the school effectively levelled the playing field in terms of institution-level factors' for ICT integration by establishing an 'ICT culture' promoting technology use and by providing teachers with ICT resources. However, Gibson et al. (2014) point out that *"research indicates that access to computers alone is not enough to impact teacher integration of these technologies"* (Gibson et al., 2014, p. 166). Teachers' responses to the innovation are thus likely to depend on differences inherent in the teachers, i.e. teacher-level factors. Examining the nature and extent of the different responses could provide insight into the reasons why teacher's computer usage changed in particular ways.

Figure 70 shows the total computer usage for each teacher before and after the innovation was introduced, arranged in decreasing order of total usage before the innovation, based on 'usage units', (see Chapter 6, page 226). However, as discussed in the previous chapter, Mitchell (1997) regards it as inappropriate to add the values for very different items to obtain **total scores** for inferential analyses. The **total change** for each teacher was therefore not tested for statistical significance, as this would have required adding frequencies of use across very different types of computer tasks.

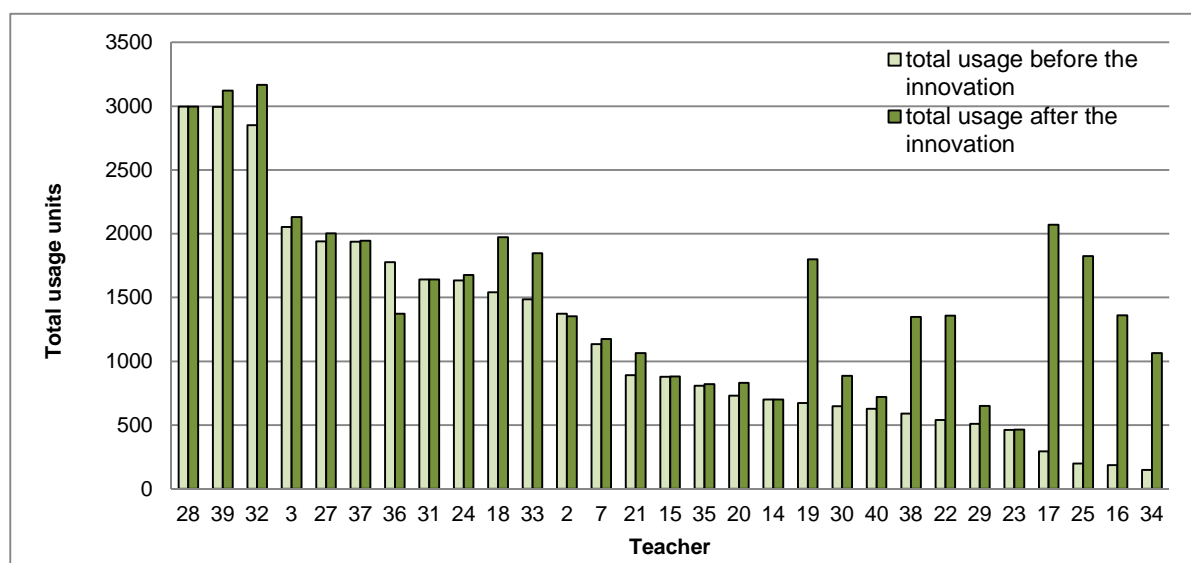


Figure 70. Individual teachers' total computer usage, before and after the innovation

Three of the 29 teachers (Teachers 28, 3, and 14) showed no change in total computer usage after the introduction of *DigiDays* (see Figure 70). For Teachers 15 and 23, the total computer usage looks unchanged, but differs by two units. For the 26 teachers for whom the total usage units showed no change I looked at the number of task types (of the 19) which increased and the number of task types which decreased for each teacher, which I then analysed for statistical significance using the two-sided sign test.

Figure 71 shows the 26 teachers for whom the total computer usage changed after the innovation, arranged in order of decreasing significance of the changes.

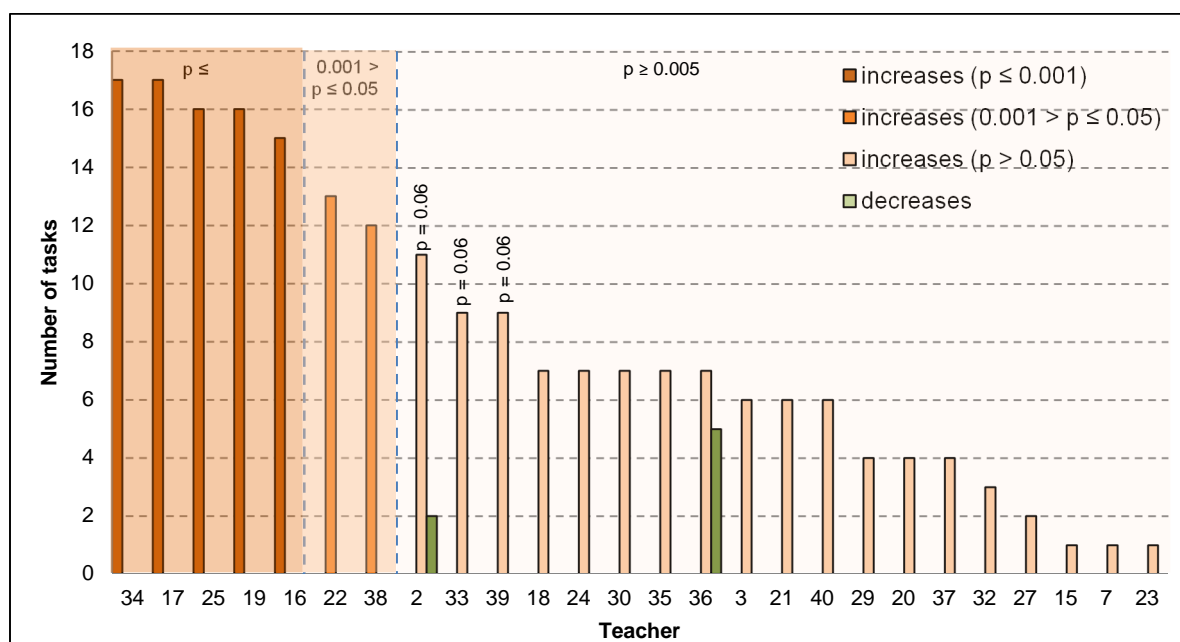


Figure 71. Increases and decreases in different computer tasks, after the innovation, for 26 teachers

Case studies of selected teachers

To better understand the factors influencing the changes in teachers' technology usage after the innovation, I selected certain teachers from each of the three groups – teachers who showed no change in computer usage after the innovation, teachers whose changes were statistically significant and those for whom changes were non-significant – as case studies. Each case study is a descriptive summary of the teachers' ICT profile. The ultimate purpose of looking at case studies was to see what these individual teachers would need in terms of professional development to promote the judicious use of technology for instruction.

Case studies of teachers who showed no change in technology use

Based on their responses to closed-ended questions about their total usage of 19 computer-based tasks before and after the innovation (see Appendix AS), three teachers showed no change in their technology usage after the innovation. One of the three teachers teaches Information Technology and Computer Applications Technology. The reason for the lack of change for Teacher 31 appeared to be that he used computers in virtually all of his Information Technology lessons, even before *DigiDays*:

All lessons ... even theory lessons I sometimes use them. Theory is your ... more like teaching how your different components work ... whatever. Obviously you'd then be pointing to a computer. You open up a computer or whatever, but ... sometimes what I'll do I'll log onto a computer and display [it] anyway to show them an example of that type of utility or a network issue or something. (Teacher 31)

Because he reported using computers as much as was possible before the innovation, the introduction of *DigiDays* had no impact on his technology usage during lessons. This teacher, because of the sustained high levels of computer use dictated by his subject, was not considered a suitable candidate for a case study.

Case study 1 (Teacher 28) is presented on the facing page. The lack of change in this teacher's total technology usage after the innovation could also be due to the fact that he was already using computers in virtually every lesson, thus he could not make much more use of technology. Examining this teacher's classroom use of computers suggests that he was using ICT in ways likely to promote meaningful learning. Firstly, he was one of only three teachers who described creating his own complex *PowerPoints*. Teachers' use of complex *PowerPoints* is more likely to engage learners in constructing their own knowledge when compared with basic *PowerPoints* (see Chapter 1, page 11). Secondly, he had set a *DigiDay* task (see Task 32 in Table 34, page 242) which made effective use of computers and was ranked joint first out of the 33 tasks, for potential to promote meaningful learning. These two points suggest that this teacher is able to combine his pedagogical knowledge and his technological knowledge to promote meaningful learning.

Teacher 28 was in a fortunate position in that the previous Head of the Geography Department had equipped all of the geography classrooms with a data projector and five computers for learner use, as well as a network point for Internet access. He thus had the necessary equipment to be able to start using ICT in his teaching as soon as he had started teaching at the school. The ready availability of ICT hardware could thus have been a major factor encouraging him to integrate technology, as was the school's ICT policy promoting the use of computers for instruction. However, the real issue is that he appeared motivated to use technology in his teaching and having the necessary resources gave him the opportunity to do so. He had already been using the mandated tasks even before he was required to do so for *DigiDays*. The pattern of greater 'teacher' than 'learner' computer usage is not due to Teacher 28 not wanting to set computer-based tasks for his learners, but rather due to the limited availability of computers in his classroom. He also displayed a high level of innovativeness towards integrating ICT by looking for new software to use in his teaching and not being afraid to try out new things. However, his focus was on using ICT to improve learning and not merely to try out new technologies.

Case study 2 (Teacher 14) appears on page 254. This teacher's high level of comfort and his ability to use a variety of ICT applications suggest that his limited use of technology in his teaching was due to a lack of motivation to use computers. His main interest in using ICT for teaching seemed to be to increase the efficiency of carrying out certain tasks and for increasing learners' level of interest in lessons, without any real consideration for the potential benefits for learning. He seemed to prefer to maintain the status quo, without exerting himself too much. The compact disc he was using had the answers to exercises from the textbook his learners used. This disc had been supplied as support material for the textbook, so had not required any effort on his part to find or purchase software he could use in his teaching.

Case study 1: Teacher 28

Gender	Male
Age group	20-29
Subject(s)	Geography (Grade 10); History (Grade 8 and 9)
Level of ICT training	No formal training
Level of ICT competence	High
Level of ICT use outside of school	High
Ranking for total ICT usage before innovation	1/29
Ranking for total ICT usage after innovation	3/29

Level of confidence: This teacher described himself as feeling confident about using technology:

... when I was at school I took ... what was it ... computer literacy ...and I got a distinction in that and ... but I mean, that was mainly because I've just been using computers ever since I was a kid, I think? So, I mean, I've grown up in that generation where ...

Level of competence: He describes himself as extremely competent using computers, described producing his own complex *PowerPoints*:

*... the only thing I don't know how to do in ... is the programming side of things. So in terms of the 'using a computer side of things' ... I mean, I'm always helping people out (laughs) to do things ...
... I found quite limiting in that using ... PowerPoint for like my school presentations, there's ... there's only so many types of animations you can do or transitions and so on ...*

Level of instructional computer usage: He used technology in virtually every lesson, but mainly for teacher instructional tasks rather than learners using computers:

I hardly use a board, I only use the projector ... and only when there's a power failure will I revert to other ... things, so there'll always be some sort of ... something that I'm showing on the projector. If it's a small video clip that I'm using to introduce the topic or notes from PowerPoint or ... but I wouldn't say a lesson goes by without using it ...

Teaching philosophy: Uses technology to enhance his teaching, and help learners construct knowledge

... and I have used Google Earth quite a bit ... like I'll hand out a map of the area so they can see what it looks like and then they must find the co-ordinates, give me the co-ordinates ... I'll put them into Google Earth and they can see what it looks like in real life, which ... which makes a big difference.

Relevance of using technology for teaching: He sees himself as modelling technology use for his learner:

... I would say that ... there was no going back in terms of where the world is progressing to in terms of technology and so I don't see people carrying books around in ten years time, so ... and notepads and so on, it will all be electronic. So I think that the more that I can encourage general use of computers to my learners, in just any sphere of life, the better, because the sooner they become au fait with it ...

Major barrier to greater technology use: He described not having sufficient computers in his classroom as the biggest factor preventing him from setting more computer-based work for his learners.

Innovative approach to integrating technology: He regularly looks for new software to use in his teaching:

... I'm constantly downloading video tutorials on different programmes which I'm trying to learn how to use...

... only so many types of animations you can do ... or transitions and so on, so ... I've got a new programme ... which is one of the Adobe creative suite programmes and so I've ... looked at creating my own video intros all together for ... a particular slideshow, you know?

He mentioned some ideas he had for trying new things with his learners:

... have a few ideas of also doing a mapwork centre thing, where they have to get ... directions from one place to another using Google maps and then ... now that they've got street view, to give me the street view of certain intersections so that we can see if there's a KFC there or whatever that they ... I'd still need to work on a ... on a lesson plan around that, but I have a ... a couple of ideas that ...

Is encouraged by the school's ICT policy:

... I probably would have been ... less ... encouraging of ... computers if I didn't know that the ... that that was the school's ... backing ... and so therefore I can ... preach it in my classrooms know that I have DK's backing in terms of where he's wanting to push the school

Case study 2: Teacher 14

Gender	Male
Age group	30-35
Subject	Accounting
Level of ICT training	No formal training
Level of ICT competence	High
Level of ICT use outside of school	High
Ranking for total ICT usage before innovation	18/29
Ranking for total ICT usage after innovation	27/29 teachers

Level of confidence and competence: This teacher felt very comfortable and competent using computers. He described being able to use a range of applications and having good computer skills. He had used computers as an "essential auditing tool" before entering teaching:

... I've been using computers since I went into ... the corporate world. We had to use computers, Excel, Word, auditing programmes, etc. So, for three years I had to use that and use formulas and all that, so that's why I've said I was competent.

He was able to create his own complex *PowerPoints*:

... for the Grade 12's I put on a ... one of the sections, I put it onto a PowerPoint with music and little ... pictures that dance and things like that.

Instructional computer usage: He described mainly using computers for administrative purposes like recording marks and preparing worksheets and tests, rather than for learner use. His only reported type of learner use involved learners looking up information on computer a couple of times a year. His computer usage during lessons was limited, both in frequency and potential to promote meaningful learning. Most of it was based on "a CD with all the answers and things on like that", which he used to project answers onto the screen:

... ja, just for memos and things like that ... 'cause we've got disks for accounting which, with all the memos ... so that we wouldn't have to just read through it.

... I just put it onto the computer and show them ... show them the memos ... the different ways of doing an example.

Other types of computer usage during lessons he described were that he had used a *PowerPoint* presentation that he had created, and that he also used his classroom computer and data projector to show movies:

I have shown ... that movie to my matrices, last year ... and the year before ... Wall Street?

... the PowerPoint presentation for the ... for the Grade 12's ... on CCs [closed corporations] ... I used that with them and found that it was successful. They were probably more interested because there was music added to it, there were little characters that would dance to the music ... and then you could go through the points one by one ...

Perceptions of relevance of using technology for teaching: His main reason for using technology appeared to centre around it being more efficient, and for enhancing learners' level of interest in his lessons:

I think I enjoy working on a computer. It's a lot better than writing out things.

... ja, if I had to do a calculation and ... I would show them just with ... on Excel, I'd show a calculation on Excel, like that.

... a lot of them use technology today and if we can ... if we can do that and ... get them more interested in the ... in school work then that's always a bonus.

Response to the innovation: When asked for his view on *DigiDays* his immediate response was not about any possible pedagogical benefits:

I thought it was [an] excellent idea ... well not only 'cause we got the day off ... but getting into the world where the kids are.

His response when asked whether he had used *Moodle* outside of *DigiDays* suggested that he chooses to use teaching methods that do not require much preparation.

... no ... we use a workbook ... in the class ... with all the frameworks in already and all the activities are done in that workbook and it's ... probably easier to monitor than to upload ... to go in and see whether they've done it or not. It's also probably being a bit lazy and not doing it on computer.

Level of innovativeness: This teacher indicated that he had ordered a subject-specific software package for learners to "start using that probably next term", suggesting that he intended making more use of computers in the future.

The comment made by Teacher 14 about “*probably being a bit lazy*” could be an important reason why there had not been any change in this teacher's computer usage, despite the school's emphasis on promoting the use of ICT for teaching and the fact that he had access to a computer and data projector in his classroom. He displayed a lack of intrinsic motivation to adopt new teaching practices and his lack of change in ICT usage despite the newly instituted emphasis on using ICT for instruction in the school. While this teacher's intention to start making more use of subject-specific software with his learners in the future could suggest that he may be shifting towards using technology more (the software having come his way without him doing anything), it could also be related to the possibility of using the software for *DigiDays* tasks, and not having to design special tasks, as suggested by the following comment:

... when we start with ... Pastel, then I can give them ... activities on DigiDays ... on Pastel itself.
(Teacher 14)

Further evidence of this teacher's apathy towards adopting ICT is illustrated by the following comment:

... ja, I think probably if I ... knew ... sites ... subject- specific ... if I could get that then I'd probably use it a lot more ... and that's probably down to me doing some research and finding ... sites that ... that can help. I know the Afrikaans teacher sent us something the other day ... to look at which I haven't had time to look at yet, which I will still look at this week ... (Teacher 14)

The comment suggests that this teacher's failure to make more use of computers in more beneficial ways is mainly due to his inaction in following up on possible actions which could have improved his meaningful use of ICT for teaching and learning. Given that this teacher felt comfortable using computers and is able to use a wide range of applications, his lack of technology usage appeared to be underpinned by a lethargic attitude, which could be difficult to change.

Case studies of teachers who showed significant change in computer use, after DigiDays

Twenty-six teachers showed changes in their total computer usage after the innovation (see Figure 70). Figure 71 shows that five of the 26 teachers had highly significant increases ($p \leq 0.001$), two had significant increases ($0.001 \leq p \leq 0.05$), while another three (Teachers 2, 33 and 39) had increases close to the traditional significance level, with p -values of 0.06. The latter increases will be regarded as significant because of the small magnitude of difference between the traditional significance level of $p = 0.05$, which represents a 5/100 chance that the observed change cannot be attributed to chance alone and a p -value of 0.06, which represents a 6/100 chance. Thus, the increases for 10 teachers (34%) will be regarded as significant (a low probability that they were due to chance circumstances). Figure 71 also shows that only two teachers, Teacher 2 and Teacher 36, showed a decreased usage (for two and five of the tasks, respectively). However, neither of these decreases proved to be significant.

Within this group of 10 teachers I selected four of the five teachers who had highly significant increases ($p \leq 0.001$) as case studies, both teachers who had significant increases ($0.001 \leq p \leq 0.05$) and one of the three teachers with an increase close to the traditional significance level (p -values of 0.06) to better understand the factors which influenced these significant or close to significant changes. Thus, seven case studies of teachers who showed significant changes in computer use, after *DigiDays*, are presented. Each case study includes a graph showing the **profile of change in computer usage** for each teacher with the bars for two types of mandated tasks teachers had to use for *DigiDays* shown in red. The two mandated tasks, Task 5 (*communicating with learners about administrative matters*) and Task 8 (*posting work on the Internet*) may not reflect real changes in

teachers' attitude and beliefs towards using computers for instruction, since teachers were required to carry out these tasks on *DigiDays*.

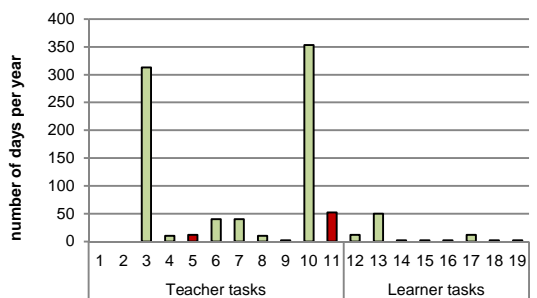
Case study 3 (Teacher 34) (see facing page) was selected because she had the lowest total computer usage before the innovation (see Figure 70), and had shown a highly significant increase in the number of computer-based tasks she was using after the innovation (see Figure 71). However, the increase in her level of usage appears to be because the school required it, without any underlying belief that computers could enhance her teaching. She reported increased usage of nine of the 11 teacher-tasks and all nine learner-tasks after *DigiDays*, although the largest increases were for teacher-tasks (Task 3 – *communicating with colleagues* and Task 10 – *using multimedia presentations in lessons*). The learner-task with the largest increase was Task 13 (*using subject-specific software to access content*), although this teacher provided no evidence, when interviewed, that she was using any subject-specific software package with her learners.

Teacher 34 was in her second year at the school when the innovation was introduced. At her previous school, she reported only having used computers for the occasional *PowerPoint* presentation, despite having had a data projector and screen in her classroom and having had access to subject-specific software. When starting at the case study school this teacher continued to make very little use of ICT for teaching, despite having a screen and a data projector mounted in her laboratory. She also had a *Mimeo*, which converts an ordinary whiteboard into an interactive one, which she reported never having used. Despite having so many ICT resources available, she had the lowest total computer usage of the 29 teachers, before *DigiDays*. After *DigiDays*, her computer usage increased across a number of teacher tasks and for all types of learner tasks, but her total overall usage remained low (tenth lowest total usage). This teacher's low usage of ICT suggests a lack of motivation to use technology for teaching, apparently underpinned by a low level of confidence about using computers for instruction, which seems to be related to her lack of ICT competence. The excerpts in her case study suggest that she was able to use only a narrow range of applications, that she relied on others to provide ready-made spreadsheets into which she could enter her marks, and that she preferred to use *PowerPoint* presentations created by others. In spite of her lack of ICT competence, she appeared willing to learn how to use computers, now that she was required to do so by the mandated change introduced by the school. In many of the excerpts given in her case study she makes reference to having learned something or learning that is taking place as she uses ICT more frequently. Some of the comments made by this teacher suggested that she sometimes relied on more traditional methods of teaching because it was easier than using technology. She explained why she had never taken learners down to the computer lab:

And just maybe the whole thing of ... setting, setting it up, you know? I tend to think "Okay, well, I don't have enough time", so I must therefore just make do with what I've got in class. (Teacher 34)

This teacher's lack of motivation to overcome possible obstacles to use computers for teaching, despite having had access to ICT resources, and that she appeared to feel more comfortable using a traditional approach to teaching, suggest that the significant change in her usage might not reflect a change in her underlying attitude towards integrating technology. After the introduction of the innovation she had started using computers more, but it appeared mainly because she was required to do so. There could be a chance that if this teacher were not required to use computers in her teaching, she would not sustain her current level of usage. For the most part, this teacher appeared to prefer using traditional teaching methods to using technology.

Case study 3: Teacher 34

Gender	Female
Age group	40-49
Subject	Life Sciences
Level of ICT training	Basic <i>Word</i>
Level of ICT competence	Low
Level of ICT use outside of school	Low
Ranking for total ICT usage before innovation	29/29
Total ICT usage after innovation	20/29 teachers
Extent of change in ICT use after innovation:	

Level of confidence: This teacher had made little use of computers, before *DigiDays*, because she lacked the confidence to do so. However, she described feeling more confident since she was required to use computers for the innovation:

Ja no, it's definitely increased. Because before I actually wouldn't even touch it because I thought "Ag, I just don't know what to do." But then, it's just, every time I do something it just grows and I just find out more things and ... Definitely, my confidence has improved a lot.

Level of competence: Her low level of competence is evident from the following excerpts, in which she emphasises how little she knows about using computers, and how she is learning as she goes along:

I mean, I'm learning every single time, even today when the kids come with the ... thing ... they have to do a brochure. I didn't know that, you know, you could actually do a brochure template and the kids could sort of do this ... I've just learnt that today [laughs].

And I said to them you have to do the graph on Excel, but I'm thinking to myself "I'm not too sure how to do it myself, but I'm going to learn very quickly".

... as far as, you know, [the] mark book, it's usually done for us, so the whole format is done. But as we're sort of going into it and looking at marks ... I'm just learning about the formulas ... sort of learning as I'm going along.

I just found that ... a lot of the PowerPoints that we've asked the kids to do ... and then I've saved them and then maybe used them for another class, and they tend to respond to that, because, you now, some of that their colleagues or their peers have done and they're kind of ... you know ... are able to maybe be more comfortable with the way that they've done them, perhaps, than if I've just gone and done it myself.

Instructional computer usage: Her use of computers in lessons, even after *DigiDays*, involved mainly using PowerPoint presentations, many of which she obtained from other teachers. As she described it she

... mainly just used PowerPoint, so ... as it is that was quite a new thing for me ...

Relevance of using technology for teaching: This teacher was not convinced that using computers benefits teaching:

I find sometimes the simplest little lessons ... I mean, you know with the matrices the other day I did ... the [ecological] pyramid [of numbers] with the ... cups and that. I couldn't believe how these matrices were loving this lesson, and it was so simple. It was polystyrene cups! And I thought, well, if I had the same lesson, maybe with PowerPoint and ... videos and clips of music, maybe it wouldn't have been as effective.

Teaching philosophy: She preferred a traditional approach to teaching, and expressed concern about learners experiencing "information overload" in lessons using technology and appeared much more comfortable with, as she called it, "sticking to the basics" and not using technology in her teaching.

Case study 4 (Teacher 17) is on the facing page. She was selected for a case study for two reasons. Firstly, she showed the greatest increase in total computer usage, after the innovation. Secondly, her computer usage is characterised by her enthusiasm for using ICT and the novel ways she was attempting to integrate ICT.

One of the novel ways Teacher 17 was using computers involved setting up a *Twitter* profile, and inviting her learners to follow her. The figure alongside is a snapshot of her *Twitter* page, which is called “*Praat Afrikaans*”. The profile for the site translates as

Learn Afrikaans! Appreciate Afrikaans. Speak Afrikaans, laugh Afrikaans, sing Afrikaans, eat Afrikaans! Everything you want to know in Afrikaans!! This teacher used the site to tweet idioms and to inform learners about Afrikaans websites, music and new book releases. However, she also tweeted instructional material, as demonstrated by the following tweet on 19

October 2010, which informs learners about four Afrikaans words used to describe various times of the day. It provides a good example of how *Twitter* can be used to teach basic content:

In die aand- saans, in die nag- snags, in die dag- bedags, in die oggend- soggens. (Teacher 17)

This teacher was one of the three teachers commissioned by the school to investigate the potential use of *Twitter* in the classroom. However, her usage of *Twitter*, described above, preceded the school requesting that she explore the use of *Twitter* in the classroom.

The value of using *Twitter* in education is debated in the literature. Two features make it useful as a tool for sharing information. Firstly, it can be accessed from virtually any communications device, providing there is an Internet connection available. This is useful because learners can access it on their cell phones, especially since cell phones have become ubiquitous. Secondly, the 140 character limit contributes to short, focused messages, which makes *Twitter* useful for sending learners short reminders of events or submission dates for work, or links to websites with supplementary reading. However, the 140 character limit undermines the usefulness of tweeting as a means of instruction. Firstly, not all students in the class would necessarily have seen the message. Those who were not following her would not have seen the tweet, and even learners who were following her could have missed the tweet due to the ‘*Twitter* feed’ constantly being updated with new tweets. Secondly, the overall contribution to learning of short instructional messages like Teacher 17’s tweet would have to be considered in the larger scheme of the work to be covered in the Afrikaans syllabus. However, Haythornwaite and Andrews suggest that using *Twitter* to inform learners about learning resources, as this teacher has done, qualifies as teaching:

... the largely informal nature of Twitter communications may mean that the application is best used for learning support to students rather than for teaching, although, when used to direct students to further learning resources, this division may get rather blurred. (Haythornwaite & Andrews, 2011, p. 13-131)

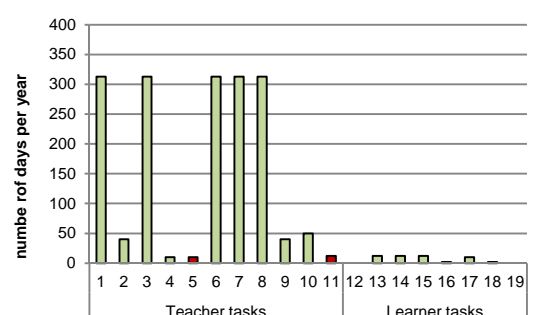
When I approached Teacher 17 for permission to mention her *Twitter* account in this thesis and to ask for feedback on setting up the *Twitter* account, she replied as follows:

You are welcome to mention my Twitter account. (I have not used it for Afr [Afrikaans] recently – to be honest, this year’s Grade 12 group are just not that into it. Weird thing, hey??) (Teacher 17)

This reply suggests that not all learners have been as responsive to this novel way of teaching. It could also be that the ‘novelty effect’ was wearing off after a year.



Case study 4: Teacher 17

Gender	Female																																								
Age group	40-49																																								
Subject	Afrikaans																																								
Level of ICT training	No formal training																																								
Level of ICT competence	Fairly competent																																								
Level of ICT use outside of school	High																																								
Total ICT usage before innovation	26/29																																								
Total ICT usage after innovation	5/29																																								
Extent of change in ICT use after innovation	 <table border="1"> <caption>Data for Case Study 4: Teacher 17 - Extent of change in ICT use</caption> <thead> <tr> <th>Task</th> <th>Number of days per year</th> </tr> </thead> <tbody> <tr><td>1</td><td>310</td></tr> <tr><td>2</td><td>40</td></tr> <tr><td>3</td><td>310</td></tr> <tr><td>4</td><td>10</td></tr> <tr><td>5</td><td>10</td></tr> <tr><td>6</td><td>310</td></tr> <tr><td>7</td><td>310</td></tr> <tr><td>8</td><td>310</td></tr> <tr><td>9</td><td>40</td></tr> <tr><td>10</td><td>50</td></tr> <tr><td>11</td><td>10</td></tr> <tr><td>12</td><td>10</td></tr> <tr><td>13</td><td>10</td></tr> <tr><td>14</td><td>10</td></tr> <tr><td>15</td><td>10</td></tr> <tr><td>16</td><td>10</td></tr> <tr><td>17</td><td>10</td></tr> <tr><td>18</td><td>10</td></tr> <tr><td>19</td><td>10</td></tr> </tbody> </table>	Task	Number of days per year	1	310	2	40	3	310	4	10	5	10	6	310	7	310	8	310	9	40	10	50	11	10	12	10	13	10	14	10	15	10	16	10	17	10	18	10	19	10
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Enthusiastic about using computers for teaching: This teacher described how she felt about using technology and how she felt about the innovation:

I think with us having a DigiDay, it's ... sort of forced you in a way [to use ICT], but I don't think I was forced. I already enjoyed doing it ... it's just allowed me to do it more.

High level of computer usage, after the innovation: She showed large increases, after the innovation, in her use of instructional teacher tasks like preparing worksheets (Task 7) and carrying out Internet searches (Task 8), which correlates with the high level of computer usage she reported:

I work on my computer every day ... every single lesson that I teach is computer-generated, is ... involves using my Proxima [data projector], involves using my ... my desktop in my class.

... I do a lot of research using the Internet and ... I have a whole lot of websites that I regularly surf, especially ... within my subject, within Afrikaans ...

I play around on the computer a lot ... all my lessons are in PowerPoint ... I do all these PowerPoint lessons for my classes.

Relevance of using technology: She described being encouraged to use computers because of learners' response to lessons using ICT:

*... they're more interested the moment you turn the screen on ... it's almost like they almost appreciate your effort more as well, because they can see that you had to think about the lesson and you had to put the PowerPoint together. You had to look for the pictures. I think it's, in general, their response to ... to classes being ... presented like that ... that for me has been fun. But it's also ... it's not boring. You know, this is my twentieth year of teaching and we **have** to move away from writing on the blackboard and teaching from the textbook kind of thing.*

High level of innovativeness: She set up a language lab in a separate venue from the Afrikaans classrooms so that learners could use subject-specific software, both during lessons and after school. She described having driven the entire process of setting up the language lab and searching for a suitable software package:

I did a whole lot of research to try and find something that would work for us and this came recommended by a whole lot of schools who said that they were using it.

Secondly, she described having set up a *Twitter* account for teaching:

The kids don't actually know it's me ... but they all follow this Afrikaans teacher ... to improve their Afrikaans and to learn more about Afrikaans.

Thirdly, she was in the process of setting up a website for Afrikaans teachers, where teachers could share work: "I have a website, as well, *Die Afrikaanse Klaskamer* [The Afrikaans classroom]".

Fourthly, this teacher tried different ways of including computers in her lessons:

... I've also designed a game. It was like a vocabulary game where ... I project ... a picture on the screen but the kids physically have to go up to the screen or, with a laser pointer, point out these items and like, call out ... as many Afrikaans words as they can.

Teacher 17 appeared very eager to experiment with new ways of using computers in her teaching, even when she wasn't sure that a particular method would work or that it would benefit learning. Another teacher reminded me about an award which had been introduced in my final year of teaching at the case study school, and which Teacher 17 had won in that particular year. This award could have had an influence on why some teachers, like Teacher 17, were striving to use ICT creatively, and but without considering their pedagogical goals:

... I don't know if you've heard about our Creative Teaching Award. Look, it's had a huge impact on the way we teach. It really has. I think it's become a very prestigious award and people really try for it ... it's great, but the kids cannot sit and listen to a lesson. They want to be entertained. They want to have flashing screens. They want to have beepers and buzzers. (Teacher 21)

Like Teacher 17, case study 5 (Teacher 25 – see case study on facing page) was enthusiastic about using computers and had shown a dramatic increase in her level of computer usage after the innovation. This teacher had not been using ICT before the innovation as she had not had ICT resources available at her previous school. She responded with gusto, however, to the idea of integrating ICT when she had the resources available at the case study school. She was sufficiently motivated and inspired to find novel ways of integrating ICT and had even become a role model for other less confident and less competent teachers (like Teachers 2 and 21) who were inspired by her ICT usage. One of the new ideas this teacher described she had tried out was that she was using *Facebook* with her Grade 8 English class:

I call myself Fraptuous Day, from the poem (the line "Oh Fraptuous day, cahloo cahlay" is from Alice in Wonderland), and in that identity I created a Facebook group ... and then invited all the kids and about half of them joined, which I thought was very surprising. (Teacher 25)

The advantage of setting up a closed Facebook group is that the administrator of the group is the only one who can invite 'friends' to join and the only one who can 'post' material on the page. This would avoid the privacy concerns often expressed in relation to sharing information on *Facebook*. Teacher 25 appeared to have a dual purpose for using social networking in her professional capacity. One of the aims relates to the social networking aspect, which Haythornwaite and Andrews (2011, p.125) believe provides learners with "*the feeling of belonging and the chance to explore their own identity*". By creating a closed *Facebook* group, Teacher 25 appeared to have created a safe space for her Grade 8s to express their feelings and for her to acknowledge their achievements:

... it creates a little home for them. You know? It's not the entire school, nobody else gets to see it and then I ask them stupid questions ... "What do you like most about being back at school?" ... right after the holidays and then they write little comments, but it's ... they feel safe doing things because they know who's there.

... whenever somebody's done magnificently well in my class, I call them 'the star of the week' and I send that to everybody. You know? "Big congratulations!" ... that kind of thing ... (Teacher 25)

The second aim relates to using the site for delivering content relevant to teaching her subject:

... I just put everything that I think is interesting ... little grammar podcasts and things that I find ... little videos about English pronunciation and funny little things I put on there for them ... a dictionary, so they get a 'word of the day' on Facebook every day, which I love. Little things ... just whatever I come across ... whatever I think will be fun to share with them ... I put on there. (Teacher 25)

Case study 5: Teacher 25

Gender	Female																																								
Age group	20-29																																								
Subject	Life Orientation and English																																								
Level of ICT training	No formal training																																								
Level of ICT competence	High																																								
Level of ICT use outside of school	High																																								
Total ICT usage before innovation	27/29																																								
Total ICT usage after innovation	10/29																																								
Extent of change in ICT use after innovation	<table border="1"> <caption>Data for Case Study 5: Teacher 25 Bar Chart</caption> <thead> <tr> <th>Task</th> <th>Number of days per year</th> </tr> </thead> <tbody> <tr><td>1</td><td>310</td></tr> <tr><td>2</td><td>10</td></tr> <tr><td>3</td><td>310</td></tr> <tr><td>4</td><td>10</td></tr> <tr><td>5</td><td>50</td></tr> <tr><td>6</td><td>310</td></tr> <tr><td>7</td><td>10</td></tr> <tr><td>8</td><td>10</td></tr> <tr><td>9</td><td>10</td></tr> <tr><td>10</td><td>350</td></tr> <tr><td>11</td><td>50</td></tr> <tr><td>12</td><td>10</td></tr> <tr><td>13</td><td>10</td></tr> <tr><td>14</td><td>10</td></tr> <tr><td>15</td><td>10</td></tr> <tr><td>16</td><td>10</td></tr> <tr><td>17</td><td>10</td></tr> <tr><td>18</td><td>10</td></tr> <tr><td>19</td><td>10</td></tr> </tbody> </table>	Task	Number of days per year	1	310	2	10	3	310	4	10	5	50	6	310	7	10	8	10	9	10	10	350	11	50	12	10	13	10	14	10	15	10	16	10	17	10	18	10	19	10
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Level of competence: This teacher described herself as “*very competent*” using computers.

... [sighs] *Word ... Excel ... those ... easy as pie ... there's nothing new there ... on [Microsoft] Office, no problems.*

When asked why she described herself as ‘very competent’, she replied:

I can do virtually anything ... the only stuff I'm not competent with is networking stuff. You know ... that kind of technical ... I cannot do. Anything else, if I can't do, I can figure out. You know, I've learnt very quickly with computers ... if you try it, sooner or later you're going to get it right. You just have to keep on trying.

Level of confidence: This teacher came across as highly confident in her computer skills, saying that she felt she “*can do virtually anything*” and was not afraid of making mistakes on a computer:

There's very little that can go wrong on using a computer. You know? Unless it's a big 'oops' [mistake] and you lose all of your files, there's very little that can go wrong.

Motivation to use computers for instruction: This teacher was self-motivated to use computers for teaching:

I don't know if it was DigiDays ... coming to [the school] was actually more ... the major factor here. That's what happened. Yes, more than DigiDay ... ja.

Level of innovativeness: She said that the innovation had allowed her to use computers in more creative ways:

It not only forced me to use a computer more, it forced me to use it in a different way. And I'm constantly looking for other things that I can do now ... which never really crossed my mind before.

Teaching philosophy: This teacher's teaching philosophy had become less traditional, after the innovation:

And I used to be one of those teachers where they would line up outside and they would sit where I told them to sit and you know ... everything would be just so. And now, it's a very different thing when you walk past there.

*... and we do still have people who think that teaching should be about teaching [said in a gruff voice] ... You know, standing in front on your class and talking to them and making them sit quietly and doing the work". My classes aren't quiet. My classes are **very, very** rowdy ... **very** chaotic.*

This type of use of *Facebook* for instruction has the potential to be motivating and inspirational for learners. The use of novel ideas like the ‘word of the day’ could be both fun and engaging. Haythornwaite and Andrews (2011, p. 108) regard the use of podcasts “as a way to expose students

to additional course content in engaging formats". However, Swan and Hofer (2011) suggest that podcasts can be used in more constructivist ways than delivering material, providing the activity they form part of is designed to enhance learner understanding of subject-related content. This is what I mean when I talk about "judicious use of ICT for meaningful learning". These researchers emphasise that

effective, authentic technology integration is predicated upon the teacher's ability to bring content, pedagogy, and technology together in a way that is greater than the sum of the parts. (Swan & Hofer, 2011, p. 78)

After having tried various new ways of using technology for teaching, Teacher 25 acknowledged, however, that her initial computer usage might not have been sufficiently discerning (judicious) to have a positive impact on learning. In the following excerpt she explains how she had to learn how to use ICT in ways promoted meaningful learning, which she suggests may involve integrating a traditional approach with using ICT:

At first, actually negatively ... you have to learn to do it right ... at first I think I leaned too heavily on all the magnificent things I could find out there and there wasn't enough of me in my lessons. And not enough of my explaining in my lessons and you still need a very healthy dose of that ... now, I think it's better ... because now I tend to integrate the two far more than I did in the beginning. (Teacher 25)

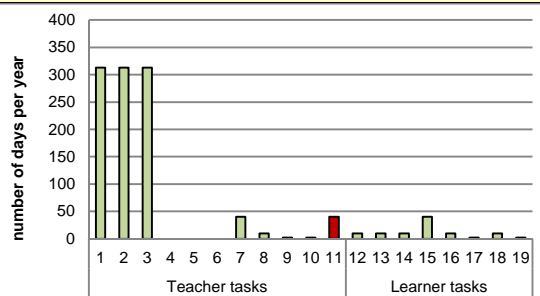
Case study 6 (Teacher 19 – on facing page) proved an anomaly. Although she had reported a highly significant increase in computer usage after the innovation, on closer examination I found that the information supplied in her interview did not correlate with the computer usage she reported when answering the questionnaire used to collect data on teachers' computer usage before and after the innovation. The information she provided during the interview suggested a lack of ICT skills, a very low level of computer usage before the innovation, and little change in computer usage after the innovation, which does not fit the increase in this teacher's reported total computer usage, after the innovation, in the questionnaire. Some of the learner-tasks which this teacher reported increased use for after the innovation could also not be linked to her subject, nor to any descriptions she supplied during the interview of how she was using computers for teaching. Using the information she had supplied during our interview rather than her reported frequencies of usage of the different tasks suggests a teacher with a low level of ICT knowledge and skills who is only using computers because she is required to do so, and who believes there is little value to using technology, especially for teaching her subject. Evidence of her resistance to change was provided by her response to the school promoting the use of *Twitter* for teaching. Rather than focusing on any disadvantages related specifically to using *Twitter*, e.g. the limited number of characters one can use when tweeting, she seemed to be resisting the very idea of change:

Again, it's the unknown, you know? As soon as you're ... I think we all fight the change, as always. And then once you kind of sit and you think about it, but it's ... it's easier to fight something that you ... you know? And I think not having all the ... confidence ... having something like that. It's the same with the Twitter. You know? Immediately ... I won't twit [sic], you know? It's like ... I resent ... I resist. (Teacher 19)

The following comment sums up this teacher's view towards using computers:

So I stay safe. I try and do what I need to do and not get too adventurous. (Teacher 19)

Case study 6: Teacher 19

Gender	Female																																																												
Age group	60-65																																																												
Subject	Art																																																												
Level of ICT training	Some formal training																																																												
Level of ICT competence	Low																																																												
Level of ICT use outside of school	Low: <i>emailing her own children and conducting basic Internet searches</i>																																																												
Total ICT usage before innovation	19/29																																																												
Total ICT usage after innovation	11/29																																																												
Extent of change in ICT use after innovation	 <table><caption>Data for Case Study 6: Teacher 19 - Extent of change in ICT use</caption><thead><tr><th>Task</th><th>Number of days per year</th><th>Category</th></tr></thead><tbody><tr><td>1</td><td>300</td><td>Teacher tasks</td></tr><tr><td>2</td><td>320</td><td>Teacher tasks</td></tr><tr><td>3</td><td>310</td><td>Teacher tasks</td></tr><tr><td>4</td><td>10</td><td>Teacher tasks</td></tr><tr><td>5</td><td>5</td><td>Teacher tasks</td></tr><tr><td>6</td><td>5</td><td>Teacher tasks</td></tr><tr><td>7</td><td>40</td><td>Teacher tasks</td></tr><tr><td>8</td><td>10</td><td>Teacher tasks</td></tr><tr><td>9</td><td>5</td><td>Teacher tasks</td></tr><tr><td>10</td><td>5</td><td>Teacher tasks</td></tr><tr><td>11</td><td>20</td><td>Teacher tasks</td></tr><tr><td>12</td><td>10</td><td>Learner tasks</td></tr><tr><td>13</td><td>10</td><td>Learner tasks</td></tr><tr><td>14</td><td>10</td><td>Learner tasks</td></tr><tr><td>15</td><td>40</td><td>Learner tasks</td></tr><tr><td>16</td><td>10</td><td>Learner tasks</td></tr><tr><td>17</td><td>10</td><td>Learner tasks</td></tr><tr><td>18</td><td>10</td><td>Learner tasks</td></tr><tr><td>19</td><td>10</td><td>Learner tasks</td></tr></tbody></table>	Task	Number of days per year	Category	1	300	Teacher tasks	2	320	Teacher tasks	3	310	Teacher tasks	4	10	Teacher tasks	5	5	Teacher tasks	6	5	Teacher tasks	7	40	Teacher tasks	8	10	Teacher tasks	9	5	Teacher tasks	10	5	Teacher tasks	11	20	Teacher tasks	12	10	Learner tasks	13	10	Learner tasks	14	10	Learner tasks	15	40	Learner tasks	16	10	Learner tasks	17	10	Learner tasks	18	10	Learner tasks	19	10	Learner tasks
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2	320	Teacher tasks																																																											
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18	10	Learner tasks																																																											
19	10	Learner tasks																																																											

Level of competence and level of confidence: This teacher referred to feeling "*not very competent*" when using computers, because she used them infrequently:

I can do the general stuff, but I do have a problem, because you don't use it all the time ...

Despite having had some basic training, and the length of time for which she had been using computers, this teacher felt that she had not made much progress in using computers:

... they did send us on courses and stuff, you know, it's like really clicking the mouse on the screen.

It's just, kind of, staying on the same level. Probably getting a little bit more quicker, you know ... managing it, and so on. You know, I mean, you've been using the same stuff for year after year after year, so I'm ... I don't think that I'm actually moving ...

When asked which software applications she used, this teacher replied

Okay, that will basically tell you my knowledge. ... Word ... it's really Word and Excel ... the basics, in Excel. And then, I don't even use the PowerPoint. I do use photographs, so it would be the bitmap and a little bit of ... you know, I'll take my own photos, put it in as photo images ... [Hewlett] Packard. You know?

Instructional computer usage: She said that before the innovation she only used computers in lessons for showing some of her photographs, but that she did not use it for "*the process of teaching*".

Not using computers of her own volition: She described feeling pressurised to use computers for teaching by what she referred to as "*the system*". She said it was not her natural inclination to use computers, even for teacher-tasks:

... being more a practical person, myself, you know, the technical ... if I need something, I go to a book and I open it and I make a photocopy ...

She also described feeling that she did not actually have a choice, after the innovation, about whether or not she wanted to use computers for teaching:

... in your ... your social or personal life, you ... it's more your choice, whereas the system basically tells you "Listen, this is what we've got to do."

Computer anxiety: She described her anxiety when she heard about the innovation and that she still felt anxious when having to use computers:

I did at that time. At the moment it's a little bit better. It does come a little bit ... easier, but I still do get the knot ... in the stomach.

Case study 7 (Teacher 16) (see facing page) was selected because the changes in her use of computers after *DigiDays* suggest that her main motivation for using technology was to enhance the efficiency with which she could carry out teacher-tasks, rather than focusing on using technology to enhance learning. In keeping with this, the largest increases in this teacher's use of computers were mainly for teacher tasks relating to administrative tasks and communicating with others. Also, the small increases in learner tasks are in keeping with what she would have been mandated to do for *DigiDays*, and might not reflect more general 'real' change in ICT usage. Her description of having found the digital novel on the Internet which learners could possibly read on their cellphones confirms the idea that she thinks technology is available only to make things easier. Assuming that the digital novel is an Afrikaans one, this could be a way of encouraging learners to read more Afrikaans. However, this teacher did not mention or allude to this potential benefit, and seemed more interested in having found something learners could read on their cellphones. The value of reading a novel on a cellphone could be questioned, in light of difficulties associated with reading large amounts of text in small fragments on such a small device. Her low level of innovativeness is demonstrated by her response to the question of whether she had ever looked new computer programmes to use in her teaching:

No ... no, that's unfortunately not my first love. (Teacher 16)

This response bears no relevance to the merits of finding new software to use in her teaching or the benefits of using technology for teaching.

Overall, it appears that this teacher increased her computer usage because she had to do so, and not necessarily because she believed that integrating technology into teaching has the potential to contribute to more meaningful learning. This suggests a lack of a clear pedagogical reasons for integrating technology which is further borne out by her reference to incidental uses of computers which have no bearing on learning, e.g. 'saving paper'. The fact that she focused on minor advantages of using technology suggest that she did not have clear instructional reasons for including technology in her teaching. The lack of a clear pedagogical motive underpinning technology integration could contribute to indiscriminate use unlikely to promote learning.

Case study 7: Teacher 16

Gender	Female																																											
Age group	20-29																																											
Subject	Afrikaans																																											
Level of ICT training	None																																											
Level of ICT competence	Fairly competent																																											
Level of ICT use outside of school	Low																																											
Total ICT usage before innovation	28/29																																											
Total ICT usage after innovation	15/29																																											
Extent of change in ICT use after innovation	<div><table><caption>Data for Case Study 7: Teacher 16 - Extent of change in ICT use</caption><thead><tr><th>Task Category</th><th>Task Number</th><th>Number of days per year</th></tr></thead><tbody><tr><td rowspan="11">Teacher tasks</td><td>1</td><td>310</td></tr><tr><td>2</td><td>360</td></tr><tr><td>3</td><td>310</td></tr><tr><td>4</td><td>100</td></tr><tr><td>5</td><td>10</td></tr><tr><td>6</td><td>40</td></tr><tr><td>7</td><td>50</td></tr><tr><td>8</td><td>40</td></tr><tr><td>9</td><td>10</td></tr><tr><td>10</td><td>20</td></tr><tr><td>11</td><td>10</td></tr><tr><td rowspan="8">Learner tasks</td><td>12</td><td>10</td></tr><tr><td>13</td><td>10</td></tr><tr><td>14</td><td>10</td></tr><tr><td>15</td><td>10</td></tr><tr><td>16</td><td>20</td></tr><tr><td>17</td><td>10</td></tr><tr><td>18</td><td>10</td></tr><tr><td>19</td><td>10</td></tr></tbody></table></div>	Task Category	Task Number	Number of days per year	Teacher tasks	1	310	2	360	3	310	4	100	5	10	6	40	7	50	8	40	9	10	10	20	11	10	Learner tasks	12	10	13	10	14	10	15	10	16	20	17	10	18	10	19	10
Task Category	Task Number	Number of days per year																																										
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	17	10																																										
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	19	10																																										

Level of competence: This teacher described herself as “fairly competent” using computers:

.. I'm comfortable enough using computers, but I won't claim that I know everything. I know enough to be able to do my day-to-day tasks and I don't get stuck ... often ... This teacher described having used computers for teaching for three years, after having had a data projector installed in her classroom two years before the innovation was introduced at the school. She said she had been using computers in lessons about once a day, before the innovation, for presenting work:

Instructional computer usage: She explained how she had used technology in her classroom, before *DigiDays*

It was ... summarising notes on a PowerPoint slide and ... allowing the children to copy it down. It was almost using ... my data projector [sic] as a replacement whiteboard.

After *DigiDays* this teacher's computer usage increased for 10 of the 11 teacher tasks, with the largest increases being for carrying out administrative tasks (Task 1) and communication tasks (Tasks 2 and 3). Her use of computer-based learner-tasks increased for five of the nine tasks, but these increases were extremely small.

Relevance of using technology for teaching: This teacher perceived the main benefits of using computers in her lessons to revolve around her learners' response and the easy access to information allowed by being able to access the Internet in her classroom (see increase in task 7 – *conducting Internet searches*):

The moment they see that the data projector is on, they immediately start taking part in lessons more. And I think the accessibility of information, rather than having to go through ten or twenty textbooks to find a new exercise and to show you've got the rule right, it's immediately right there.

Another benefit she mentioned was saving paper by not having to print out work.

Instead of necessarily having to print out work and kill more trees, we can ... show it to the children. The children understand computers more ... than they necessarily understand ... I know this sounds awful ... something printed out. They relate easier to something in their world.

She also felt that computers “make it easier to relate to the children and therefore they might learn more”.

Level of innovativeness: When asked about how she had been affected by the innovation, she replied that “*It has definitely challenged me to explore a bit further*”. However, this teacher's idea of exploring a bit further revolved around searching for new resources on the Internet, which displays a limited level of innovativeness. In the following extract she describes incidentally finding a resource that her learners could use, rather than a focused search for software her learners could use:

... I found a digital novel available for the kids, which they can download onto their cell phone and read as an SMS ... and if it wasn't for the fact that I was scouring the Internet looking for DigiDay tasks, I would never have found this.

The last two case studies in this section are for teachers who showed nearly significant changes ($p = 0.06$) after the innovation.

Teacher 39 (see case study 8 on the facing page) had used computers at a previous school for administrative tasks, but she had not been able to use computers during lessons because she did not have the necessary resources for using ICT for teaching.

I started in January last year and I was at [her previous school] for five years. So, for the last six years ... I've been expected to use computers in teaching ... for everything. We were expected to type up our own papers ... do our own marks ... work on Pencilbox. I didn't have a projector in my class so I wasn't teaching with the computer. (Teacher 39)

After arriving at the case study school this teacher made good use of the resources available to her. She had the second-highest level of total computer usage, before the innovation. She described her usage before *DigiDays* as follows:

... mostly showing the children things ... software, ja ... showing them simulations ... of whatever I'm teaching. I like to break the lesson with something visual. (Teacher 39)

Despite only a small increase in total computer usage, she retained the second highest ranking of total computer usage of the 29 teachers, after the innovation. This teacher, given her high level of computer usage before *DigiDays*, had already been using computers extensively for many of the the typical teacher tasks, so the only scope for further increases was in the learner-tasks required for *DigiDays* (mandated Tasks 5 and 7), with most of the increases being for learner tasks. However, she did not attribute these increases to her having been required to use technology for *DigiDays*. Rather, she felt that the ICT culture in the school had encouraged her to make more use of computers. This suggests that the changes she made were of her own volition, and had not been forced on her by the school.

[The school] has made me use computers more ... and yes, DigiDays, I think, has just been an add-on to that. I wouldn't just say it's DigiDays. (Teacher 39)

Teacher 39 appeared to be sufficiently competent and confident to be able to use computers to effectively enhance her teaching. She appeared to have a good technological pedagogical content knowledge in that she used technology to illustrate concepts to improve learners' understanding. She was one of two teachers involved in setting the science simulation task which made effective use of technology and promoted learners constructing their own knowledge (see *DigiDay* Task 33 in Table 34, page 242). She understood that computer-based tasks need to be designed to take advantage of the potential benefits of using technology:

... you've got to be more creative than you are with pen and paper. So we have tried simulations as a DigiDay [task] before and I think it worked very well ... where we let the children play with the software. And let me tell you what: I've never ever even considered explaining limiting reagents to Grade 9s. It's ... its Grade 11 and 12 work and the Grade 11s and 12s battle with it but this simulation was just brilliant. It just did it so simply because it started off as sandwiches [laughs] which the kids could do [sic]. You know, when they first started they were like "Of course we know how to do this" and then as soon as you start putting particles in they're just like "Wow!" They can't believe ... I couldn't believe actually, to be honest with you, it could be taught so easily. (Teacher 39)

She did not use technology just for the sake of using it, but was selective in how she used it. Her determination to use computers for learners, even though she did not have the resources readily available at her previous school, suggests that she is convinced that using technology can benefit learning and that she is intrinsically motivated to use ICT in her teaching.

Case study 8: Teacher 39

Gender	Female																																											
Age group	30-39																																											
Subject	Physical Sciences																																											
Level of ICT training	None																																											
Level of ICT competence	Fairly competent																																											
Level of ICT use outside of school	Moderate																																											
Total ICT usage before innovation	2/29																																											
Total ICT usage after innovation	2/29																																											
Extent of change in ICT use after innovation	<div><div><div>number of days per year</div><table><thead><tr><th>Task Category</th><th>Task Number</th><th>Number of days per year</th></tr></thead><tbody><tr><td rowspan="11">Teacher tasks</td><td>1</td><td>0</td></tr><tr><td>2</td><td>0</td></tr><tr><td>3</td><td>0</td></tr><tr><td>4</td><td>0</td></tr><tr><td>5</td><td>10</td></tr><tr><td>6</td><td>0</td></tr><tr><td>7</td><td>0</td></tr><tr><td>8</td><td>0</td></tr><tr><td>9</td><td>0</td></tr><tr><td>10</td><td>0</td></tr><tr><td>11</td><td>50</td></tr><tr><td rowspan="9">Learner tasks</td><td>12</td><td>20</td></tr><tr><td>13</td><td>20</td></tr><tr><td>14</td><td>20</td></tr><tr><td>15</td><td>20</td></tr><tr><td>16</td><td>20</td></tr><tr><td>17</td><td>20</td></tr><tr><td>18</td><td>20</td></tr><tr><td>19</td><td>20</td></tr></tbody></table></div></div>	Task Category	Task Number	Number of days per year	Teacher tasks	1	0	2	0	3	0	4	0	5	10	6	0	7	0	8	0	9	0	10	0	11	50	Learner tasks	12	20	13	20	14	20	15	20	16	20	17	20	18	20	19	20
Task Category	Task Number	Number of days per year																																										
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Level of ICT competence: This teacher gave a measured answer to the question of how competent she felt about using computers

Ja, fairly competent. It just depends ... I have hiccups with computers at times but ... sometimes I don't, so it just really depends on what I'm trying to do and on how things go.

Eager to use computers for teaching: She described wanting to use computers for teaching:

*And it really was something I was desperate to do, so I **so** enjoy [the current school] because I've had that opportunity ...*

... I've been wanting to teach Science like this for so long.

Level of innovativeness: She described looking for new software and finding ways to integrate technology into her teaching.

I found PhET when I was at ... [her previous school] ... and I had it at [her previous school] and I just couldn't show the children. I actually used to show them on my laptop ... and we'd all huddle around the ... the laptop and look at whatever I was showing them on PhET.

The other one that I use 'cause it's free is McGraw. It's also for free on the internet. McGraw chemistry, it's fantastic.

Judicious use of computers in her lessons: The way she used computers in lessons appear to enhance the teaching of particular content and concepts in her subject:

... it just gives one concept. Like the children will want to know molecular orientation and it will just give it quickly on the board. So they can see the molecules can collide this way or they can collide that way and then I switch it off.

Relevance of using computers for instruction: She had a clear focus on using ICT to enhance learners' understanding of abstract concepts:

They're free downloads, and they just give the kids a visual on what you're trying to tell them and because you can isolate different things, you can really give them the whole picture. The children battle when you tell them it's a frictionless environment. They don't know what you're talking about ... until you can show them this is the situation with friction and this is the situation without friction. Because, you know, living in a world where there is friction it's very hard to tell children to imagine something where there's none.

So, ja ... the ... the physics has been incredible but then in the same sense the chemistry has been amazing as well, because to show them what's going on with the particles at a molecular level, I haven't ... I had to use magnets on the board.

Case study 9 (Teacher 38) is shown on the facing page. This teacher was chosen as a case study because she illustrates the development of a more positive attitude towards using computers in response to the innovation promoting the use of ICT for instruction. She displayed a cautious approach towards using computers, which could have contributed to the fact that the increases in her task usage were predominantly in two teacher-tasks: Task 2 (*communicating with parents*) and Task 3 (*communicating with colleagues*). The increases that she showed in four learner-tasks were very small.

This teacher initially appeared to be responding to prompts from external factors when using technology in her teaching. The first prompt had been the directive from the school's Executive Committee that computers be used for teaching and learning. The second prompt was the free software that the Head of the Mathematics Department required the maths teachers to be trained in and to use for *DigiDays*. It was only after these two prompts that she was sufficiently motivated to go out and look for software to use in her teaching. Her comment about no longer having an excuse not to be using technology with all the resources that the school had supplied suggests that she tried to fit in with what was required of her, to be successful within the system. Once the necessary resources had been provided for her, however, this teacher felt much more inclined to using computers, to the extent where she was motivated to look for her own software. An important factor which seems to have inspired this teacher to look for software to use in her teaching appears to be the training offered in the mathematics department, by the Mathematics Head of Department. It is possible that, because the training is being offered within the mathematics Department, it focused specifically on how to use technology appropriately for teaching mathematics, which may have allowed Teacher 38 to see with computers could be relevant for her teaching. The combined effect of having the ICT resources available and having had training focusing on how to use technology for teaching her subject may have contributed to the change in this teacher's attitude towards computers, and improved her level of confidence. She appeared to want to use computers of her own volition, and in a variety of ways, as suggested by her looking for new software, rather than because she was required to do so.

Case study 9: Teacher 38

Gender	Female																																								
Age group	40-49																																								
Subject	Mathematics																																								
Level of ICT training	None																																								
Level of ICT competence	Fairly competent																																								
Level of ICT use outside of school	Low																																								
Total ICT usage before innovation	22/29																																								
Total ICT usage after innovation	18/29																																								
Extent of change in ICT use after innovation	<table border="1"> <caption>Data for Case Study 9: Teacher 38 - Extent of change in ICT use</caption> <thead> <tr> <th>Task</th> <th>Number of days per year</th> </tr> </thead> <tbody> <tr><td>1</td><td>0</td></tr> <tr><td>2</td><td>40</td></tr> <tr><td>3</td><td>320</td></tr> <tr><td>4</td><td>320</td></tr> <tr><td>5</td><td>10</td></tr> <tr><td>6</td><td>0</td></tr> <tr><td>7</td><td>0</td></tr> <tr><td>8</td><td>10</td></tr> <tr><td>9</td><td>0</td></tr> <tr><td>10</td><td>50</td></tr> <tr><td>11</td><td>10</td></tr> <tr><td>12</td><td>0</td></tr> <tr><td>13</td><td>0</td></tr> <tr><td>14</td><td>0</td></tr> <tr><td>15</td><td>0</td></tr> <tr><td>16</td><td>0</td></tr> <tr><td>17</td><td>0</td></tr> <tr><td>18</td><td>0</td></tr> <tr><td>19</td><td>0</td></tr> </tbody> </table>	Task	Number of days per year	1	0	2	40	3	320	4	320	5	10	6	0	7	0	8	10	9	0	10	50	11	10	12	0	13	0	14	0	15	0	16	0	17	0	18	0	19	0
Task	Number of days per year																																								
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Level of competence: This teacher described herself as

Fairly competent ... I know some things but I'm definitely not brilliant.

Instructional computer usage: She made the following comment about her level of computer usage, before *DigiDays*

Well, a little bit. I'd love to be able to use it more ...

After the innovation she showed huge increases in a number of teacher tasks dealing with communication (Tasks 2, 3, 4, and 5), followed in magnitude by *presenting in lessons* (Task 10) and small increases in preparing *PowerPoints* (Tasks 8 and 9).

Response to the innovation: Teacher 38 is an example of a teacher who appeared willing to incorporate computers into her teaching, once it was clear to her that she was going to have to use of computers for teaching and learning and once she was provided with software to use, and training on using the software:

... we've all got projectors now, in our classroom. So we actually don't have an excuse. We've got to use it. So now that we've got it and we've got all this free software that's been loaded for us and that ... and we're having training sessions in our Maths meetings ... then it's ... ja, becoming more and more used.

She also indicated that she had found it useful to work with other teachers. She described how she was encouraged by the mathematics teachers working together to upload their task to *Moodle* for the first *DigiDay*:

We managed to get it all working between us [laughs] ... between the five of us or whatever ... we managed to ... it took us a while to learn how to do it but now it's so easy [slight laugh] but ja, we did manage to get it right.

Level of innovativeness: She appeared to have been sufficiently encouraged by the combination of factors mentioned above, and her successes with using computers with her learners, to go out and find software she could use in her teaching:

... I've actually had lessons where we've all gone to the computer room so they've all been at a computer and they've all done statistics via Excel ... using formulas. They've loved it. Brilliant!

... just in terms of making me look, want to look for more software available ...

Teaching philosophy: The following comment suggests that she does not rely solely on using traditional approaches in her teaching:

*Ja. It's best when **they're** all busy. It's much better when they're using the computers than when they're just staring at the screen [in the front of her classroom] ...*

Case studies of teachers who showed non-significant change in computer use after DigiDays

Excluding the three teachers with p -values of 0.06, sixteen teachers (55% of the group showing changes) showed non-significant increases in computer use after the innovation. Four of these teachers have been chosen as case studies to better understand their responses to the innovation promoting the use of ICT for instruction.

Case study 10 (Teacher 40), an example of a teacher who made judicious use of ICT to enhance learning, is presented on the opposite page. Although the change in the number of tasks he was using was not significant, he was chosen as a case study because of his apparently judicious reasons for using technology for teaching. This teacher's low level of computer usage before *DigiDays* resulted a low ranking of 21 out of the 29 teachers. After *DigiDays*, his ranking went down to 26 out of the 29 teachers. His use of technology for all types of teacher tasks, except for the two mandated teacher tasks, remained unchanged after *DigiDays*, possibly because he was using technology as much as he could for these types of tasks. Before *DigiDays*, this teacher reported using all eight types of learner tasks, on average, a couple of times a year. After *DigiDays*, his computer usage of four learner tasks increased. The changes in frequency of the learner tasks used by this teacher correlated with the school requirement to produce tasks which learners could complete on computer, for the monthly *DigiDays*.

This science teacher was selected for a deeper examination of how his computer usage changed after *DigiDays* because when I interviewed him a number of interesting things emerged. Firstly, at his previous school this teacher had use computers in much the same way the case study school wanted them used as part of the *DigiSchool Project*. Secondly, this teacher seemed to appreciate the various ways that using computers could potentially enhance science teaching and learning. Despite these two factors his computer usage appeared hardly to have changed. However, what appeared to be minor changes had important implications for learning. This teacher was the only one who showed a profile of change with less emphasis on teacher tasks, and more on learner tasks. Increases in learner tasks, provided the tasks are meaningful, are likely to have greater potential to engage learners and promote the construction of knowledge than increases in teacher tasks. The small magnitude of the increases does not reflect this teacher's judicious use of computers to enhance learning. He had set the *DigiDays* task (Task 33) which was ranked joint first for potential to promote meaningful learning.

It is possible that his previous experience had provided this teacher with a clear idea of the value of using computers to enhance his science teaching, and to allow his learners to obtain good marks. He was clearly focused on completing his curriculum and maximizing his learners' levels of attainment. Although he was not afraid to experiment with new things, he only used ICT resources if he was convinced that it would improve learning.

This teacher would have qualified as a *Selective adopter* according to the system of Donnelly et al. (2011, p. 1481). These researchers suggest that for individuals in this group to be encouraged to make more use of computers "*would need a change in environmental factors such as assessment or other mandated changes*". The changes in computer usage shown by Teacher 40 appear to be related to the **mandated** computer usage required by the school after the innovation.

Case study 10: Teacher 40

Gender	Male																																								
Age group	40-49																																								
Subject	Physical Science																																								
Level of ICT training	None																																								
Level of ICT competence	High; some programming knowledge																																								
Level of ICT use outside of school	Low																																								
Total ICT usage before innovation	21/29																																								
Total ICT usage after innovation	26/29																																								
Profile of change in ICT use after innovation	<table border="1"> <caption>Data for Profile of change in ICT use after innovation</caption> <thead> <tr> <th>Task</th> <th>Number of days per year</th> </tr> </thead> <tbody> <tr><td>1</td><td>10</td></tr> <tr><td>2</td><td>10</td></tr> <tr><td>3</td><td>10</td></tr> <tr><td>4</td><td>10</td></tr> <tr><td>5</td><td>40</td></tr> <tr><td>6</td><td>10</td></tr> <tr><td>7</td><td>10</td></tr> <tr><td>8</td><td>10</td></tr> <tr><td>9</td><td>10</td></tr> <tr><td>10</td><td>10</td></tr> <tr><td>11</td><td>10</td></tr> <tr><td>12</td><td>10</td></tr> <tr><td>13</td><td>10</td></tr> <tr><td>14</td><td>10</td></tr> <tr><td>15</td><td>10</td></tr> <tr><td>16</td><td>10</td></tr> <tr><td>17</td><td>10</td></tr> <tr><td>18</td><td>10</td></tr> <tr><td>19</td><td>10</td></tr> </tbody> </table>	Task	Number of days per year	1	10	2	10	3	10	4	10	5	40	6	10	7	10	8	10	9	10	10	10	11	10	12	10	13	10	14	10	15	10	16	10	17	10	18	10	19	10
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Level of ICT confidence and ICT competence: He described himself as competent using computers for instruction because of his experience in using computers specifically for teaching:

I would say most applications, yes.

I think because I've been using computers ... for a very long time now in teaching. It was something that I decided ... that was essential to teaching, not only for my own ability to put documents together, which would ... replace the old typewriter from that stage on, but because it was becoming essential and as I moved to various schools during the course of the last 8 years, schools were becoming progressively more ... involved in, in ... not only in teachers using computers for their own ... ability to produce documents, but also in their teaching.

Instructional computer usage: He made limited but judicious use of computers in lessons:

... I tend to look for ... little short ... if you like, simulations, in science ... that can help to replicate a ... could be an experiment that we couldn't do otherwise in a class and so, in many cases they may just be animations or something like that ... but really, you know, just ... to serve to ... to further enhance something that we ... typically would do as a textbook activity. So if we can't replicate something as a ... practical ... experiment because we don't have the means or it's something that is not necessarily in the realm of ... a school-based type of an experiment, then of course I rely on animations and simulations.

When asked about any computer applications he would have difficulty using, his mind turned to the recent drive by the school to promote the use of *Twitter* in the classroom, which he did not think would be beneficial:

... some of the ... the more social networking things, which I don't think have any real bearing and application of ... I haven't seen the benefits yet, in terms of enhancing teaching and the teaching of science ...

Focused on delivering the curriculum, and on learner attainment: He described computers "as a tool for delivering the curriculum".

... I'm very, I'm normally very ... eager to learn, especially if I immediately see the benefits that it has to my teaching, and especially to the students, if there's going to be a benefit for them. I would need to see them [the potential benefits], in particular, I suppose, you know, in ... fulfilling my immediate needs, which obviously is science teaching and how I could deliver the curriculum.

Because I think we need to use innovative ways ... the kids are certainly using it, and if there are benefits and it is a medium that the kids actually appreciate and it would ... then I would say we need and would want to explore it a bit more.

Level of ICT innovativeness: He is open to trying out new ICT applications or techniques, providing he is convinced that it offered a clear pedagogical benefit for his learners (see extract above).

Case study 11 (Teacher 30) is shown opposite. She also showed non-significant changes after the innovation. The major features that stand out for Teacher 30 are her low levels of ICT competence and ICT confidence, which could explain her low level of computer usage before the innovation. She described having used computers during lessons “*probably only once or twice a week*”, before *DigiDays*, mainly for presenting in lessons and looking things up on the Internet.

This teacher showed very few increases in task usage after the innovation, even though she said she now used computers “*practically every second day*”. The increased usage she reported after *DigiDays* related to three teacher-tasks with ‘real’ increases (i.e. increases other than for mandated tasks required for *DigiDays*). The teacher-tasks which increased were *creating basic* and *complex PowerPoints* (Tasks 8 and 9) and *presenting in lessons* (Task 10), which is exactly what this teacher was using computers for before the innovation. However, despite the increase in creating *PowerPoints* (Tasks 8 and 9) she said it was easier for her to “*just rather flash up pictures or references or ... places ... cartoons ... people ... things like that*” than to create *PowerPoints*. She reported increased learner usage of only two tasks: learners *carrying out simulations* (Task 19) and *consulting with experts on the Internet* (Task 12). With regard to her increased usage of Task 12 after the innovation, it is possible that this teacher regarded ‘accessing websites on the Internet’ as ‘consulting with experts’ – there was no evidence, either from the interview with her or from any of her *DigiDay* tasks that she had indeed asked learners to consult with experts.

In keeping with her low level of ICT competence, this teacher described experiencing a “*bit of trepidation*” at having to set learner computer-based tasks for *DigiDays*. This could explain why one of the first *DigiDay* tasks she set was a very basic one for which learners had to find information on Rasputin and answer questions in *Word*.

The view expressed by this history teacher about the possible lack of relevance of technology for use in her subject because of the need for lots of classroom discussions is similar to what was reported by John and La Velle (2004). These researchers examined the influence of teachers’ beliefs about their subject culture on their attitudes towards using ICT. They reported that

... historians were more guarded and felt that the humanistic nature of the subject might be compromised. (John & La Velle, 2004, p. 321)

However, her comment about History not always lending itself to using computers highlights the fact that not all topics of work may lend themselves to computer-based tasks.

This teacher’s emphasis on teacher-focused teaching, her apparent lack of intrinsic motivation to use computers to enhance her subject teaching as opposed to using it because her learners enjoyed it, suggest that she was mainly using computers because of the requirement by the school to use computers for instruction.

Case study 11: Teacher 30

Gender	Female																																								
Age group	40-49																																								
Subject	History																																								
Level of ICT training	No formal training																																								
Level of ICT competence	Low																																								
Level of ICT use outside of school	Low																																								
Total ICT usage before innovation	20/29																																								
Total ICT usage after innovation	22/29																																								
Profile of change in ICT use after innovation	<table border="1"> <caption>Data for Case Study 11 Bar Chart</caption> <thead> <tr> <th>Task</th> <th>Number of days per year</th> </tr> </thead> <tbody> <tr><td>1</td><td>0</td></tr> <tr><td>2</td><td>0</td></tr> <tr><td>3</td><td>0</td></tr> <tr><td>4</td><td>50</td></tr> <tr><td>5</td><td>400</td></tr> <tr><td>6</td><td>0</td></tr> <tr><td>7</td><td>0</td></tr> <tr><td>8</td><td>50</td></tr> <tr><td>9</td><td>40</td></tr> <tr><td>10</td><td>50</td></tr> <tr><td>11</td><td>50</td></tr> <tr><td>12</td><td>10</td></tr> <tr><td>13</td><td>10</td></tr> <tr><td>14</td><td>0</td></tr> <tr><td>15</td><td>0</td></tr> <tr><td>16</td><td>0</td></tr> <tr><td>17</td><td>0</td></tr> <tr><td>18</td><td>0</td></tr> <tr><td>19</td><td>10</td></tr> </tbody> </table>	Task	Number of days per year	1	0	2	0	3	0	4	50	5	400	6	0	7	0	8	50	9	40	10	50	11	50	12	10	13	10	14	0	15	0	16	0	17	0	18	0	19	10
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Level of ICT competence: This teacher described herself as “*not very competent*” about using computers, which could explain her low level of computer usage before the innovation. She described having used computers during lessons “*probably only once or twice a week*”, before *DigiDays*, mainly for presenting in lessons and looking things up on the Internet.

Relevance of using technology: She did not see computers as always being relevant for teaching her subject

... the nature of my subject is discussion and talking, so I can't sit and put everything on ... on a computer ... examples for them to do ... it's not like that. You need to discuss and argue and so on and write essays. It's not ... it doesn't always lend itself to technology ...

She regarded the usefulness of ICT for presenting visual images and accessing information on the Internet, as the major reasons she used technology in her classroom:

Obviously for looking at cartoons, looking at YouTube ... videos, downloading stuff ... everything ... current affairs ... all of that's relevant for my subject.

... just the visual matter that ... that's available. If you're talking about Robert Mugabe you can put up a picture of him. If you're talking about Zapiro cartoons you can put up cartoons.

She indicated that she was hugely motivated to make more use of technology by her learners ICT skills and knowledge:

They tell me about programmes, they tell me about things I don't know about. I have to go and look it up so that I can answer their questions. So, I think it's ... I think it comes from them actually.

Anxiety about setting computer-based tasks: This teacher described experiencing a “*bit of trepidation*” at having to set learner computer-based tasks for *DigiDays*.

Level of innovativeness: The following comment illustrates that this teacher depended on others to suggest resources that she could use in teaching, rather than looking for them herself, which suggests a low level of innovativeness, but also a discerning approach to using computers in her teaching:

... I use sites that people tell me about. I look into it first and see if it's relevant ... whatever website ... I don't really use a lot of ... say, things I don't know about ...and then communications other history teachers make, they'll send a link for something and then I'll look into it.

Case study 12 (Teacher 29) is shown on the facing page. This teacher comes across as somebody who is trying to comply with the school's new ICT policy, but who is hampered by her lack of adequate ICT knowledge and skills. However, despite her apparent willingness to use computers for teaching, the following comment demonstrates some lack of inclination to using computers more effectively in her teaching:

I just sort of have got tired of trying to learn a new system, when what I'm using is working perfectly. On Moodle day [DigiDays], I'll use it [Moodle] ... but I'm also at that age now when, you know, when I was younger I would have been terrified and I would have made sure and killed myself to try and get the hang of this. I'm not in a terrible hurry. (Teacher 29)

She had hardly used computers before coming to the case study school, hence her reference to having not been computer literate. Part of the reason she described herself as now feeling “*fairly comfortable*” using technology was that, before teaching History, she had been in the Geography Department. The Head of the Geography Department had helped her with improving her computer skills, which is why she refers to her computer skills as continually improving. Despite the Head of Department's efforts, however, this teacher still felt she needed more training, more than five years after having started using computers at the school. This could be why she described herself as “*slow using technology*”. Her reference to her knowledge being very basic compared to many others suggests that she may have been feeling some pressure to make more use of computers and comply with the level of ICT usage considered to be the norm in the school.

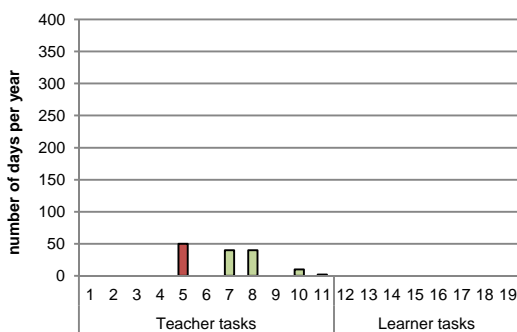
This teacher's lack of ICT competence and lack of motivation to use computers more effectively for instruction contributed to her using computers in ways which did not necessarily promote meaningful learning. Her focus on the incidental benefits of using technology masks how little she used computers in ways which could enhance learning. Hennessy, Ruthven, and Brindley (2005, p. 185) refer to this type of use, where computers are used in the absence of a clear pedagogical reason, as the “*uncritical use*” of ICT. The comment below by Teacher 29 reinforces the idea that she wants to integrate computers but does not know how to do so effectively:

But it just ... it takes so much effort. Because I don't know what I'm doing and I get so frustrated. So you just tend to stick with what you know, and not get too creative. (Teacher 29)

This teacher did not appear to be actively resisting making more use of computers for instruction but also did not appear to be trying too hard to use computers more effectively.

Without the appropriate knowledge and skills, and a clear focus for integrating technology to enhance learning, her response to the innovation could be described as ‘more of the same’. She expressed a desire for more ICT training but her main focus seemed to be on wanting to be able “*to make my lessons more stimulating*”, rather than for improving learning. Teacher 29 could be supported to make more meaningful use of ICT in teaching with professional development aimed at helping her to use computers more effectively.

Case study 12: Teacher 29

Gender	Female																																								
Age group	40-49																																								
Subject	History																																								
Level of ICT training	None																																								
Level of ICT competence	Basic <i>Word</i> ; email; Internet searches																																								
Level of ICT use outside of school	Low; mainly for playing computer games																																								
Total ICT usage before innovation	16/29																																								
Total ICT usage after innovation	28/29																																								
Profile of change in ICT use after innovation	 <table border="1"> <caption>Data for Case Study 12: Teacher 29 Profile of change in ICT use after innovation</caption> <thead> <tr> <th>Task</th> <th>Number of days per year</th> </tr> </thead> <tbody> <tr><td>1</td><td>0</td></tr> <tr><td>2</td><td>0</td></tr> <tr><td>3</td><td>0</td></tr> <tr><td>4</td><td>0</td></tr> <tr><td>5</td><td>50</td></tr> <tr><td>6</td><td>0</td></tr> <tr><td>7</td><td>40</td></tr> <tr><td>8</td><td>35</td></tr> <tr><td>9</td><td>0</td></tr> <tr><td>10</td><td>10</td></tr> <tr><td>11</td><td>5</td></tr> <tr><td>12</td><td>0</td></tr> <tr><td>13</td><td>0</td></tr> <tr><td>14</td><td>0</td></tr> <tr><td>15</td><td>0</td></tr> <tr><td>16</td><td>0</td></tr> <tr><td>17</td><td>0</td></tr> <tr><td>18</td><td>0</td></tr> <tr><td>19</td><td>0</td></tr> </tbody> </table>	Task	Number of days per year	1	0	2	0	3	0	4	0	5	50	6	0	7	40	8	35	9	0	10	10	11	5	12	0	13	0	14	0	15	0	16	0	17	0	18	0	19	0
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Level of ICT confidence: This teacher described herself as "*fairly comfortable*" using ICT, as long as she was using it for things she knew how to do:

I enjoy them, and I'm comfortable, as long as I'm working within my realms ... of what I know.

Level of ICT competence: She referred to her lack of ICT competence:

I'm not very computer literate ... well, I wasn't ... but I'm getting there.

... but I'm not very, very good, because I know ... my knowledge is still quite basic, compared to many others ...

... like let's just take Word for example, or Excel ... Excel I know even less ... less about ... I can't draw up a spreadsheet on Excel.

Feeling of frustration: This teacher described feeling frustrated because of her lack of ICT competence:

... it's been five years of ongoing learning and I'm getting ... I get frustrated because I'm now at the point when I really want to work with it.

Expressed a need for more training: She expressed a need for more ICT training at the school:

You know, the basic ... you know the sort of beginner. I'm a bit beyond the very, very early beginning ... you know, I wouldn't need lessons on ... how to switch the computer on and I can create my Word documents ... but just in terms of ... like using all the ... the options available to you ... how to ... do the graphics, you know ... or how to create ... you know, I've learnt things by chance, by people showing me. To give you an example of ... create a block, a text box to put a picture in ... those little things ...

Relevance of using technology: This teacher seemed to regard the main benefits of using computers to centre round improving the efficiency of carrying out various teacher tasks:

When the kids ask questions, we just google and we ... I put up the stuff. It's marvellous ... I use that a lot ... especially History. You know, the kids ask such random questions, so it's wonderful ... so I love it and we just google quickly.

... because it's been wonderful, because a lot of them, their handwriting ... especially with history essays, you can't read half the stuff.

She also placed quite a lot of emphasis on the advantages of using technology to keep learners entertained, rather than on any potential benefits it offered for improving learning:

I try and just jump around a bit, because the lessons ... you know ... a 45-minute lesson ... to keep a Grade 8 completely hooked the whole time ... it's much easier if you, you know, you keep switching, you know, sort of grabbing their attention.

Another example of what this teacher regarded as a benefit of using computers was saving paper:

... our school's gone this whole eco-friendly ... so we try and use paper as little as possible.

Case study 13 (Teacher 23 – on facing page) is arguably the most complicated of the 13 case studies. During our interview she initially came across as a highly competent and dedicated teacher who preferred her tried and tested traditional methods of teaching and who was actively resisting integrating technology into her teaching:

If I'm discussing, teaching, talking, explaining, and somebody over there is busy doing something completely different on that computer, I can't see it. Now when we queried that we were told "Yes, but we should walk around the classroom to keep an eye [on things]." Well, that's not what I was employed to do. I was employed to teach my subject, not to police my subject. And if I'm walking around the classroom, kind of leaning over people to see whether Daniel or Jonathan or whoever is busy doing something else, I'm not teaching properly. (Teacher 23)

Her judicious comments suggest that she was against the 'technological determinist' approach at the school, especially the mandated computer usage on *DigiDays*, which she was not convinced could benefit learning in her subject:

... I don't like to have time taken out of my classroom and out of my school day. So I haven't been keen on it.

... it's constant interaction ... it's constant talking ... they do the work at home. I think ... that's something that I have felt quite strongly about as well and I've voiced quite loudly and got quite unpopular for it and ... that is ... subjects are different ... and they can't all be treated in exactly the same way. (Teacher 23)

However, the apparent active resistance she presented outwardly actually masked a deep-rooted sensitivity about her lack of ICT competence. Although she had never used a computer in her classroom and was resistant to the ICT innovation, she was not completely closed to the idea of using computers in her subject, but was hampered by her lack of knowledge about how to use them. She gave the following example of how she might use computers in a lesson, if she knew how to do it:

*... if I ... were a little brighter when it came to something like using a SMART Board or a computer to put pictures up or something like that, you know? If I wanted to show, for example, pictures of Salem, Massachusetts, 1692 as an introduction to *The Crucible*, and I knew how to do that, that would be very useful, but that would be a tiny aspect of what I would then do. (Teacher 23)*

When prompted about whether she thought such usage would enhance her lesson and if so, how, she replied:

*Yes, I think it would, because as an introduction, if you're talking, for example, about *The Crucible*, which is what I have been doing, now ... having visited Salem, Massachusetts ... it would be very interesting for the kids, I'm quite sure, for me to be able to put up the jailhouse or the hanging tree or the square and the boulders with the names on it, but it would simply be an introductory lesson, that's all it would be ... thereafter, back to text. So, it would be interesting, it would be ... probably quite valuable in that the visual would, you know, help them to remember and to understand and to be interested ... rather than just talking ... ja, that would be useful. (Teacher 23)*

I found the interview with this teacher very moving as it became more apparent that she felt belittled by being the butt of staffroom banter about her lack of computer expertise. She explained that she had not yet used computers in the way she envisaged using them

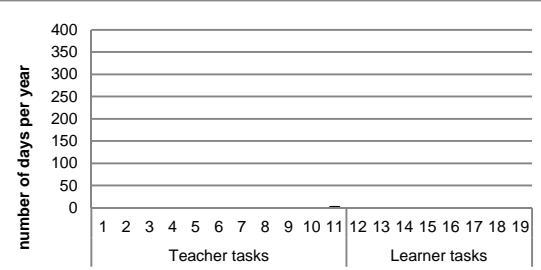
... because I don't know how. (Teacher 23)

She explained why she was reluctant to ask for help:

[Sighs deeply] You know what? I'm loathe to do it. I really am loathe to do it, because everybody's busy ... it makes me feel stupid, because I don't know how to do these things. (Teacher 23)

She also expressed strong feelings of resentment towards the changes being introduced at the school, which she felt ill-equipped to cope with. For example, she expressed some concern about how she would manage lessons in which learners were using computers. This teacher, because of her very great need for assistance with using computers for the teaching of her subject, is a good example of someone who would benefit from support tailored to meet her specific needs when integrating technology.

Case study 13: Teacher 23

Gender	Female
Age group	50-59
Subject	English
Level of ICT training	None
Level of ICT competence	Low; basic <i>Word</i> ; email; basic Internet searches
Level of ICT use outside of school	Low
Total ICT usage before innovation	5 th lowest of 29 teachers
Total ICT usage after innovation	29/29
Extent of change in ICT use after innovation	

No computer usage for teaching: This teacher had never used computers for teaching, and did not have a computer in her classroom when I interviewed her:

No, I don't even use them during lessons now, after DigiDays. I don't use computers at all ... I haven't actually taken out a computer in the classroom, ever.

High computer usage for teacher tasks: She used computers for preparing all of her notes and worksheets:

There are times when I spend ... hours and hours on it ... into the night, because I'm putting something together for the kids ...

Perceived relevance of using ICT and teaching philosophy: She strongly believed that computers have little relevance in her subject, carefully explaining why:

... if I became confident and au fait with the whole thing, then I probably would use it for certain things, but I certainly wouldn't replace my own teaching with that, because I believe totally, in English, that your teaching comes through in what you say, and how you say it and how you explore it and how you discuss it and that cannot be replaced by a computer.

*I could not **possibly** replace what **I** do in a discussion on a novel, or in the reading and discussion on a ... a play such as ... King Lear, with a computer ... the backup that comes from the computer, and that comes in the form of the additional note which is something that can, you know, help them study for the final exam, from the computer, but I could not **use** that computer ...*

Low ICT competence: She did not use computers for teaching because she did not know how (see extract above and below). She also felt that the recent emphasis on using technology undermined her capability as a teacher:

If I have the computer, then I must be trained in how to use it, so that it actually is not just something that's sitting in the way making me feel doubly guilty or doubly stupid.

Fear of losing status: She had difficulty asking for help, especially from younger members of her department, because she felt it undermined her position as Head of English.

All you're doing is you're undermining yourself in a situation where you're heading up a team ... you know what you're doing. They're actually having to learn what to do in your subject but you don't know what is actually the flavour of the month in the school right now ...

... in this school, right now, if you're a computer buff, you are in. And if you're not a computer buff, you're just stupid.

Resistance to change: She expressed frustration at the introduction of the innovation:

It's what I'm exposed to here and the fact that they keep changing things that makes me feel so very uncomfortable.

... I cover everything that is absolutely essential in order for them to achieve in the subject and then suddenly now I've got to go and produce something else ... because now somebody else has got some bright idea.

Teaching philosophy: She displayed a strong focus on assessment and learner results:

*But then I also have to question at the end of the day ... **RESULTS!** You know? We've got to come out at the end of the day with **RESULTS**. Now, do we play with these results or do we **get** these results?*

The purpose of selecting certain teachers for more in-depth investigation of the changes in computer usage after the innovation was to look at how individual teacher's computer usage had changed in relation to their ICT profiles (including the length of time for which they been using computers, the extent to which they use computers out of school and how they use computers for teaching and learning) and their beliefs and attitudes towards using computers for teaching. Not unexpectedly, the 13 case studies revealed that different teachers have very different ICT profiles and varying beliefs about the relevance of using computers for teaching. Further analysis of the 13 teachers is necessary to better understand the reasons why teachers were using computers the way they did and the possible implications thereof for providing professional development that best supports individual teachers with integrating technology in ways that promote meaningful learning.

Analysing the changes in computer usage for the 13 case study teachers

Earlier in this chapter (see page 246) I presented a scattergram which I used to analyse the extent to which *DigiDays* tasks promoted meaningful learning. This analysis showed whether teachers were making effective use of the potential benefits offered by ICT, and provided insight into the type of support teachers would need to be able to make better use of the advantages of using technology when they designed digital learning activities. In this section I use a second scattergram to analyse whether teachers were making effective use of the potential benefits offered by ICT in their **general teaching**, and what types of support they would need to make better use of computers for enhancing learning.

Figure 72 shows the 13 case study teachers represented on two intersecting continua based on how they were using ICT in general, after the innovation. Each continuum represents a different type of behaviour related to using technology for teaching.

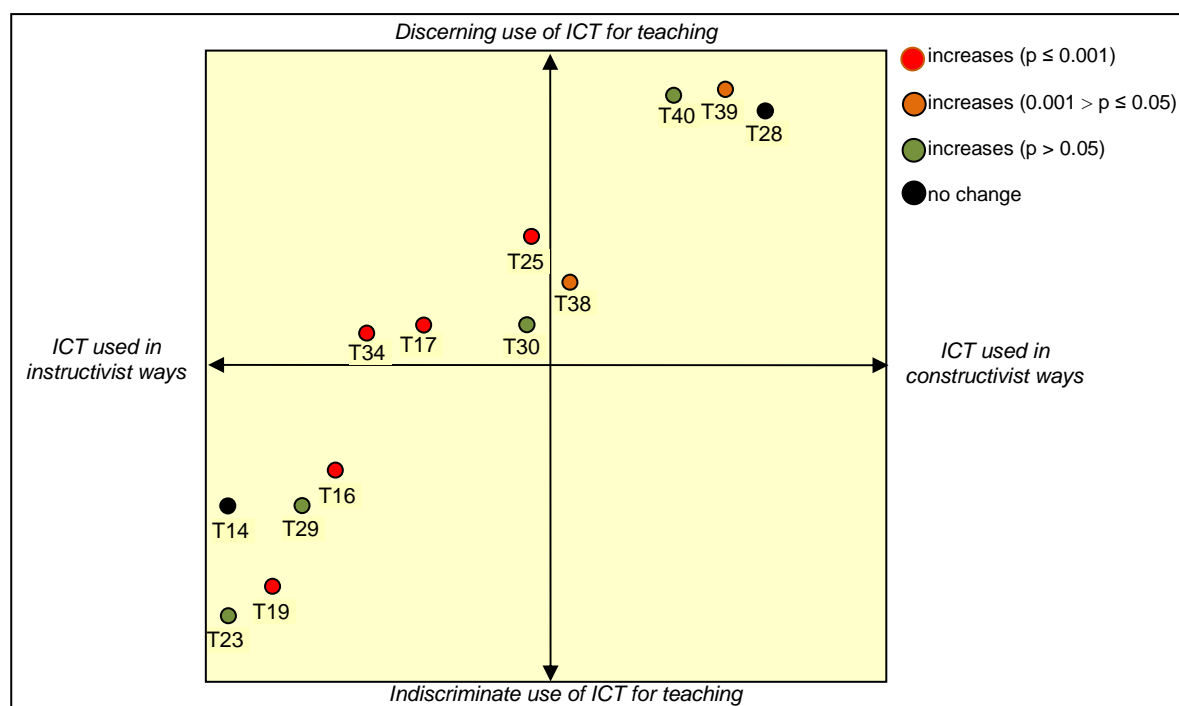


Figure 72. Scattergram of 13 teachers based on how they were using ICT for teaching

The vertical continuum ranges from the indiscriminate use of computers for teaching (at the extreme lower end) to the discerning use of ICT. The five teachers represented below the horizontal continuum were judged to be using computers in less discerning ways, i.e., without due consideration for the effect technology use would have on their teaching. They may have been using ICT simply because it is the modern thing to do (i.e. like computer determinists). The eight teachers plotted above the horizontal continuum were judged to be using computers in more judicious ways, i.e. they used appropriate technologies in specific ways to enhance learning. The 13 case study teachers fell into only three of the four quadrants based on the way they were using computers for teaching, i.e. their behaviour. However, based on the different reasons underlying their practices, a number of subgroups could be identified within each quadrant. In their model, which “*identifies four types of teachers in relation to ICT integration into their practice*”, Donnelly et al. (2011) do not make provision for different reasons underlying teachers' computer usage, or that the underlying reasons for their actions might differ, so that different subgroups of teachers might exist within the same quadrant.

The horizontal continuum ranges from teachers using computers in instructivist ways (left-hand side of the horizontal continuum) to using technology in ways which promote constructivist thinking, at the other end. Some researchers (e.g. Drent & Meelissen, 2008; Ertmer et al., 2012; Kozma, 2003; Peeraer & van Petegem, 2012) believe that the potential for ICT to promote meaningful learning appears to be greatest when technology is used to help learners construct knowledge in ways not possible without using technology. Instructivist teaching, which focuses on the transmission of knowledge rather than promoting knowledge construction, would thus not take advantage of the ways technology can potentially benefit learning, and can be thought of as the lowest level of integrating technology for teaching. Nine teachers represented to the left of the vertical continuum were judged to be using computers in instructivist ways, i.e. in place of, or to support, traditional teaching. Four teachers were using computers in constructivist ways, and are thus placed to the right of the vertical continuum.

The three quadrants into which the 13 case study teachers fell are:

- **Teachers who were using technology in ways which would not take advantage of the potential benefits of using ICT for learning, and for instructivist teaching.** Five teachers were placed in the bottom left-hand quadrant. These teachers were using computers in ways which suggested that they were not integrating technology into their teaching in discerning ways which utilised the real educational benefits of technology. They were also using ICT in instructivist ways. If I used the classification of Donnelly et al. (2011) these five teachers appear (based on their behaviour) to be *Contented traditionalists* (see Chapter 2, page 59). According to Donnelly et al. *Contented traditionalists* prefer to rely on the tried and trusted traditional methods of teaching because they can be sure of the results these methods will produce. However, when their reasons for their computer usage were examined it became clear that this is not a homogenous group. Based on the reasons for their practices there appear to be three subgroups of teachers:
 - **Apathetic traditionalists.** The underlying reason for these teachers being content to maintain the status quo and not want to change the way they are using computers is that they seemed disinterested in using technology more effectively because of the extra work it would entail. They were thus characterised by their apathetic attitude, which manifested at

the time of this ICT innovation as a reluctance to integrate technology. Two teachers fell into this group. Teacher 14 (see case study 2 on page 254) chose to use technology mainly to deliver content, in ways not likely to promote constructivist learning, even though he described himself as competent and confident when using computers in his teaching and he indicated he appreciated the relevance of using computers in his subject. His pattern of computer usage was thus not underpinned by a lack of ICT competence or a lack of appreciation of the relevance of using technology in his subject but rather by his apathetic attitude, as illustrated by his comment about “*probably being a bit lazy*”. The second of the *Apathetic traditionalists*, Teacher 29 (see case study 12 on page 275) repeatedly referred to her lack of ICT competence and how this prevented her making more effective use of computers for teaching but was not prepared to put in the necessary time and effort to improve her ICT skills despite. Professional development aimed at encouraging *Apathetic traditionalists* to use computers more effectively in their teaching would have to focus on motivating them to overcome their inertia and to adopt a more positive attitude towards using computers for teaching and learning. These teachers could benefit from seeing how other teachers use computers effectively in ways which enhance learning.

- **Contented traditionalists.** Teachers 19 and 23 (see Case studies 6 and 13 on page 263 and page 277, respectively) had similar reasons for not wanting to use ICT for teaching. Both had been teaching for a very long time and who were very highly respected as teachers and were not convinced that computers could improve on their existing teaching methods. These teachers would have qualified as *Contented traditionalists* using the description of Donnelly et al. (2011). *Contented traditionalists* “*try to resist it citing they do not need it for their practice*” (Donnelly et al., 2011, p. 1478). However, even though it appeared that these teachers were avoiding using computers for teaching, they could not make more use of computers because they lacked the knowledge and skills to be able to use technology to enhance learning. The lack of appropriate ICT knowledge and skills could have impacted on their attitude towards using ICT for teaching – they might not have fully appreciated the potential of computers to enhance learning. These teachers might make more use of computers for teaching if they had the necessary technological knowledge and a better understanding of what can be achieved when computers are integrated into teaching, possibly through seeing examples of ways in which computers could be used to enhance learning in their subject. The complex reasons underlying these teachers’ resistance to change suggests that they would need support in many areas if they were to make the mandated changes required by the school. However, this would not guarantee that these teachers would use computers outside of the mandated changes unless they were convinced that using ICT could benefit learning in their subjects.
- **Inadvertent users.** Donnelly et al. (2011) describe *Inadvertent users* as being unlikely to look for ICT resources and rather depending on others (e.g. colleagues/ the institution) to provide resources. These researchers also describe these individuals as not having “*a particular focus per se in that they are more of an accidental user of a particular ICT in the classroom*” (Donnelly et al., 2011, p. 1478). Teacher 16 (see case study 7 on page 265) was placed to the left of the vertical continuum because her computer usage focused mainly on finding resources for use in her teaching, and for using her screen as a replacement whiteboard. She was placed below the horizontal continuum because of her non-discerning

usage of computers. Because of her willingness to use computers for teaching outside of the mandated usage required by the school this teacher could not be classified as a *Contented traditionalist* (teachers who were content with their current teaching practices and thus reluctant to try something new), nor does she qualify as an *Apathetic traditionalist*, (teachers who were not willing to make the effort to integrate ICT more effectively than they were before the innovation was introduced). She was thus termed a 'user' to distinguish her from the 'traditionalists'. Even though she was willing to use computers her computer usage lacked a clear pedagogical focus and appeared 'incidental', e.g. she described finding a novel for learners to read on their cell phones, and she was involved in setting *DigiDay* Task 21 (see Table 34 on page 242), for which involved learners designing a Valentine's Day card on computer and which had little value for subject learning. Teacher 16 was thus judged to be an *Inadvertent user*. *Inadvertent users* like Teacher 16 would need support aimed at improving the technological knowledge so that they could avoid the incidental use of computers and select more appropriate ways of using technology to benefit learning.

- **Teachers who were using computers in discerning ways, for instructivist teaching.** Four of the 13 case study teachers were placed in the upper left-hand quadrant (see Figure 72). These teachers were using technology in instructivist ways (hence their placement to the left of the vertical continuum) and were using technology in discerning ways (thus meriting their placement above the horizontal continuum). Two subgroups of teachers could be distinguished in this quadrant, based on their reasons for using computers.
 - ***Circumspect users.*** Teacher 30 (see case study 11 on page 273) and Teacher 34 (see case study 3 on page 257) were grouped together because both were selective about when and how they included technology in their teaching, and avoided the inadvertent use of ICT, and both used technology in instructivist ways. Teacher 30, a History teacher, used technology for projecting political cartoons and videos which she then used as a basis for discussion, which is why this teacher has been placed close to the vertical continuum. Teacher 34, a Life Sciences teacher, was using computers mainly for presenting *PowerPoints*. The reasons underlying their computer usage were that both teachers believed that technology had limited relevance in their respective subjects and both would only use computers where they felt such usage would be better than their current practice. However, it appeared that these teachers were constrained from using computers for more constructivist teaching because they lacked the knowledge and skills to be able to use technology to enhance learning, e.g. Teacher 30 described herself as "*not very competent*" about using computers. This limited knowledge could mean that they did not know how to use technology to promote more constructivist learning and thus used computers mainly in instructivist ways. It could also mean that they did not know how to use computers more discriminatingly (hence their placement so low down the vertical continuum). Despite their limited knowledge of how to use computers in more constructivist ways, (she should the most significant change in the number of computer tasks she was using, after the innovation) but was limited by her lack of knowledge of the different ways in which technology could be used to enhance learning in her subject. There are a number of ways she could be making more discerning use of computers to promote constructivist learning, given the plethora of resources available for enhancing learners' understanding of biological concepts, e.g. suitable animations showing protein synthesis and DNA replication could help learners better

understand these complicated processes. The teachers in this subgroup would benefit from professional development aimed at improving firstly, their knowledge of the affordances of different technologies for enhancing learning, and secondly, from seeing how other teachers use computers effectively to enhance learning, which could enhance their perception of how computers could be relevant in their subject.

- **Innovative users.** Teachers 17 and 25 (see Case studies 4 and 5, starting on pages 259 and 261, respectively) would be considered *Creative adapters* based on the categorisation used by Donnelly et al. (2011). *Creative adapters* “have no qualms about trying new techniques in their teaching” and are able to adapt a new technology for use in their teaching (Donnelly et al., 2012, p. 1479). I prefer the term *Innovative users* over *Creative adapters* because it better conveys the main reason motivating their use of ICT, viz. experimenting with new ways of using technology for teaching. Their focus was on using computers in innovative ways, and not always on the potential benefits for learning. Because of their high level of innovativeness, these teachers did not appear to be constrained by a lack of technological knowledge and skill. For example, Teacher 25 said “if I can’t do, I can figure out. You know, I’ve learnt very quickly with computers ... if you try it, sooner or later you’re going to get it right. You just have to keep on trying ...”. An approach to teaching based on finding novel and/ or creative ways of integrating ICT raises the danger of technological considerations sometimes superseding their pedagogical reasons, leading to “*technological determinism*” (Fisher, 2006, p. 296). Technological determinism is based on the common belief that using technology will transform education. Fisher cautioned against the idea of seeing technology as a “*silver bullet*” that will improve learning (Fisher, 2006, p. 298). Using technology does not automatically promote constructivist learning. These teachers would need support in the form of professional development aimed at helping them understand that the creative use of computers does not automatically lead to better learning and that a more judicious use of computers is needed for meaningful integration of technology.
- **Teachers who were using computers in discerning ways, for constructivist teaching.** Four of the 13 case study teachers (Teachers 28, 38, 39, and 40 – Case studies 1, 9, 8, and 10, starting on pages 253, 269, 267, and 271, respectively) were placed in the upper right-hand quadrant (see Figure 72). These teachers were using technology in discerning ways (see vertical continuum), but unlike the previous group were using technology in constructivist ways (see horizontal continuum). These teachers were grouped together because their underlying reason for using computers was to use computers as a tool to benefit learning. These teachers are aware of how using technology can benefit learning in their subject and have the requisite technological knowledge and skills to be able to support a discerning approach towards using computers, i.e. they know enough about using technology for teaching to be able to select appropriate technologies to help learners construct their own knowledge. In addition, they avoided the indiscriminate use of computers and used technology selectively in ways which they perceived to have educational value. This group of teachers thus best epitomises the judicious use of computers to support constructivist learning. According to the model of Donnelly et al. (2011) these teachers would be regarded as *Selective adopters*.

Based on their reasons for using computers a number of different subgroups were evident among the 13 teachers represented on the scattergram. This underscores the importance of extracting reasons,

not just behaviours, if one wishes to tailor professional development for teachers, based on their specific needs, to encourage the judicious use of computers for teaching. These findings suggest that a one-size-fits-all approach to providing training for ICT integration is unlikely to be effective. This aspect will be explored further in the final chapter of this thesis.

7.2 FACTORS UNDERLYING THE CHANGES IN TEACHERS' COMPUTER TASK USAGE, AFTER THE INNOVATION

This section answers the following research question, restated below for convenience:

Research question 3: What general factors influenced teachers' use of technology after the innovation?

In Chapter 2, I reviewed 48 papers reporting on the factors affecting teachers' use of ICT as part of my conceptual framework. My review of these papers revealed that the factors affecting teachers' use of ICT for instruction occur at three levels: institutional-level factors, teacher-level factors, and factors involving learners. Factors at all three levels emerged in my study.

7.2.1 Factors arising at the institutional-level

When the ICT innovation was introduced at the case study school, the school's Executive Committee set about improving the ICT infrastructure (see Figure 66 on page 212, in Chapter 6). However, it is well established in the literature that teachers' uptake of ICT for instruction is a complex process influenced by many factors, and that the provision of resources will not automatically promote teachers' use of ICT (e.g. see Gibson et al., 2014). This raises the question of whether the Executive Committee provided the ICT resources expecting that, as widely discussed in the literature (see e.g. Ward & Parr, 2008), technology would reform teaching in the school and bring it more in line with 21st-century learning, or whether they had sound pedagogical reasons to promote teachers' use of technology for improving learning. Where the use of ICT for educational purposes is promoted because the technology is available, this is unlikely to directly improve learning (see discussion on page 14, paragraph 2 in Chapter 1). The concept of ICT being the driving force behind integrating ICT into teaching is referred to in the literature as "*technological determinism*" (Fisher, 2006, p. 296) or "*technology push*" (ten Brummelhuis & Kuiper, 2008, p. 99). Fisher had the following to say about technological determinism:

technological determinism in education, by appearing to locate causation in the technology, leaves largely invisible the work—including intellectual and emotional work—which teachers must undertake, in order to use the technology to realise the claimed potential improvements and transformations. Further, technological determinism is silent on contextual factors. It implies that the uniform application of a given technology will yield uniform results, taking no account of the highly contingent nature of teaching and learning and the complexities of individual settings." (Fisher, 2006, p. 297)

The comment by Fisher underscores that the focus should not be on just using technology in education, but rather on WHY and HOW technology can be used to contribute to meaningful learning. I will use the term 'pedagogical pull' as an alternative to concept of technology being the driving force behind ICT integration. Pedagogical pull puts the emphasis squarely on using technology in education as a tool for promoting meaningful learning. The concept of pedagogical pull shifts the emphasis from

the ubiquitous but uncritical use of technology in education to using technology judiciously to improve learning.

The following discussion reports on the categories of institution-level factors, as reported by teachers, in order of relative importance of the influence the factors had on teachers' use of ICT for teaching.

Support-related factors

In my review of the 48 papers factors relating to support for teachers wanting to integrate technology into their teaching were mentioned more frequently than any other category of factors (see Figure 9, page 34 in Chapter 2). In my research the following support-related factors emerged as influencing teachers' use of ICT.

- **The ICT policy in the school.** One of the most crucial aspects of creating an environment conducive to pedagogical push is the existence of a clear strategy for integrating technology, but the following problems were apparent at the case study school in my study:
 - **The lack of a clearly articulated ICT plan.** There was no evidence to suggest that the school had a formalised written ICT plan guiding the integration of technology. However, Vanderlinde et al. (2012) point out that it is not the existence of a **formalised** plan that contributes to the success of ICT integration initiatives, rather that a plan exists. These researchers emphasise that an ICT plan, whether formalised or not, should go beyond the technical aspects of what ICT infrastructure will be provided and focus on what educational institutions hope to achieve by integrating technology and how these goals will be attained. Since the school management had no written ICT plan, their strategy for promoting the use ICT for teaching focused mainly on the provision of ICT resources. However, the Executive Committee had not conducted a needs analysis of what resources teachers either needed, or wanted, so that any strategy to improve the ICT resources was based on what the Executive Committee thought teachers needed, and not on their actual needs. In addition to not knowing what resources teachers needed, the Executive Committee did not assess the state of ICT competence of teachers. This meant that the generic training provided did not allow for differentiated support for teachers who varied in their levels of technological knowledge and skills. Although fundamental to teachers integrating technology into teaching, the provision of ICT resources alone is not sufficient to promote the effective use of technology for teaching, and hints at technology push rather than pedagogical pull.
 - **The ICT 'plan' kept changing.** In the absence of a formalised plan for integrating technology, it appears that the school's ICT policy took shape over time, and some teachers were disturbed by apparent changes. While some researchers (e.g. Lim et al., 2011; Tondeur et al., 2008) suggest that an ICT integration plan should not be regarded as static, but should accommodate any changes in teachers' needs as they integrate technology into their teaching, the changes in the school's ICT strategy appeared to be the result of having to deal with problems which had not been fully anticipated. One teacher pointed out that when the innovation was first presented there had been an expectation among staff and parents that the innovation would involve teachers being required to use computers for teaching more intensively and more frequently than only on *DigiDays*:

... which was initially the way, I think, the ... information went out ... that the parents would buy these laptops and that kids would have the opportunity to bring them to school and they could use them to take notes, and we could deliver the curriculum and they could go on in, maybe in class, and access work ... the way DigiDays is operating at [the school] is different to the way it was introduced. Initially, I think, the parents and even the staff had the impression that, you know, there'd be a lot of computers in the class, and it will be something that will be actively happening in class, on a fairly regular basis, but DigiDays is really being confined to just that. (Teacher 40)

Another teacher expressed frustration at how the innovation had eventually ended up being implemented:

Last year when we started this whole thing with DigiDays and the kids had to bring laptops and they brought their little notebooks, they were specifically told "No 3G cards" which is madness. I understand the motivation for it, because with every good part of technology, there's a negative and you gonna have kids going onto porn sites, playing games and Battleships and all the other awful things. Well, not that Battleships is awful, but, you know, they're going to be on Facebook and Twitter and that sort of thing. But then you've got to actually make a decision. Are we ... a DigiSchool? Are we not? If we are a DigiSchool, then you've got to take the bad with the good and ... make provisions for that ... don't go halfway and this is why the laptop story has failed in ... the school, because the kids see no ... relevance in bringing a laptop and lugging it around and having the ... worry of it, when they can use a pen and paper, without the worry. (Teacher 21)

The comments of Teacher 21 also raises questions about whether the school's decision to encourage learners to bring laptops to lessons was pedagogically motivated, i.e. designed to enhance learning, and whether they had thought about the difficulties which might accompany learners having laptops in the classroom. The study by Fried (2008, p. 911) highlighted the problem of "*students spending considerable time during lectures using their laptops for things other than taking notes*" and found that the use of laptops interfered with learners ability to pay attention during lessons, which negatively affected their performance when assessed.

The opinions expressed by Teacher 21 in the extract above suggest that the school had not anticipated that learners might not want to bring their laptops to school just for taking notes, and that they might want to be able to use the Internet for accessing resources. It appears that right from the beginning of the innovation a decision had been taken to not allow learners to use 3G cards at school. As Teacher 21 explained

... the parents were asked not to ... but a lot of them ... not a lot ... but some did buy the modem ... (Teacher 21)

The school's decision to not allow learners to access school network could have been made to avoid discipline problems occurring in lessons or because this would overburden the school network. The problems with the school network, and how these problems obstructed the use of ICT for instruction, especially on *DigiDays*, are discussed later in the section on *Problems with the functionality of equipment*.

Despite initial expectations that most, if not all, learners would have laptops in lessons and that teachers would be required to integrate technology into their lessons, especially in light of the expense parents would have incurred buying laptops for their children, the learner laptop initiative eventually fell by the wayside, as Teacher 21 explains above. The ICT innovation thus came to centre around *DigiDays*, when teachers were specifically required to use computers for learning. Teacher 40 summed up the impact of *DigiDays* on the extent to which teachers' were using computers, after the innovation,

... and so that [computer usage] has increased, because we ... we've committed to doing it on those specific days ... (Teacher 40)

- **Teachers were not consulted about the ICT initiative.** Tondeur et al. (2008, p. 217) refer to the importance of teachers and school administration having “a *shared vision*” of how and why technology should be integrated into teaching, but point out that there may not always be time to include teachers in the planning process. It appeared that the school had adopted what Tondeur et al. (2008, p. 217) refer to as a “*top-down*” approach to implementing the ICT plan. Teachers were unaware of the plan until they were informed of the ICT initiative at a staff meeting in the October of the year prior to the introduction of the innovation:

It was ... either the end of last year or the beginning of this year, at our staff meeting. No, it must have been last year. (Teacher 29)

... the October I think it was, before I came to [the school] ... they'd introduced it. (Teacher 36)

The lack of consultation with teachers during the planning stages of the innovation contributed to some teachers being frustrated at how the innovation had been implemented, which did not always fit in with their idea of how technology should be integrated. Teacher 21, especially, was vociferous in her criticism (see extract towards top of previous page).

A number of teachers also described feeling anxious when they were told that they would be required to implement an ICT innovation at the beginning of the following year, which could have been alleviated had there been consultation during the planning process:

I was a bit nervous, to be ... to be honest with you, and anxious 'cause I wasn't sure if I could come up with good ideas to present to kids to actually do at home. I... obviously not having spoken to anyone who's ever done it before I ... I wasn't sure what I would be required to do. (Teacher 36)

Oh, scared out of my wits. 'Cause it's immediately, you know, I can't even, you know, kind of do the stuff ... and just kind of shut my mouth, like “Ooh, okay, okay, hopefully this will pass. (Teacher 19)

... [I must] admit we were very overwhelmed by ... thinking ... “What on earth?” (Teacher 39)

The ICT culture

The ICT culture refers to the level of ICT usage considered the norm in an educational institution. The innovation created a culture at the school which promoted the use of technology for instruction. However, this evoked different responses among the teachers. Eight teachers (Teachers 2, 17, 21, 22, 25, 28, 29, and 38) felt encouraged to make more use of technology by the school promoting the use of ICT:

... I probably would have been ... less forward in my ... in my encouraging of ... of computers if I didn't know that the ... that that was the school's ... the school's backing ... (Teacher 28)

They are quite in favour of it. In fact, the more we use [computers] the ... better. (Teacher 32)

Teachers 19 and 23, who were reluctant about computers for teaching, were unhappy about the new emphasis the school was placing on using computers. Teacher 23, especially (see case study 13 on page 277) felt as if the prevailing ICT culture was undermining her standing in the school.

The level of technical support available in the school

Teachers interviewed during the first phase of the study had described two problems with the low level of technical support available in the school, which contributed to delays in resolving technical problems (see page 113 in Chapter 4). The first problem related to the insufficient number of technical support staff. The second related to the support staff being unwilling to help. Similar problems with the level of technical support appear to have persisted after the innovation, as suggested by the following comment:

*Oh, there was a point in time where it ... sjoe, it was **difficult**. It was really difficult to try and get support and to try and get them to fix things and to try and ... just silly things ... like ... your email's not working or your ... your speakers are not working or ... you know ... silly little things. (Teacher 17)*

The lack of adequate support appears to have prompted the school's Executive Committee to undertake a survey of teacher's technical support needs about six months into the innovation, Teacher 29 describes the survey in the following extract:

... In fact, they've had a massive survey now, hey. We've all had to fill in our gripes. Admin [the school administration or Executive Committee] sent out this whole survey on how they're going to improve the IT. And Teacher 3 said "Please be straight and honest about it", because he said he's very frustrated and we do need to fix a whole lot of things up. So that's a good step in the right direction. (Teacher 29)

After the survey the technical support system was revamped. One of the changes that was made was that a new technical staff member, dedicated to the college, was employed. This would have somewhat alleviated the problem of technical support staff being stretched across the preparatory school, the pre-preparatory school and the college, which had been an issue even during the first phase of the study. Teacher 29 had the following to say about this:

... they've got this new guy, you know, because one of the big things from the [survey] ... and I do agree ... I do agree there ... the IT were stretched, because to manage three schools ... and the primary school seemed to get preference all the time. (Teacher 29)

The second change, post-survey, was the introduction of an online system for logging requests for technical support, which some teachers described as having improved the response time:

... and also they've got a logging system where you log a request of ... whatever and they work according to urgency and ... and it's been great. I must say, the last, like, year, our IT department have really stepped up and the support that I get from IT has been great. ... and they really come and fix things quickly ... (Teacher 17)

... requests, are seen to faster now, in the last couple of months. (Teacher 29)

However, even after the technical support system had been revamped, some teachers still experienced difficulties. The logging system, instead of alleviating problems, was described by two teachers as a source of frustration, especially when they only needed help with what is described as minor issues, but they still had to log a request for help, and then wait for assistance:

... I will literally need a small technical question answered and so I will rather email them quickly and say "What's the answer to this question?" and they'll say "Please log a request through the ... through the system." You log a request and you never get an answer to the question ... (Teacher 28)

You know I will email IT a question and then I'll get into trouble because we're supposed to go through [the] Intranet, and sometimes I just want a 'yes' or a 'no' answer, and I'll be told "There is a system to go through". (Teacher 29)

Two teachers reaffirmed the inference from the comment by Teacher 28 (first quote above) that the new system had not completely resolved the problem of long response times:

... look, they're knowledgeable and their support is there but the time ... the timing of it is very slow. To them, you put in a request, it ... can take quite a long time for it to come through. If there's a huge problem then they're there straight away but if it's something relatively small it does take a while. (Teacher 30)

I think the support's there. It's not as instant [sic] as we would want ... (Teacher 32)

The length of time it took to resolve technical problems meant that some teachers would rather approach other members of staff for ready help, as opposed to the technical staff. The extracts below illustrate this point:

And the support ... everybody's so busy. You know? They're all busy with their own stuff and I'm not ... pointing fingers and saying "Listen ... ". I mean, Teacher 3, if we really want something you can go [to him], but those [sic] would be basic stuff that I would ... [for example] change the ... value [sic] of marks and whatever and he's always very willing ... (Teacher 29)

Then I will email Teacher 31 and I'll get the answer. You know? It's just not user-friendly enough. (Teacher 28)

Two teachers described specific problems with unresolved technical issues, despite the new, improved technical support system:

I've got the data projector but I just need someone to come extend it from my ceiling but I've got a very peculiar ceiling and that's why I think they've ... been loath to come to my classroom. I don't have a normal flat ceiling like everybody else ... they've been promising me they're coming to put it in, but ... (Teacher 35)

I've got a laptop ... that I'm paying for ... through the school. I'm very frustrated, though because it's ... it's been giving me endless trouble. I've probably had to take it in five times already. It keeps giving me a Microsoft error and there's something wrong with Microsoft and the computer guys ... ja, they just keep just fixing it ... but in February it crashed and they hadn't updated my work, so I lost all my work from October. (Teacher 39)

Some teachers felt the survey had not resolved what they perceived to be the unhelpful and sometimes patronising attitude of the technical support staff:

... No, I get confused. I really just get confused, because they ... they do talk about stuff there and even if you have a kind of lecture, the amount of stuff that's going on and they presume we're all there and then I've got this void, this gap here [indicates her head] and I have a headache and I start doing this [rubs her temples with her fingertips] and then I go home and I have some tea. (Teacher 19)

... I've had better treatment from the IT department in the last year but there's still an element of "Ooh, little old lady with her computer ... like driving in her little car"... you know ... attitude ... but they have been better. They are trying. (Teacher 21)

The following comment by Teacher 22 perhaps best illustrates the negative impact that a lack of adequate technical support could potentially have on teachers' use of ICT. This teacher described how she had initially been sufficiently encouraged to want to make more effective use of her SMART Board, but had been discouraged by the IT department repeatedly loading the incorrect software.

*And this year I was ... because of my excitement, because I was feeling so much more confident I **wanted** to not just put stuff on my projector ... but actually interact with it and use it for ... for writing down notes and things..... and you know analysing by drawing circles on everything and arrows and things ... and I was just getting the hang of it, and then they reloaded everything onto my computer and it was the wrong programmes. So, once again, I've got a ... SMART Board ... I want to use it but I can't use it. And every time that happens, because that's happened for three years in a row now ... three years in a row. It's put me off a bit and then it'll take a long time for me to get back to the stage where I actually act on it again. (Teacher 22)*

In my review of 48 papers the technical support available to teachers emerged as an important factor influencing teachers' use of ICT. It was the factor with joint highest frequency of the 21 institution-level factors identified from the papers (see Figure 10 on page 34 in Chapter 2). In my study, while some teachers (e.g. Teachers 17, 21 and 29) acknowledged that the level of technical support had improved since the survey was conducted, the level of support available, post-survey was still negatively influencing the technology usage of 11 of the 29 teachers interviewed, to varying degrees.

Availability of finances to supply needs

Financing the acquisition of ICT resources is likely to be an important factor limiting the rate at which ICT can be integrated at most educational institutions. Financial restrictions could have broad implications for a number of aspects of integrating ICT. For example, it would influence the number of technical support staff the school could afford to employ and the extent to which the ICT infrastructure could be improved, as well as maintenance of existing hardware. At departmental level it would affect the purchasing of new software. For example, the Mathematics Department was not able to purchase a software package they would have liked to use, because of financial restrictions:

... but using software that we could have access to because at this Maths conference they told us all about all these things you could do on Geometer Sketchpad but we don't have that version of Geometer Sketchpad and it's too expensive for the school to use ... to get. (Teacher 38)

Instead this department sought out open-source software, especially for use with learners on *DigiDays*.

Hardware-related factors

As discussed on page 237 (see '*using multimedia presentations in lessons*'), the increased availability of computer hardware (desktops or laptops) and the installation of data projectors into all classrooms contributed to teachers making more use of technology for 'teacher-tasks'. Three teachers who had started at the school shortly after the introduction of the innovation described how having the necessary computer hardware available in their classrooms encouraged them to use computers in their teaching. For example, Teacher 35 made the following comment:

This is the first time I've been at a school where I've actually got the computer in my classroom and I ... and I work on it a lot ... in the classroom ... you know ... all the time now. (Teacher 35)

While most teachers seemed satisfied with the ICT equipment they had available for **their use**, some teachers complained about the shortage of computer hardware for **learner use**, difficulties experienced when they wanted to take learners to the computer lab, and problems with the functionality of ICT equipment, as impacting negatively on their use of computers with their learners.

- **The lack of computers available in classrooms for learners to use.** Only two departments in the school, the Geography and Afrikaans departments, had computers available in classrooms for learners to use. However, in each case there were insufficient computers for an entire class of learners, which had implications for how effectively these computers could be used for learning. In the case of the Geography Department, there were five computers available in each of the three geography classrooms. The Head of the Geography Department, Teacher 27, explained how the limited number of computers prevented her from using them effectively for teaching:

I have five. And with ... having ... about seventeen pupils per class ... it's just very difficult to do a, sort of, interactive lesson where they all have to submit, on five computers.

I have set a lesson using those five computers ... but it wasn't very effective. It was rushed. They didn't produce anywhere near the ... sort of, quality that I expected. They all did manage to ... to get on and all that type of thing but it was very ... it was very superficial. I didn't find it very, sort of, productive. (Teacher 27)

Although there are other possible reasons why this computer-based task proved ineffective, e.g. the task may not have been effectively designed, or the teacher may not have allocated sufficient time for the task to be completed properly, this teacher's concerns about there being

insufficient computers for a whole class of learners appear valid within the context of the lesson she described.

Although the Afrikaans Department had eight computers dedicated for learners to use, these were not in the Afrikaans classrooms, but in a nearby classroom which they called the “language lab” or “virtual lab”:

We ... we have a classroom allocated ... close to the Afrikaans quad [quadrangle] ... to the back of the auditorium. (Teacher 17)

There were too few computers in the language lab to accommodate a whole class:

So we have a separate little venue set up with only eight computers in there, but then we just split our classes up into three ... (Teacher 17)

... each class probably gets a lesson once a cycle. (Teacher 16)

The real benefit of the language lab appeared to lie in the fact that learners could book one of the eight computers in the mornings before school and in the afternoons:

And then the children have the opportunity, either before school or after school, to go and spend as much time as they want to. (Teacher 16)

Although booking systems could lead to problems of accessibility (see next bullet point), Teacher 16 indicated that this was not really a problem when it came to the language lab:

*.. they **have** to book, but ... fortunately, because we have eight computers available, there's almost always one spare, so if they haven't booked, there's still the opportunity for them to quickly sneak in. (Teacher 16)*

Where teachers did not have computers available in their classrooms, like the Geography Department, or more easily available for use within their subject, like the Afrikaans Department, this impacted on how they could use computers for teaching. For example, Teacher 25 explained how not having computers available in her classroom prevented her from setting interactive lessons:

*You see, for that kind of thing you need at least a computer per two kids. And even with the big computer drive, even with my Grade 8's, who are the best at it, I never had that amount of computers in my classroom ... which makes it **very** ... **very** difficult (hits the desk with the palm of her hand to emphasise the 'very's'). (Teacher 25)*

Even in the Geography Department, where they had 5 computers for learner use in each of the three classrooms, one of the teachers, when asked to name the major factor limiting her use of computers with learners, referred to the lack of availability³⁰ of sufficient learner computers for effective learner usage:

It's really the access I think. From the point of view of the fact that there's not enough and that you need to go around the class all the time. You know? (Teacher 27)

- **Insufficient computers available in the computer labs.** The other place where computers were available for learners to use during lessons, other than in classrooms, was in one of the two computer labs. Each computer lab was equipped with 25 computers. In addition, there were six laptops available in the media centre³¹, which teachers could book for use during lessons. Despite having these resources available, some teachers in the school indicated that this was

³⁰ Although this teacher used the word “access”, the concept she was referring to is better encapsulated by the word ‘availability’. ‘Access’ or ‘accessibility’ refers to being able to make use of a resource, while ‘availability’ refers to there not being enough of a resource to go around. Teacher 27 had computers in her classroom for all of her learners to use, but she felt that there not enough computers in her classroom for all of her learners to use. Thus, ‘availability’ better captures what she is trying to express.

³¹ The number of laptops was later increased to provide sufficient laptops for a class of 25.

not sufficient. Two teachers explained why they had not taken classes down to the computer lab:

No, not with the kids because my class is ... too big. (Teacher 30)

Maybe the lack of space ... lack of ... available computers? Because, I mean, the one class that I could perhaps do it with, is 27, so that could be a bit of a problem. (Teacher 34)

Teacher 27 and Teacher 28 mentioned the lack of availability of ICT for learner use as the major factor limiting their use of computers with learners.

- **The lack of accessibility of computers for learner use.** In the first phase of my study a number of problems relating to the lack of a booking system and/ or ineffective booking systems had emerged. Developments at the school appeared to have alleviated somewhat the problem identified during the first phase of the study of teachers gaining access to the computer labs during lessons. As the following teacher explained, having a second computer lab increased the chances of a teacher being able to book one of the two:

... in the early days I did have problems but now that there's two computer centres, it's generally quite easy. Ja, so it's usually ... quite easy to get into the computer room. Especially because we're have Maths every day, so in the seven days there's bound to be a free lesson we can use. (Teacher 38)

To coincide with the ICT innovation, the school had introduced an online booking system for the computer labs, as described by Teacher 27:

We have an Internet booking facility ... it's been created on ... where the timetable ... because we need to sort of have ... we don't have enough access in the hub [media centre]. We obviously need to be aware of the CAT and the IT timetables to see when the room is available ... for use. And so it's ... the Internet programme's been designed to ... show which days, and ... what lessons are available so that you can go on and book it. Which means you just highlight your name, stick it in, and then everybody knows if it's booked for the Geography Department for that day for that time period and whatever. (Teacher 27)

Two points arise from the comments made by Teacher 27. The first is that teachers' access to the computer labs is limited. Teachers could only use the labs when they were not being used for the teaching of IT:

... and obviously we have to fit in with the ... IT ... timetables. We can only use it when they're not using it. They're both pretty good. Both Teacher CB and Teacher 20 are pretty good about allowing ... us in and ... but there are 20 classes in the school and two computer labs, of which Computer Science get, obviously, priority ... (Teacher 21)

The second point is that, even though the booking system had been in operation for about two years, some teachers appeared to be unaware that a formal booking system was in place:

Well, there isn't one, which I've had words with Teacher 31 ... often ... (Teacher 21)

I don't know quite how it works. I ... I'm unaware. (Teacher 24)

... I'm actually not too sure. (Teacher 34)

- **Problems with the functionality of equipment.** Two major factors relating to the functionality of equipment, both of which had been identified during the first phase from the study, appear to have persisted during the second phase:
 - **Frequent power failures at the school.** Four teachers (Teachers 17, 25, 30, and 34) described the frequent power failures experienced at the school as the **major** factor discouraging them from using computers in lessons, for example:

... you just get very frustrated when you've gone to all the trouble to plan a lesson or to build the PowerPoint (sic) or whatever and then ... then there's a power failure. (Teacher 17)

Power breaks. Power breaks ... that is very frustrating ... (Teacher 30)

- **Faulty equipment.** Four teachers (Teachers 18, 19, 33, and 39) described being prevented from using computers in lessons by malfunctioning equipment. For example, Teacher 39 described how frustrated she was by her laptop not working properly, which meant that she could not use her data projector for presenting in lessons:

... that has been so frustrating and now it's not reading my projector so we have plugged Teacher 40's computer in at my desk and its reading ... its putting his laptop onto the projector but not mine so now we're think that my feed has gone on my ... so ... I don't know what's wrong with my computer ... so that's very frustrating. (Teacher 39)

Software-related factors

From my review of 48 studies to develop my conceptual framework for the investigation into factors affecting teachers' use of ICT, three software-related factors were identified. The **availability of instructional software** was mentioned most frequently followed by the **quality of the software available**, and finally the **ease-of-use of the software** available. All three problems were identified in the first phase of my study, some of which persisted into the second phase.

- **The availability of computer software.** Generally, the teachers in the study did not indicate many problems relating to a lack of availability of software to use in their teaching. One teacher, Teacher 32, explained that he was not aware of subject-specific software available for teaching his subject. He therefore used resources off the Internet related to whatever topic he was teaching:

... not that I'm aware of specifically for LO [Life Orientation]. I know this website is ... one, it's something you subscribe to and it's a ... it's got vast resources from lesson plans to lesson schedules, to specific clips, to ... you know? We ... we just take aspects of it ... so ... that's a great resource. But I think for Life Orientation because also the ... subject is so broad ... you know, there isn't ... well, not that I'm aware of, software that's just specifically for that. (Teacher 32)

Only the Mathematics Department had indicated that they were unable to purchase some software that they needed because of financial restrictions. This department had not indicated this as a serious problem, however, as they had found open source software that they were using. Two science teachers also described making use of open source software, even though they had subject-specific software available which they said was adequate for their needs:

Yes. I love PhET. It's my favourite friend. It's for free. They're free downloads. (Teacher 39)

I'm happy with the software and I think there's a lot of free software out there, which I think is a lot more meaningful. (Teacher 40)

The huge amount of open-source software available on the Internet, and also the tendency for teachers to use learning objects off the Internet, could explain why only the Physical Science and Afrikaans departments used subject-specific software. Twenty teachers described using videos during lessons, suggesting that most teachers were relying heavily on resources off the Internet, rather than purchasing subject-related software packages.

- **The suitability of software.** The comment by Teacher 40 (see previous bullet) about free software being more meaningful raises questions about the suitability of some software packages which claim to have been designed according to sound instructional design principles. For example, the Afrikaans Head of Department described a number of difficulties she had encountered when looking for a **suitable** software package to use in her language lab. Despite visiting a number of IT stores and bookstores she described coming up:

... empty-handed and disappointed. I found one or two programmes that I looked at and they were not great. Those ones that you buy from _____ like "Learn Afrikaans in twenty minutes" or whatever they're called and I was really disappointed. It wasn't doing what I wanted it to do ... I did try and search the Internet and I found quite a lot but they were very ... junior, you know, aimed at baby children [sic]. (Teacher 17)

This teacher seemed to have a very good idea of exactly what she wanted in a suitable programme for teaching Afrikaans. She described some of the merits of the programme she finally ended up buying:

We're running a software programme called ... Lesers is leiers [Readers are leaders] and ... it's a fabulous programme. It ... when kids go there for the first time it calibrates their reading speed immediately. It comes up saying your reading speed is that of a nine-year old or a ten-year old or whatever. And it improves vocabulary, it improves comprehension, it improves grammar, it improves memory, it improves reading speed... five different skills that it improves. It's lovely. It's got nice graphics and nice sounds and all sorts of things happening. (Teacher 17)

In Chapters 8 to 12 of this thesis I report on the evaluation of a multimedia software package to assess its suitability to support Life Sciences teachers implementing the requirements of the new curriculum introduced in South Africa, and having to teach new content relating to the topic 'biodiversity'.

- **The ease of use of computer software.** The difficulty of use of software has been identified in other studies as a factor discouraging teachers use of ICT for instruction (e.g. Butler & Sellbom, 2002; Pelgrum, 2001). The major software-related issue mentioned by four teachers in my study was that they found *Moodle* difficult to use. This low figure must be seen in light of the fact that at least four teachers (Teachers 7, 15, 21 and 23) had never uploaded a task onto *Moodle*, leaving this task to another member of their department, while seven other teachers had only used *Moodle* on *DigiDays*, and had perhaps not considered things like how user-friendly the interface is. Two teachers, both of whom **had** used *Moodle* outside of *DigiDays* for uploading tasks pointed out features which they found made *Moodle* difficult to use:

... there's parts of it which were a little bit frustrating, like you go and I think it kind of looks archaic in its structure ... like it really doesn't look very modern ... and, for me, I seem to be more visually stimulated so I'm ... here I am trying to make nice presentations and funky backgrounds in different colours and stuff and Moodle ... you can't change anything. It's just plain grey, nothing else. (Teacher 28)

I'd love for it to be easier to use. It's very, very difficult to use. Multiple choice, for instance ... to put one multiple choice exercise onto Moodle can easily take me an hour ... you have to pick the question, put in the question, put in the mark, connect the next question. You can't just copy and paste or something like that, so it's very, very time-consuming. And then, I would like my work to be available across grades, but it's very difficult to import. Grammar exercises are grammar exercises ... so my Grade 9's and my Grade 10's can use exactly the same exercises ... for me to take my Grade 9 work and make it accessible to my Grade 10's, especially something like multiple choice, which is what I want to use ... you have to redo the entire thing. Ooh, it's a pain. (Teacher 25)

Some teachers in this study highlighted the following features of *Moodle* which they found useful. These features include allowing teachers to comment on aspects of the work (allowing for formative assessment/ feedback), prompts for giving learners instructions about the work and being able tracking student submission of work:

... they have an option to choose a mark so they've got a little mark in. One of those little right-clicks and it gives you lists of marks. You choose your mark and they give you a block in which you can write a comment. (Teacher 22)

... you can click on it and it will show you all the ones that have sent their work in and you can tell Moodle what time, when it's going to be cut off. (Teacher 29)

... when it can be opened and when it's got to be handed in by ... and all of that's controlled by Moodle ... you use it ... various different settings ... just to control those parameters. (Teacher 33)

I have previously discussed the importance of software in turning ICT hardware into learning tools (see paragraph 2 on page 5 in Chapter 1. In my study software was not a major factor hindering teachers' use of technology for teaching. Teachers who wanted to try out new ways of incorporating technology into their teaching (see case studies 4 and 5 for Teachers 17 and 25, respectively), or teachers who wanted to use computers for enhancing teaching and learning (see case studies 9 and 10 for Teachers 38 and 40, respectively, on pages 268 and 271) went out looking for suitable software to use. Teachers' willingness to find software to use in their teaching could thus be used as an indicator of their level of innovativeness, as will be discussed in the next chapter.

7.2.2 Factors arising at the teacher-level

The literature abounds with evidence for the importance of teacher beliefs, attitudes, and knowledge on teachers' integration of ICT. Drent and Meelissen (2008), when investigating the factors affecting teachers' innovative use of ICT, found that "*several factors on teacher level influence the implementation of innovative ICT-use in education*" while "*school level factors turn out to be of limited importance for innovative use of ICT*" (Drent & Meelissen, 2008, p. 187).

The interviews conducted with the 29 teachers in my study, and the case studies of 13 of these teachers (starting on page 253), suggested the following teacher-level factors as being the most important ones affecting teachers' use of ICT after the innovation.

Teachers' ICT competence

Teachers' ICT competence emerged as the most frequently mentioned factor across the papers reviewed (see Figure 8, page 33 in Chapter 2). Recent research by Vanderlinde, Aesaert, and van Braak (2014) confirms the importance of ICT competence as a variable affecting teachers' use of computers. In my study teachers' level of technological competence also emerged as a major factor underlying teachers' ability to use computers to enhance learning. It affected the following aspects of teachers' computer use.

- **The types of *PowerPoints* teachers created.** Teachers' lack of knowledge of how to prepare complex *PowerPoints* might hinder the more meaningful use of *PowerPoint* in lessons. Although nine of the 28 teachers (excluding the IT teacher, who described rarely having to use presentations in his computer-based lessons), when asked in a questionnaire about how confident they were when **using** *PowerPoint* indicated that they were confident, this could apply to **presenting** *PowerPoints* in lessons rather than **creating** *PowerPoints*, especially complex ones, which have a greater potential to engage learners than basic presentations. Only seven of the 28 teachers (Teachers 14, 15, 17, 24, 25, 28 and 30), when interviewed, described having created their own complex *PowerPoints*, as described by two teachers:

... I often edit ... like I'll copy and paste images off the Internet which you can't download and then edit them and Photoshop them, add labels to them and then put them into a PowerPoint ... (Teacher 28)

I put it onto a PowerPoint with music and little ... pictures that dance and things like that. (Teacher 14)

- **Teachers' use of Moodle.** One possible reason why some teachers were making limited use of Moodle outside of *DigiDays* could be that they found it difficult to learn to use, which has already been discussed under the section *Ease of use of computer software* on page 293. Because of the time implications of learning to use Moodle and actually using it on *DigiDays*, these two issues will be dealt with later in this chapter, in the section dealing with 'time' as a factor affecting teachers' use of ICT.

The influence of ICT competence on teachers' use of computers for teaching is not a straightforward, direct relationship, as shown by case study 2 (Teacher 14), on page 254. Despite having used computers before in the corporate world this teacher was making little use of computers for teaching and learning, suggested that the way he chose to use computers in his teaching was mediated by other factors.

Teacher beliefs

Teachers' beliefs about teaching and learning, as pointed by Pajares (1992), have long been acknowledged as one of the most important factors influencing teachers' use of technology for instruction. Belo, van Driel, van Veen, and Verloop (2014) made the following relevant points about teachers' and the beliefs they hold. Firstly,

Teacher beliefs are part of larger belief systems. These systems contain beliefs about teaching and learning in general (e.g., conceptions of learning and beliefs about a range of topics such as the regulation of students' learning processes, goals of education, the nature of knowing and knowledge development, assessment, and so on) and domain-specific beliefs (e.g., beliefs about the nature of the subject, curriculum goals, instructional strategies for teaching particular content, and so on) (Belo et al., 2014, p. 3)

Secondly, these researchers found that the literature suggests that teachers' belief systems are not always comprised of consistent beliefs, e.g. individual teachers may have constructivist beliefs about learning but retain traditional beliefs about teaching:

Some studies found consistencies in teachers' belief systems whereas other studies show that individual teachers had mixed and divergent beliefs. (Belo et al., 2014, p. 3)

The implication of these two points is that teachers' belief systems are complex.

In my study, the following teacher beliefs emerged as the most important ones affecting the use of ICT after the innovation.

- **Teaching philosophy.** Teaching philosophy refers to teachers' beliefs about teaching and learning. An awareness of their own teaching practices and goals could allow teachers to choose technologies which better suit their teaching styles. Drenoyianni and Selwood (1998) found that teachers' use of computers was related to their educational goals.

In Chapter 1, page 13, (see paragraph 2) I pointed out that some researchers erroneously believe that the use of technology for teaching is automatically consistent with a constructivist view of learning. Niederhauser and Stoddart point out that "*computer technology, in and of itself, does not embody a single pedagogical orientation*" (Niederhauser & Stoddart, 2001, p. 15). Dori et al. (2002, p. 512) emphasise that the main tenet in constructivist technology-embedded learning is to allow learners "*to learn by experiencing and doing*", which allows learners to construct their own knowledge through deep cognitive processing and making meaning of the

knowledge to be learned. Some teachers in my study expressed the misconception that letting learners use computers is inherently interactive. For example, Teacher 32 believed that:

... its more interactive and you can try keep their attention a bit more. (Teacher 32)

Ten teachers in my study expressed constructivist beliefs about teaching and learning, which translated into *DigiDays* tasks which promoted meaningful learning. In the following excerpt Teacher 33 explained his teaching philosophy and why he was receptive to the *DigiDays* innovation:

... in [my] previous career with SAB I was put through a ... distance learning programme which is run by Heriot-Watt University in Edinburgh ... and that involved some limited use of interactive computer stuff ... so I'd already seen some of the benefits and some of the stuff which could be achieved ... so I'd already been open to those kinds of ideas and had gone through the kind of initial thing of ... that all teaching has to be a person in front of a group of people ... I'd kind of moved away from that ... so I was a lot more open and a lot more receptive to using something like DigiDay. (Teacher 33)

Other examples of teachers who expressed more constructivist views are given below:

... and that's the whole thing with learning. It's one thing to see it, it's a totally different thing to actually do it yourself. And that's ... that's where I think computers can be incredibly powerful ... (Teacher 24)

*Okay, in the classroom they are watching **me** do it. At home, they are doing it themselves... which is always better. (Teacher 37)*

*... It's best when **they're** [learners] all busy. It's much better when they're using the computers than when they're just staring at the screen [onto which the teacher is projecting material]... (Teacher 38)*

I think, for one, a lot of the animations require the kids to ... at least to do a little bit of reading on-screen, which tends to be a downfall as a teacher, because we tend to do all of that for them. We read and we tell them and we tell them what we're going to tell them, and so it forces them to interact ... forces them to read ... forces them to interact with the animation in a meaningful way in the sense that they have to ... translate pictures in ... in some instances, into actual substances and then they actually have to ... try to interpret the outcome ... and so I think it forces the kids to be more active learners rather than passive learners ... (Teacher 40)

The view expressed by Teacher 40 probably best embodies the constructivist view of teaching. This science teacher (see case study 10 on page 271) had set the *DigiDay* task scored at the joint highest level for effect of using ICT and for the pedagogical design implied in the task (see Table 34, page 242).

In contrast to the constructivist philosophies expressed by these teachers, 17 teachers expressed more traditional views of teaching. Her traditional view of teaching made Teacher 23 (see case study 13 on page 277) reluctant to use computers for instruction:

I produce an end result ... children sitting with computer in the classroom and possibly, computer books [sic] in the classroom, might not be doing exactly what it is that I'm wanting them to do. (Teacher 23)

Teacher 27 also displayed a conservative view of teaching:

*... I think at the beginning I thought it would be that there would ... we would lose control. I think in a lesson with **me** using the computers I can sort of control what's happening and if I think it's going ... it's not the way I want it, I ... you know, you can introduce different things. Whereby, on DigiDays, you, sort of, put it up and you don't have the pupils in front of you and so I was a bit apprehensive in the beginning, that you wouldn't get the [right] kind of response back ... (Teacher 27)*

Teachers, 23 and 27, in their comments above, also displayed some anxiety about managing lessons using computers. Using computer technologies in lessons changes the nature of classroom management, which can be a source of anxiety to teachers. Gibson et al. (2014)

point out that computer anxiety is an important factor “*reducing the integration of computer technologies into the classroom setting*” (Gibson et al., 2014, p. 166).

- **Perceived relevance of using technology for instruction.** Teachers may be more inclined to use computers where they perceive a real benefit for learning in their subject. According to Pajares (1992)

Teachers often teach the content of a course according to the values held of the content itself. As with self-efficacy beliefs (Bandura, 1986), this combination of affect and evaluation can determine the energy that teachers will expend on an activity and how they will expend it. (Pajares, 1992, p. 210).

This suggests that the beliefs teachers hold about the nature of their subject and how it should be taught will influence their perceptions about the value of using technology to enhance learning. When interviewed, some teachers focused on the benefits of using computers not directly related to learning. For example, Teachers 7, 14, and 29 mentioned how much easier and quicker it was for them to use computers to carry out tasks. However, in this section I focus only on teachers' perceived relevance of using technology **for instruction**, when such usage can potentially enhance learning. When considering teachers perceived relevance of using technology for instruction, I look at teachers' perceived relevance of using technology in their general teaching, for teaching their including their perceived relevance of using *Moodle* outside of *DigiDays*, and how teachers felt about the usefulness of learners using technology on *DigiDays*.

- **Perceived relevance of using technology in general teaching.** Excluding the Information and Computer Applications Technology teachers, 21 out of 29 teachers cited the visual aspect of using computers as the main reason why they were using technology in their lessons. Teachers from the science subjects (Natural Sciences, Life Sciences and Physical Sciences), especially, pointed out how the visual aspect of using computers enhanced their teaching. The most discerning use of visuals to enhance learning came from two Physical Sciences teachers. One emphasised that he would not have been using computers for a whole lesson, but would have selected animations which helped learners illustrated to better understand abstract concepts:

If you're talking about a whole lesson with computers – no.

... your whole electromagnetic effect ... motors and dynamos and the whole concept of left-hand rules and right-hand rules and ... it's a very difficult concept to explain. When the kids see the simulation, they pick it up immediately, because there they can actually see it rotating and they can see force-fields and they can see current flowing and they get it. Without that, it's almost impossible to teach them that concept. (Teacher 3)

The pragmatic use of computers by the other science teacher, case study 10 (Teacher 40), and how this promoted meaningful learning, has already been discussed (see pages 272-273).

Two Natural Sciences/ Life Sciences teachers made the following comments about how they use visuals in their teaching:

... I love the graphics that we have access to ... particularly for Biology ... the videos that one can download off YouTube, I think they're just incredibly powerful teaching tools ... (Teacher 24)

... why waste half the lesson trying to do a very good drawing of a cell on a ... on a whiteboard, when I can use electron photograph or electron micrographs ... blown up so that they can see them properly ... (Teacher 33)

The Mathematics Head of Department also expressed a pragmatic and judicious reason for using computers in her lessons:

So it tends to be those things, those sections where you've got a picture. Whether it's a geometry diagram or a graph, something like that ... perhaps a number pattern where you've got a lot of different equations ... where the computer is useful I'll use it. But I won't use it just for the sake of making a pretty lesson because, you know, there are times when it is better to write it on the board. (Teacher 37)

Some teachers with more traditional views of teaching felt that computers were either not useful in their subject, or were only of limited use. For example, the English and History Heads of Department emphasised the need for discussion in their subjects, which meant that they did not feel that using technology was always relevant to their teaching

You see, in English, if you're studying a text such as a Shakespeare ... or a novel ... you have obviously ... the novel in front of you. They've got work that they've done and it's a lot of discussion. It's not a computer thing at all, its discussion ... we discuss ... we throw our ideas around. (Teacher 23)

... the nature of my subject is discussion and talking, so I can't sit and put everything on, on a computer, examples for them to do ... it's not like that, you need to discuss and argue and so on, and write essays. It's not ... it doesn't always lend itself to technology. (Teacher 30)

This comment by Teacher 30, a History teacher, suggests that she was not resisting using computers, but was selective in how she would choose to use technology. In a comment below she clarifies which aspects of using technology she considers relevant to her teaching:

Just the visual matter that ... that's available. If you're talking about Robert Mugabe you can put up a picture of him. If you're talking about Zapiro cartoons you can put up cartoons. It just makes the subject much more interactive so they can actually see what's going on. (Teacher 30)

An Art teacher explained that hands-on work in her subject sometimes made computer use inappropriate:

I wouldn't at this stage lend myself out to ... to basically do some graphic work on the computer ... I'm a hand-rendering ... I believe they've got to hand-render ... you know, I often get students that say they want to do art, but they'll do computer graphics, you know, the art one, because they actually don't physically have to draw ... you know ... because they can manipulate ... and we get the feedback that we get from the tertiary ... people say the kids need to do ... to be able to do hand-rendering. They kind of getting the cop-out because they can manipulate stuff, but they still can't shade and they don't know the basics. But they find if you send them a student that has got the basics, then they're ... get very quickly [sic] ... go into the computer stuff and the ... animation, because they can ... they can draw. (Teacher 19)

Where teachers were resisting using computers, like Teacher 23, it could be that they lacked the knowledge of how computers could be used in their subject, and would benefit from professional development aimed at improving their knowledge of the affordances of different computer applications for teaching their subject (technological pedagogical knowledge – TPK) and/ or knowledge about how they can use various technologies to teach specific sections of content (technological content knowledge – TCK).

Teachers of Physical Science, Life Sciences, Geography and Life Orientation were more likely to express the view that using technology offered different benefits for learning in their respective subjects.

... Geography obviously lends itself to PowerPoint presentations and ... internet ... animations and all that type of thing. (Teacher 27)

However, the four Mathematics teachers emphasised that they could only make limited usage of computers in their subject. One teacher put forward the following as one of the reasons why she felt that computers offered limited benefits in her subject:

... because they've actually got to practise more ... their algebra skills and whatever ... (Teacher 38)

One history teacher expressed a similar view about the limited relevance of computers in her subject:

... the nature of my subject is discussion and talking, so I can't sit and put everything on ... on a computer, examples for them to do ... it's not like that, you need to discuss and argue and so on, and write essays. It's not ... it doesn't always lend itself to technology ... (Teacher 30)

Two other teachers also felt that computers had limited relevance for teaching English. One teacher compared how computers could be used for teaching biology compared with the limited usage she felt was possible for teaching English:

*... with most subjects, your text is a means to an end, whereas with English it **is** the end. So, we are studying the text. If it was the human body, it's wonderful to say "Right, zap that piece and let's fit this piece" and "Oh, look what happens when we squeeze the stomach, it goes 'blach'". I mean it's great, whereas we don't have as much ... I mean, there are ... there's plenty that we can do, but not **as** ... essential for ... for the subject. (Teacher 24)*

- **Perceived relevance of using Moodle outside of DigiDays.** Only three departments (English, Science, and Geography) used Moodle for learner-tasks outside of DigiDays. One of the English teachers, Teacher 25, had loaded some quizzes onto Moodle:

I set a whole course for our Grade 9's on grammar, with little grammar exercises, and they did it during the term, so they had one of those to complete a week ... and that was all on Moodle. (Teacher 25)

Some members of the English Department felt that using technology had benefited learning, in the case of the grammar quizzes:

*... the comment from the other English teachers is that there was a strong correlation between the kids who had **done** those quizzes and their results on the grammar sections on comprehensions. Yes. Because it had forced them, and even if they were lazy and didn't go and look, the fact that they kept getting that one wrong meant that they had to think about it and ... and ... so it encouraged them to at least engage with the subject matter. (Teacher 24)*

However, the correlation between the children who had done the quizzes and the results on the test is probably largely due to those learners having had more practice doing the grammar quizzes than anything to do with having done the quizzes on computer.

Teacher 38, a Mathematics teacher, also described having used Moodle outside of DigiDays:

I know I did one. I did one on compound interest versus simple interest ... which wasn't a DigiDays thing. But that was last year ... so maybe, ja ... once, I've done it once. I set it on Moodle and then we actually did it in class. We went to the computer room and did it. And they did it via Moodle. (Teacher 38)

One of the Geography teachers had found a way of 'forcing' his learners to use Moodle:

... I will put stuff on ... on Moodle for them to do for homework and not give them any other option so I ... I have been trying to force it, but I mean, that's not obviously going to make up their main set of marks or whatever ... but just to get them in line, especially with the Grade 8s, so that if they get used to it this year, then in years going forward they'll be more inclined to do the Moodle side. (Teacher 28)

Where other teachers were making use of Moodle outside of DigiDays, it was for uploading resources rather than for uploading specific tasks which learners had to complete on computer. The following are examples teachers gave of resources they had loaded onto Moodle:

Our Grade 10 book is all about a school band and they refer to various different bands, Greenbay and ... covers and I found both clips on YouTube and uploaded them onto Moodle, so that the kids, in their own time, can find out what these bands sound like. (Teacher 16)

What I have done is if I've found, like, interesting material, on the holocaust, let's say, then I'll post that on Moodle. I haven't done it a lot, because I keep posting in the wrong place, so I've got to still ... I just do it incorrectly. (Teacher 29)

I must admit I haven't used ... I don't use Moodle other than, maybe for a DigiDays or else just to maybe give the kids extra information ... like exam papers. That's what I've managed to use it for. (Teacher 34)

These findings correlate with what Schoonenboom (2014) reports, namely that, in the literature,

A consistent finding is that LMSs [Learning Management Systems] are used most frequently for the distribution of learning materials, less frequently for communication between instructor and students, and even less frequently for online assessment or collaborative learning. (Schoonenboom, 2014, p. 247)

- **Perceived relevance of learners using computers for *DigiDays*.** When asked whether they thought that *DigiDays* had had any impact on learning, teachers responded in the following ways. The responses of two teachers who sat on the school's Executive Committee were not included in these counts:

Ten teachers (Teachers 15, 20, 27, 29, 33, 34, 35, 37, 39, and 40) focused on the potential benefits for learning if learners carried out computer-based tasks. Some teachers pointed out that using computers allows learners to do things they would not have been able to do off computer:

I hope, more meaningful for the kids, in the sense that ... they are interacting in ... in different ways with material. ... [before] as a teacher I would put the activity together and I would control it from a computer and they would sit back passively, but now, it's different because now they have to actually engage with the actual ... software and they actually have to ... to troubleshoot and work through it and really meaningfully try to ... to work through it. (Teacher 40)

*I think it gives the children a different approach. It enables us to do ... certain sections of work ... it enables us to demonstrate them very nicely. With our matric group we did ... an exercise on their DigiDay where they could actually construct and demonstrate the theorems for themselves. So, I think it aids their understanding. I ... everything that we do we ... we are trying to enhance the mathematical content of our syllabus. We're not just doing ... going through the motions ... of just making them do an ordinary worksheet and say "Question one, the answer's twenty-seven and question two, the answer's thirteen" kind of thing. We're trying to **use** the computer as a tool... rather than, you know, the traditional way that we tend to fall back on. (Teacher 37)*

One teacher pointed out that learners using computers allows for differentiated learning:

I think we ... we're missing a lot of children in our assessments at the ... the way we assess, I just don't think caters for some children out there and I just think this allows us to show them things differently, allows them to play with things differently and also to present their work in ... in a manner that many of them just have a natural talent for but there's ... there's never been an avenue for it before. (Teacher 39)

One Life Sciences teacher emphasised that the benefits for learning depended on the design of the task:

... where we've really gone and done our homework properly, and we've managed to find additional links and that ... where material can be either animated or linked to a particular video feed or something like that, there I think the learning has definitely improved and picked up. (Teacher 33)

Another teacher pointed out that the benefits for learning depended on the level of motivation of the learner, illustrating again that it is not the use of computers but engaging learners in the work which makes the impact:

... what impact it has on learning? Well, I think it ... can [go]... both ways, if you really work through DigiDay that can have a huge impact on learning. It can increase learning ... but if you're taking DigiDay like on holiday [sic] I don't think it'll be ... will have a huge impact on your learning. I think it all depends on learner to learner. If you really sit and you submit your work ... ja then it will have a huge impact. (Teacher 20)

Five teachers (Teachers 2, 16, 22, 25 and 32) focused on learners benefiting from being required to work on their own. For example:

Number one ... it teaches them they can work completely independently (Teacher 25)

I don't know if it's specifically on learning, or if it's more on ... more on just time management and responsibility and learning how to actually taking ownership of what ... what they have to do. (Teacher 32)

... I think getting them to work a lot more independently ... I think letting them use technology. Learning to work in their own time ... having to time-manage [sic] (Teacher 2)

Some teachers focused on learners having access to more resources when using technology: Some of the comments above by teachers (see e.g. comments by Teachers 16, 29 and 33) made reference to learners benefiting from the larger number of resources they could access using technology. The following comment sums up this idea:

They've become more aware and they're using the media and they're using technology just to find out more, which is increasing their knowledge. (Teacher 30)

Four teachers (Teachers 14, 19, 28 and 38) focused on the technical skills learners were gaining by using computers on *DigiDays*, rather than on any potential benefits for subject-learning:

It's getting them to ... to use those programmes which will, they'll probably use at 'varsity or in the workplace. (Teacher 14)

*To get children onto the computer, it's worth ... it's definitely worth it. Just to **force** them to use Excel and Word, I think, it's brilliant, I really do. (Teacher 38)*

Two teachers felt that *DigiDays* had impacted negatively on learning. Teacher 23 pointed out that more children were being required to come to school on *DigiDays* because they had not submitted work on previous *DigiDays*. She also pointed out a problem with plagiarism:

... and just observing what has been happening and how many children have been put into detention and how many children are being forced to come here on DigiDay and sit there and now instead of having one teacher babysitting we have six teachers babysitting ... I don't think that that adds up to being particularly successful. I also know that a lot of children have been caught for lifting things off computers. I know that children have been caught for ... even with the matrices, sending out one thing and everybody copying it, you know, just cutting it and pasting it and copying it. I don't think that that's educationally sound. (Teacher 23)

Teacher 21 pointed out another problem which had arisen with a multiple-choice quiz which had been used as a *DigiDays* task:

It was a good exercise and it was going to test everything we wanted to know with these kids and they ... they fiddled the system. Within 11 minutes they'd worked out how to ... to get hundred percent without ... even reading a single question. I still can't remember how they did it, but we got very suspicious when our weak kids were coming back with hundred percent immediately, you know, they were on ... I mean, you couldn't even read the passage in 11 minutes, let alone ... (laughs). So they'd somehow bummed the system 'cause we'd given them a double chance to ... to resubmit and so now, we ... we just can't do that. They get one shot at it and that's it. (Teacher 21)

One teacher felt that that learners appreciated working at home on *DigiDays*:

... I think the kids appreciate it more because ... they can also work in bed, you know? I ... if I look at my own children, they'd rather actually be in their own comfort zone than at school.
(Teacher 18)

The findings from my study underscore the idea that teachers' hold complex belief systems which influence the extent to which they integrate ICT into their teaching. The two main teacher beliefs which emerged from the study as impacting on the uptake of technology were teachers' perceptions of what constitutes good teaching and whether using technology could enhance teaching and learning.

7.2.3 Factors arising at the learner-level

Three learner-level categories of factors influencing use of ICT were identified in my literature review: **learners' level of ICT competence**, **learners' level of interest** and **learners' access to computer hardware at home** (see Section 2.4.3 on page 60 in Chapter 2). While all three categories of factors emerged in my study the unusual situation of learners' working at home on *DigiDays* brought two new factors to the fore. In addition to learners' not having access to computer hardware at home, the problems of learners' not having the necessary software and not having Internet access emerged.

Learners' access to computer hardware at home

When initially named, during my literature review, this category of factors referred to the extent to which learners have technological resources (e.g. machines, printers, speakers) to use at home. My study revealed two new factors in this category which influenced the type of computer-based tasks teachers could set for learners on *DigiDays*. To be able to complete *DigiDays* tasks at home, learners needed access to particular software applications, and to the Internet. For this reason I have renamed this category as ***Learners' access to computer resources at home***. Teachers mentioned the following problems relating to learners not having access to appropriate resources at home which prevented learners from either carrying out or completing their *DigiDays* tasks in time to meet deadlines.

- **Some learners did not have access to the necessary hardware at home.** The problem of learners not having access to computers at home was the main reason for setting up the system whereby learners could work under supervision in the computer lab on *DigiDays*. A lack of access to computers, specifically, was not the only problem, as Teacher 34 explained.

... I think a lot of them don't want to print at home or they don't have access to a printer.
(Teacher 34)

While the issue may have been a lack of access to a printer at home, some parents may also have been worried about the extra costs involved in learners printing work at home, and could have discouraged their children from doing so.

- **Some learners did not have access to the necessary software at home.** This was one of the new factors influencing teachers' use of technology for teaching which emerged in this study. Where learners had access to computers at home, they were likely to have access to generic software like *Microsoft Word*, *Microsoft Excel* and *PowerPoint* – the programmes used for most of the 33 *DigiDays* tasks I looked at (see Table 34 on page 242). However, where teachers wanted to use software programmes other than these, they had to consider whether

learners would be able to access the package. One teacher explained that their Department had to use free software which learners could download from the Internet for the *DigiDay* task to ensure all learners would have it:

... you know, because I've been used to working on Equation Editor all the time but because it's not freeware, we had to use something that is freeware for the kids. (Teacher 35)

Where learners need to download software to use on *DigiDays*, they might experience difficulty with the download, or may not know how to download software off the Internet. The comment below by a Geography teacher highlights the importance of teachers being available to deal with queries arising not only from content-related issues, but also technical issues:

. then, during that day, for most of the day, I'll be online to be able to answer any problems if they're not able to download it or they ... 'cause I ... I've been putting most of it in PDF format, and some of them don't have the latest Adobe reader and that gives them errors and so ... I have been on ... normally online for most of the time to be able to answer those sort of queries... (Teacher 28)

Learners not having the necessary software (e.g. Adobe reader) meant that learners could not complete tasks:

I also found with the DigiDay assignment with the brochure, one of the requirements was they had to bring us a hard copy, and a lot of them didn't ... or else they couldn't convert ... something was wrong with the PDF file ... (Teacher 34)

The comments by these two teachers raises another issue, that of the technical competence of the teachers setting *DigiDays* tasks. Teacher 28 might have been more likely to be able to help learners sort out technical queries because of his own technical skills. Teacher 34, however, was less likely to have been able to help learners resolve technical issues, as she appeared unable to explain what the problem was and eventually said that something was wrong with the PDF file she had loaded on to *Moodle*. This issue reaffirms that setting computer-based tasks for learners requires teachers to have at least a basic understanding of the software programmes that they are using, so that they are in a better position to field queries from learners about basic technical issues.

- **Some learners did not have Internet access at home.** Two teachers referred to problems arising from learners not have access to the Internet at home. Teacher 40 pointed out that some parents had to incur extra expense to ensure that the children could access *Moodle* at home.

... some parents did opt to buy [a 3G card], but obviously it came at an additional expense. And, for most part, either they would have to [buy a 3G card], which introduced more expense for them, or those kids would ... then would come to school. (Teacher 40)

Two teachers described how learners' lack of Internet access impacted on *DigiDays*:

The digital use [sic] is fine. It's not fully effective yet, because the Moodle system that we're using [on DigiDays], sometimes there's hiccups, you know? In terms of ... not so much from our side, but with ... depending on the children's access to the Internet. (Teacher 29)

... or their Internet bundle is ... has run out ... their cap level has been reached ... (Teacher 33)

One member of the administrative staff, who had two children in the College, said that the costs incurred when her children had to find resources on the Internet often resulted in her having very high Internet data costs. This is something which the school's Executive Committee might not have taken into consideration when they came up with the idea of dedicated technology days on which learners work at home.

Functionality of equipment

The implications of learners working at home are, firstly, that learners would be working in different locations, some of which might be more prone to certain types of technical problems like lightning strikes or poor Internet connectivity. Secondly, learners are likely to be working on ICT equipment of different types and levels of functionality, which would be beyond the school's control. Two teachers described the types of technical problems which could impact on learners successfully completing *DigiDays* tasks:

... we have problems ... from a user side of Moodle ... that guys end up in areas where there's no 3G connection ... (Teacher 33)

... look, technology's always a disadvantage because ... you know ... kids' laptops don't work or the emails not whatever or ... I remember we had the one digiday when the whole of the _____ area ... their ADSL lines were down. (Teacher 2)

It appears that the school might not have anticipated the technical problems which cropped upon *DigiDays*, problems which might have been avoided had the school spent the necessary time and effort drawing up a strategic plan before the innovation was introduced.

Level of interest

Learners' motivation to use ICT, at school and at home, influences teachers' use of computers. Where students respond positively to using computers in lessons teachers might feel encouraged to make more use of computers for instruction (Donnelly et al., 2011; Ertmer et al., 2012; Ng & Gunstone, 2003; Ward & Parr, 2010; Williams et al., 2000; Wood et al., 2005).

In my study five teachers described feeling encouraged to make more use of computers in lessons by the positive response from learners. One teacher, when asked about the major factor which encouraged her to use computers in her lessons, responded as follows

What encourages me? I think it's the children's response.

They ... they're such a digital generation that ... they just listen more. They ... they're more interested the moment you turn the screen on. They ... it's almost like they almost appreciate your effort more as well, because they can see that you had to think about the lesson and you had to put the PowerPoint together. You had to look for the pictures ... ja, I think it's, in general, their response to ... to classes being ... being presented like that ... for me has been fun ... (Teacher 17)

Two History teachers commented about being encouraged to use computers in lessons because of the positive response from learners:

But it does grip them more, you know, than just hearing you drone on and on in front of the classroom all of the time. So, I find from that point of view it's good. It gives me a break too. I love that opportunity just to sit and observe them while they are now looking at something and it's giving them another take on something and they can ask questions and ... So it's definitely motivated me to use technology more. (Teacher 29)

... if you give them permission, they're allowed to Google on their phones and so ... and so they ... you know? They use it more, so it encourages you to use it more, actually. (Teacher 30)

The comment by Teacher 29 raises the potential danger of teachers using computers to entertain learners rather than for sound pedagogical reasons, and underscores the need for teachers to be trained in the judicious selection of technologies to enhance learning, and not just for introducing variety into lessons.

Some of the matric teachers pointed out that the Grade 12s had not responded well to the idea of losing a day of school on *DigiDays*, and being required to work on their own at home. It seems that the

time and syllabus pressures of preparing for an external final examination which would determine whether or not they could go on to study at tertiary level resulted in learners not wanting a day off school.

... Some of the matric girls just said to me "Ma'am, we're not ... we're not doing this. We can't do ... learn all this now. I'm just doing the paper and pen." [Student's name] said "I'm not going this route. I'm just doing paper and pen. I can't." (Teacher 2)

Well, the matrices did not enjoy it. ... the matrices complained ... they felt that ... and I think they probably were suffering from much the same disease as I suffer from, and that is they didn't like the idea of change ... and the more academic ones, basically were very critical and they felt you know they needed the classroom time ... they needed the teaching time. (Teacher 23)

... the matrices are the only group that appears resistant because it's just so much work for them. They ... they find it a lot of work ... (Teacher 30)

Learners' ICT competence

Learners' level of technology competence emerged as an important factor affecting teachers' use of learner computer-based tasks on *DigiDays*. This correlates with this factor having been identified as the major learner-level factor affecting teachers' use of ICT (see Chapter 2, pages 60-61), from my literature review. Teachers mentioned the following problems related to *DigiDays* arising from some learners not knowing how to use particular software programmes:

But for a lot of those children, especially the juniors, up until Grade 8 and 9 ... those two are ... those two grades give a lot of problems, because a lot of them don't know what they're doing on the computer ... and so they battle, and so moms and dads have been hugely frustrated. Then they're getting phone calls at work or if they are at home, they don't know how to help and then, we're ... we're still getting phone calls all the time because there's problems. (Teacher 29)

Or because ... the thing that they are meant to do is missing or hasn't been opened or unlocked or ... whatever ... or because they don't know how to work x, y, or z on ... on a particular application. (Teacher 24)

There seemed to be one or two things that were not related to the technical side. And that's been all along, but it's more with the maths, and, I don't know which other subject, where the children created on one type of document and then, when they load it on to Moodle, the teacher can't pick it up on this side. And we've been told to send those individuals, as they crop up, to Teacher 31, and he'll show them how to convert their documents. (Teacher 29)

Some teachers might take for granted that learners would be able to carry out a particular task on computer, which some learners might not know how to do:

*But you know what, if someone hasn't shown you how to **do** a table in Word or Excel, then they can spend ... thirty minutes trying to make a table and ... you know, for us who kind of use it regularly we're kind of going ... "Do the table". (Teacher 24)*

The problem of having different learners with different levels of ICT proficiency could have been overcome had the school anticipated some of these. One of the things that could have been done is that learners could have been trained – before the innovation was introduced – on how to use computers to minimise the problems encountered on *DigiDays*. In the following extracts teachers suggest the need for such training. The first comment the points out some parents felt that the single session of training learners received on how to use *Moodle* did not prepare them sufficiently for *DigiDays*. The second comment emphasises the need for learners to be trained on how to sift through all the information on the Internet, and make judicious choices about what is relevant and what is not:

But a lot of them ... I mean we've had quite a bit of flak from the parents after that first DigiDays, because they felt there wasn't sufficient training and, you know, this just ... this burdened the parents more. So ... ja. I mean, the concept's lovely and the kids are sold on it. There're one or two ... because they got a lot of feedback ... they did a survey afterwards, with feedback from the children and there was a lot of positive feedback, but a lot of children were very candid and they also, they've said ...

that's why I thought they would have established more training now, because that was one of the things that came through, but not yet. (Teacher 29)

But I think for our kids, I think that is a huge issue for them. You know, we tell them "Go and research this". For us it's easy because we're varsity graduates. We know how to skim read. We know how to you know, kind of extrapolate [sic] the important information. They don't have that skill and I think it's a critical skill that they learn ... but even in terms of choosing sites to recommend to them, one's got to be incredibly discerning, just so that it's at the right level and the right content and ... because they ... they are unable ... particularly the juniors, but I strongly suspect the seniors as well, to ... to decide what is critical and what is not ... so, I think the information overload issue is ... a negative when its overload ... it's a positive that you've got so much choice. (Teacher 24)

With only three categories of learner-level factors having emerged from both the literature review and my study, this level of factors appears to have a less noteworthy effect on teachers' use of technology for teaching compared to the institutional-level and teacher-level factors. However, given the nature of the innovation introduced at the case study school, viz., dedicated technology days on which formal lessons were suspended and learners carried out computer-based tasks at home the problems associated with learners not having access to the necessary hardware and software were particularly evident. It appears, in many cases, but the school had not anticipated the sort of problems that arose because learners were working at home, and in different locations. It also appears that the Executive Committee might have assumed that learners would be able to use their software applications and might not have anticipated the need for learners to be trained, not only on how to use *Moodle*, but also on how to use various other types of software. The danger problems learners experienced on *DigiDays* highlights the complexity of inter-related factors that have to be taken into account when introducing an ICT innovation involving dedicated technology days on which learners work at home.

7.3 EFFECT OF ICT TRAINING PROVIDED ON TEACHERS' USE OF TECHNOLOGY, AFTER THE INNOVATION

A lack of training had been identified as a problem inhibiting teachers from using ICT, in Phase 1 of the study. For this reason, and because the school had addressed the issue of training before introducing the innovation which I investigated in Phase 2, I decided to investigate the effect of the training provided for *DigiDays* on teachers' use of technology. This section answers the following research question:

3.1 To what extent, and in what ways, did the amount and nature of the ICT training provided affect teachers' use of technology?

The training teachers received in preparation for *DigiDays* was described in Chapter 6 (see pages 214-215). However, it was limited to training on how to use *Moodle*. From my literature review on factors influencing teachers' use of ICT, two important categories of training-related factors emerged, as discussed in Chapter 2, and these are used to structure the following discussion.

7.3.1 The nature of the ICT training provided

When teachers were asked, during the interviews, about how useful they had found the *Moodle* training, there were three types of responses. One group of teachers found the training useful. The second group of teachers had found the training useful, but suggested that the training had not fully

equipped them to use *Moodle*. The third group was emphatic that the training had not met their needs, and had not adequately prepared them to use *Moodle* on their first *DigiDay*.

Teachers who found the training useful

Fourteen teachers found the *Moodle* training for *DigiDays* useful (Teachers 2, 3, 7, 14, 15, 17, 20, 22, 30, 32, 33, 36, 37, and 40). Two of these teachers (Teachers 3 and 7) were members of the College Executive committee, while a third was the mother of one of the trainers. Omitting these three teachers to reduce the possibility of any bias in favour of the training leaves 11 teachers who objectively stated they found the training prepared them for *DigiDays*. One English teacher explained:

... they were extremely clear, clear enough that when I didn't type it in right and ... and could check that I'd done it right 'cause they also sort of showed us how to check ... and sitting to it ... you know sitting down to it by myself ... I had the ... the training and I had the little notes that they had given and so it was very clear and quite thorough and ... and that worked well for me. (Teacher 22)

Teachers who found the training useful, but still needed help

Three teachers (18, 34 and 37) said they had found the training useful, but said they still needed help afterwards, or had to sort out issues for themselves:

Okay, it was a lot more clear, but ... I had to ask, say, somebody else in the department just to, sort of, make sure that we were all on the same page. (Teacher 34)

... it was good but ... a lot of what I had to go through I taught myself. (Teacher 18)

Look, I came away and I ... I am the sort of person that has to do it myself ... before I ... I could tell you "Yes, I understand it" or "No, I didn't" ... as soon as I started playing it with myself there were ... questions I had to ask. (Teacher 37)

Teachers who had not found the training useful

Twelve teachers (16, 19, 21, 23, 24, 25, 27, 28, 29, 35, 38 and 39) said that they had not found the training useful. Table 35 is a summary of their reasons.

Table 35. Summary of the reasons why teachers did not find the *Moodle* training useful

Problem	Teachers	Total
Teacher felt that too much information was given at the training	16, 35	2
Teachers didn't understand technical jargon used in training sessions	23, 19, 21, 39	4
Trainers went too fast for teachers to keep up	23, 29	2
Training content did not cover what teachers needed to know to use <i>Moodle</i> on their first <i>DigiDay</i>	18, 25, 27, 28, 19	5
Group was too large	24, 38	2

The two most frequently mentioned problems were

- **The training had not adequately prepared teachers to use *Moodle* confidently on the first *DigiDays*.** The main thrust of this problem appears to be that the training consisted of trainers demonstrating how to use the package, with teachers following their prompts. Teacher 28 explained that this meant that some of them might have been unable to remember how to do these things for their first *DigiDay*.

*... we were just shown the simple things ... how to ... just to like, log on ... how to put your profile picture there ... how to personalise your profile, how to create a course, how to upload tasks ... but there's ... there's lots of teachers who **still** don't know how to log on to Moodle ... (Teacher 28)*

Two teachers explained that they only learnt how to use *Moodle* when they used it:

Look, I came away and I ... I am the sort of person that has to do it myself before I ... I could tell you "Yes, I understand it" or "No, I didn't". Um ... as soon as I started playing it with myself there were ... playing with it myself there were questions I had to ask. (Teacher 37)

... I just did, when I ... when we had to do it for DigiDay then I learnt how to do it properly. (Teacher 38)

- **The use of technical terms that the teachers did not understand made it difficult for them to understand what was being explained.** The following comment by one of the teachers describes how this affected her:

... they gave us lessons and they spoke in a language that we've never heard of. So we went home feeling very angry and frustrated and called on Teacher 25 to help. (Teacher 21)

Two teachers said they would have preferred training in small groups, or one-on-one:

No, I found ... a big training session, I didn't find so useful. It was much easier to learn from other people in my department. The one-on-one way. But one person teaching the 35 of us, I didn't learn that much in that session ... much smaller groups, where we all had our own computer and we were all doing something specific for our subject. (Teacher 38)

I think if we're going to do a training session on how to set up quizzes, then it should be in smaller groups. (Teacher 34)

The differences across teachers' experiences of the Moodle training suggest that the teachers in a group cannot all be treated the same, and that meeting the training needs of individual teachers would be a more effective way of supporting teachers, rather than providing generic training and leaving teachers to their own devices. The following comment by one teacher illustrates the need for differentiated support:

Yes, and also I think to have a training session with an entire staff, and a staff that ranges from those who are basically connected to a computer ... and those who actually have come into this after, you know, many, many years of teaching, where it wasn't the, the main focus of teaching ... is a little bit silly, because you need to say "Well look, let's work with ten at a time, so that individual attention can be given." I mean, surely we are in education, we should know those things ... (Teacher 23)

7.3.2 The amount of training

The reports by teachers on the sufficiency of the training they had received also varied greatly. Some teachers felt that they had received enough training on how to use Moodle, especially since the trainers sent out weekly tutorials.

Ja. Enough training and enough ... they sent out tutorials, every week I suppose, on how to do this, how to do that, how to do the next thing. So there was a lot of training and support. (Teacher 2)

Although Teacher 2 felt that there had been sufficient training, some teachers might not have worked through the weekly tutorials.

Some teachers felt that they needed more training on how to use Moodle:

The only difficulty has been, for me, is that ... as I say, I'm moderately good on the computer, so I'm not that good with Moodle yet, because we also haven't had much training.

... but the training was very 'min' [Afrikaans for 'little']... (Teacher 18)

There was some provision for ongoing training by means of tutorials which were circulated by email. In addition to that a refresher course was held at the beginning of the second year of the innovation that anybody who needed to could attend. Teacher 29, who had low ICT competence and a low level of intrinsic motivation (see case study 12, on page 275) had attended the refresher course:

And so, I need substantial training for reinforcement. ... I went to a refresher course at the beginning of this year to try to get me up to speed. Well, they had, for the new teachers that started this year ... there're about five of them, they had a training course on Moodle and then any of us who wanted to go, could go again, so I went. (Teacher 29)

Other teachers suggested that they would have liked an additional session on the more sophisticated features of using *Moodle*.

I think ... maybe just like the finer things. (Teacher 34)

The following comment by one of the Physical Science teachers encapsulates the idea of different teachers needing different levels and types of training according to their specific needs:

And even when we sat in that computer lab and they were trying to like ... explain Moodle to us. You've really got to work with computers until you are comfortable. (Teacher 39)

7.4 EFFECT OF TIME PROVIDED FOR USING ICT FOR TEACHING ON TEACHERS' USE OF TECHNOLOGY AFTER THE INNOVATION

It is well documented in the literature that the demands on teachers' time leave little time available for teachers to carry out the activities required to integrate ICT into their teaching (see Russell & Bradley, 1997; Ward & Parr, 2010). In the following extract Teacher 29 describes some of the demands on teachers at the case study school which might make it difficult for them to find time to use ICT.

I mean, in our school, some of our teachers ... their extra-murals are unbelievably heavy. And, I mean, they just can't face finding another 45 minutes every day to sit and pfaft with this. You know, when they are only getting back from all their sport - three or four times in that five day week - you know, they're getting back at half-past-six, seven. (Teacher 29)

Three distinct time-related factors emerged from my literature review on the factors affecting teachers' uptake of technology, viz., time to learn how to use technology, time to prepare lessons involving technology, and time to use ICT in lessons. All three of these time-related factors were also found to have prevented the teachers who participated in the first phase of the study from making more use of computers. The ICT innovation introduced at the school, which marked the second phase of the study investigating the factors affecting teachers use of ICT, had made special provision to set aside time for teachers and learners to use technology for instruction. For this reason I wanted to see how the teachers felt about the time provided for using ICT on *DigiDays*. In addition to the three time-related factors identified from the literature and during the first phase of the study a fourth set of 'time' factors relating to *DigiDays* emerged during the second phase of the study. I will first discuss the three time-related factors identified from the literature and the early phase of the study and then the issue of 'time and *DigiDays*'.

This section answers the following research question:

3.2 To what extent, and in what ways, did the amount of time provided for using technology for instruction affect teachers' use of technology, according to the teachers?

7.4.1 Time to learn how to use ICT

Eight teachers mentioned not having enough time to learn to use ICT as a factor discouraging them from using computers more in teaching. Table 36 is a summary of the problems mentioned by the eight teachers.

Table 36. Problems with not having enough time to learn how to use ICT

Problem	Teachers	Total
Teacher does not have the time to learn how to use new programmes	18, 19, 23, 33, 36, 38	6
Teacher does not have the time to learn how to use <i>Moodle</i>	29, 27	2

Teachers did not have the time to learn how to use new programmes

Six teachers said they did not have the time to learn how to use new software applications. Two examples of the comments teachers made in relation to a lack of time to learn how to use new software are given below:

Ja, I haven't actually used Plato [a software package] yet ... I haven't found the time to actually get stuck into it and ... and be familiar with it. (Teacher 33)

I think it's a time thing and not really getting to know ... on the other side of it, I don't know how we ever taught without the computers or technology. I wish I was further ... in the process. It still feels like I'm the ... the donkey ... in the race ... nobody's fault, purely mine. I just don't have time to go and sit and go on a course or allow myself to sit down ... (Teacher 19)

Teachers did not have the time to learn how to use Moodle

The above comment by Teacher 19 highlights the problem of teachers who are less confident and less competent using ICT taking longer to learn to use new software compared to teachers who feel more comfortable around technology. This problem was also expressed by another teacher, in relation to learning how to use *Moodle*:

Because Moodle's something new, it takes me ages to figure out and I make mistakes, etc., and when you're under pressure, with marking and that. I actually haven't got the time to ... to pfaff, then ... then you tend to just side-line it. (Teacher 29)

Teacher 29 was not the only one to refer to the length of time needed to learn how to use *Moodle*. Teacher 27, who had been using computers for longer than Teacher 29, and who appeared to be more technologically savvy, also referred to it having taken a very long time for her to learn how to use *Moodle*, and needing help not provided in the training sessions, although it appears that she may have been looking to do more than just basic things:

It has taken ... it has taken a lot of hours and a lot of ... sort of asking within the department. Asking, sort of, my colleague and whatever to explain, to ... you know? "Is there a shortcut, is ...?" You know? "Is there an easier way of doing this?" All that type of thing. So yes, it has taken a ... a large number of hours. (Teacher 27)

7.4.2 Time to prepare lessons involving ICT

Selwood and Pilkington (2005) suggest that there are two opposing perspectives on the time required to prepare lessons involving ICT. On the one hand, using computers could save teachers time by allowing them to carry out tasks more efficiently. On the other hand, some teachers might find that the length of time needed to prepare lessons using ICT increases their workload (e.g. Priest et al., 2004; Bauer & Kenton, 2005; Ward & Parr, 2010). The teachers who emerged in my study are shown in Table 37 and are discussed separately after the table.

Table 37. Teachers' perspectives on the length of time needed to prepare lessons using ICT

Perspective	Specific issue	Teachers	Total
Using computers saves time	Makes it easier to find resources	16, 21, 24, 25, 27, 39	6
Using computers increases teachers' workload	Takes a long time to set up MCQs on <i>Moodle</i>	25	1
	Takes a long time to set computer-based tasks for <i>DigiDays</i>	2	1
	Takes a long time to create <i>PowerPoints</i>	14, 15, 17, 30	4
	Takes long to mark on computer	21, 22	2
	Takes long to plan lessons where learners are working on computers in media centre	34	1
	Even though preparing work using ICT can be time-consuming, teacher sees it as part of the job	7, 33	2

Using computers saves teachers time

Although six teachers mentioned the wealth of resources available on the Internet only one teacher emphasised the time-saving advantages of computers allowing access to a wide range of resources:

*In the end it's substantially faster than having to page through books or magazines, especially when you're looking for a comprehension test to fit in with the theme of work, it's so easy to ... you know ... simply google it and it's right there. You've got twenty, thirty **thousand** choices to choose from ... in the end it's actually made it a lot faster than it was when we started teaching. (Teacher 16)*

The other teachers said they found it time-consuming to find appropriate resources on the web:

My time to ... especially since I told you I need to make sure that my lessons are structured, and I can't just throw things in there. So to find the right video is very time-consuming. You know? To find the right little cartoon, is very time-consuming. So that's the first thing. It's very time-consuming for me. (Teacher 25)

... so, for example, with cardiovascular, I used some stuff off the web, and then there were three presentations that I took a bit out of this and a bit out of this and a bit out of this, but, you know, it can take you four hours to do that ... it's worthwhile in the end, but it does, it takes that amount of time ... for this little fifteen-minute presentation and in fact, if you just let it run it would run in two minutes or something. (Teacher 24)

... there's so much info out there. You've got to be incredibly discerning or you've got to go through so much stuff ... to really find what you're looking for. It's not the first or the second one, necessarily. And even if it is, you've got to check it against another three ... and that all takes time ... (Teacher 24)

Using computers increases teachers' workload

Teachers might be discouraged by the length of time it takes to set work involving computers. In my study, the specific issues most frequently mentioned were

- **Time to prepare *PowerPoints* to present in lessons.** Four teachers mentioned the time needed to prepare *PowerPoints* as a factor discouraging them from creating *PowerPoints*, especially complex ones, which could have contributed to the smaller increase in the number of teachers creating complex as opposed to basic *PowerPoints*, after the innovation was introduced at the school (see Figure 67 on page 234).

But the PowerPoint, if you want to put music and get all these characters and stuff which makes it a bit more animated then it ... it does take a bit of time ... (Teacher 14)

... I don't do such lengthy PowerPoints that it takes too much time. (Teacher 15)

... if I have more time, then I'd really do fancy PowerPoints where ... where things fly in and fly out and do beautiful 'fades' and stuff like that and ... and when I don't have time then I don't have time. (Teacher 17)

I find it just takes ... me time to ... to put a whole thing ... to put a whole ... PowerPoint together, whereas I just rather flash up pictures or references or ... places, cartoons, people, things like that. For me, that's easier. (Teacher 30)

- **Takes long to mark work on computer.** Two teachers (Teachers 21 and 22) complained about the length of time it takes to mark work on computer. In the following extract Teacher 21 explains that she found marking on *Moodle* an arduous process:

... if you mark it on Moodle, if you do it through an edit process or whatever, that's four to five clicks of a ... of a mouse as opposed to a tick or a cross with ... with a pen. So, from a ... an ease point of view, the pen is still easier, in terms of marking. (Teacher 21)

Since this teacher found marking on *Moodle* such an arduous process, I asked whether she was able to mark learners' *DigiDay* tasks not using *Moodle*. She explained, however, that this came with its own set of problems:

Then you've got to copy it, put it onto a Word ... or I might be able to print it. But I'll tell you why I don't print it directly, because they very often use, like size 46 font or something like that, so it takes nine pages to print half a page of ... So then you've got to go and look ... even if you give them instructions, there's no ... there's no guarantee that they're going to put it in a size 11 or a size 12 font ... whether they're going to have broad margins so that you can actually get the whole thing on a page. So when we're paying for the printing, we can't afford to spend nine pages for a ... you know ... half a page of work ... that kind of thing. And also, again, it's time consuming: copy-paste-put onto a Word document-press print-send to printer-go there-go and print it out. There's also no guarantee that they will all be there, so you've got to do it one day, then you've got to go and do it again the next day and open up the computer and ... (Teacher 21)

- **Takes a long time to plan lessons where learners are working on computers in computer lab.** One teacher mentioned that she was discouraged from planning lessons where learners worked on computer in the computer lab because of the length of time it took to plan those lessons:

And just maybe the whole thing of ... setting, setting it up, you know? I tend to think "Okay, well, I don't have enough time", so I must therefore just make do with what I've got in class. (Teacher 34)

Teachers might be discouraged for different reasons. Firstly, it might be a lack of ICT competence which makes setting effective computer-based tasks take some teachers a long time to do. Secondly, teachers who are not convinced that learners' using technology could improve their learning might be reluctant to spend time preparing computer-based tasks.

Two teachers expressed the view that that it was not an issue to prepare lessons using ICT because they considered it part of their job. Both teachers explained that because of time constraints during the school term, they used school holidays for exploring and/ or evaluating different resources to using in their teaching:

*Well, certainly now. I mean like on the holidays now I most definitely will go onto those **millions** of ... I've just had to save so many things into a folder ... from the Geog society. ... But I will now just spend time slowly going through and looking at, and all that sort of thing, you know as much as I can. (Teacher 7)*

... and it's something which I want to try and get my mind around ... these holidays ... is just start thinking about it to say "Well, what kind of stuff would go into something like that" and then I would have a look and see whether I could do it in Moodle or whether I needed to get assistance ... (Teacher 33)

7.4.3 Time to use ICT in lessons

Eighteen of the 29 teachers (62%) mentioned the time required to use computers in lessons as a factor discouraging them from using ICT. The types of problems teachers recounted about trying to use computers during lessons are summarised in Table 38 and discussed after the table.

Table 38. Summary of problems relating to time needed to use technology during lessons

Type of problem	Specific problem	Teachers	Total
Lessons are not long enough to promote computer usage	Not enough time to use computers because teacher feels pressure to finish syllabus.	2, 3, 17, 19, 23, 25, 27, 34, 40	9
	Time constraints in lessons means teachers prefer to use short computer segments (animations or simulations)	3, 27, 28, 39, 40	5
Time lost in lessons due to problems with the functionality of equipment	Slow Internet speed affects time taken to download material	14, 18, 23, 24, 25, 30, 33, 34	8
	Problems with malfunctioning hardware	33, 35, 39	3

Lessons are not long enough to promote computer usage

Having limited time in lessons to cover the content, teach the necessary skills, administer assessments, and provide feedback means that lesson time is of a premium:

And, you know, the lessons aren't long. We have ... we don't have enough time ... and then, of course, on cycle days and Wednesdays ... shorter ... we really don't have enough time. (Teacher 23)

Teachers gave four reasons why the limited length of lessons discouraged them from using computers:

- **Some teachers feel under pressure to complete their syllabus.** Nine teachers mentioned the pressure they feel to complete the syllabus as a discouraging factor hindering their use of computers in lessons. The problems with having a limited time in which to complete the syllabus are exacerbated at the senior level, where teachers are preparing learners to sit an external examination at the end of the year. Two of the science teachers, when asked about the major factor limiting their use of technology use in lessons replied:

Time. You know, our syllabus is unbelievably chock-a-block and it's too big to fit in. As it is, this year we ... we've pulled out six weeks worth of matric work which we've covered in Grade 11 ... which we won't cover again in matric. That's the biggest challenge. (Teacher 3)

I think it's always a time constraint ... I think especially with the seniors, we're always bound by a very broad curriculum that has put huge pressure on us to cover work at a pace that we're not comfortable doing ... (Teacher 40)

Because of the greater perceived pressure at the senior grades, some teachers were more inclined to use computers in lessons with the junior grades, rather than their senior grades, as this English teacher described:

... I must say, in matric we haven't used computers in terms of lessons at all. We just ... we're on such a tight ... schedule. We're working out of setwork books, literally all of the time, so we haven't used it any stage in class in matric ... little bit in Grade 11, but the juniors, 8, 9 and 10, it's brilliant ... we've used it a lot. (Teacher 2)

- **Time constraints in lessons results in teachers resorting to using short computer segments (animations or simulations).** The limited time available in lessons and the pressure teachers felt they were under to complete their syllabus impacted on the way teachers used computers in lessons. Five teachers described using computers in short bursts to illustrate a

point or concept, rather than for a protracted length of time during lessons, so as not to use up too much precious lesson time. In the Science Department it appeared to be the norm to use short computer segments during lessons, to introduce a section or illustrate a concept. All three Physical Science teachers (Teacher 3, 39, and 40) described this type of usage. For example, Teacher 3 said the following about how he used computers in his science lessons:

So for most of the section, you'll be dealing with equations of motion, and falling bodies, and you've spoken it all and you've done examples and then there's a brilliant little five minute clip and it's showing the graph that gets plotted as ... as the objects fall, etc. ... it's things like that. Five minutes ... ten minutes ... and it's just really to highlight the concepts that you're trying to get across. (Teacher 3)

Two of the three geography teachers also described using short computer segments during lessons, as explained below:

... matrices, you don't really have time to do the sort of lengthy ... you know, BBC's [BBC videos] that they've got, documentaries that take lesson after lesson. You sort of, cut ... use snippets out of them to ... to sort of, start a lesson or introduce a lesson. (Teacher 27)

This comment again highlights the influence of pressures teachers are under to complete the syllabus, as this teacher specifically refers to not having time to show her Grade 12 class longer computer segments.

Time lost in lessons due to problems with the functionality of equipment.

In the literature, problems with using ICT equipment has been cited as one of the reasons why some teachers have limited time to use technology in lessons (e.g. Al-Fudail & Mellar, 2008; Bauer & Kenton, 2005; Butler & Sellbom, 2002; Cox et al., 1999). In my study, one Life Sciences teacher described the following two problems relating to ICT infrastructure as the **major** factors discouraging him from using computers for presenting work from the Internet during lessons.

(Sighs.) Most probably two ... first one is slow network speeds ... and the second one is my little projector doesn't show red (slight laugh). For some reason ... doesn't show red (said in a bemused fashion)... there's a fault somewhere, because it's ... I've taken different computers, plugged it into this same projector ... same thing happens ... taken my computer, plugged it into other projector and it's fine. And I just haven't been able to get that addressed yet. It's really it's a hardware frustration ... and if you're showing a presentation where you want to show differences between oxygenated and deoxygenated blood, colour is quite important. (Teacher 33)

Other teachers shared this teacher's concerns about losing time in lessons because of equipment-related difficulties:

- **Problems arising from the slow speed of the school's Internet connectivity.** In addition to Teacher 33, seven other teachers (Teachers 14, 18, 23, 24, 25, 30, and 34) also mentioned problems with the rate of data exchange supported by the network, or narrow bandwidth, as a factor discouraging them from using computers. A low rate of data exchange would affect the speed at which, for example, webpages can be opened on the Internet or videos can be downloaded. Teacher 24 expressed the impact of the poor connectivity on teacher's time in the following comments:

... It's a time issue related to connectivity.

The thing that puts me off it, again, is the connectivity, and the amount of time that it takes to actually ... so it can, it can just ... it can suck hours out of your day. (Teacher 24)

Two other teachers also referred to the slow network speed. One of these two teachers explained why he hardly ever showed videos in his lessons:

... with YouTube, I know they ... they're very keen to see funny things or whatever but ... you know ... when you try and get one off the Internet, it does take quite a while to download. That would probably be the ... the biggest factor. (Teacher 14)

Teacher 25 pointed out that to avoid waiting for videos to download during lessons she was now doing this at her own expense at home:

And we've got a problem here because it can take me an hour to download a five minute video. Slow, slow, slow. I'm now at the point where I'm buying Vodacom data bundles so that I can do it at home. (Teacher 25)

Although this was a feasible option for this teacher, it might not have been for teachers who did not have Internet access at home (e.g. Teachers 24 and 28) or who are not prepared to spend their personal money on it. Where teachers are not able to have the resources ready for use in a lesson, this could mean that some teachers might refrain from showing videos in lessons, as suggested in the following comment:

Also what happens is that sometimes, whatever it is you're doing takes too much time in your lesson. It's very nice if you have time beforehand to set everything up and to make sure everything is ready, but if, by the time the kids walk into my classroom, everything isn't ready, I don't use it. (Teacher 25)

- **Problems with malfunctioning ICT equipment.** In his answer to the question about the major factors discouraging him from using computers in lessons (see previous page), Teacher 33 referred to an issue with his data projector that he was having difficulty resolving. I have already discussed the problems Teacher 35 had described with getting her data projector up and running (see page 288) and the negative impact of the problems Teacher 39 was experiencing with her laptop on her use of technology during lessons (see pages 288 and 292). Other researchers (e.g. Butler & Sellbom, 2002; Sandholtz & Reilly, 2004) have pointed out that teachers often find that they spend huge amounts of time dealing with technical issues when they should rather be focusing on using technology to enhance learning.

7.4.4 Factors relating to time and using technology on *DigiDays*

The allocation of days dedicated to using technology could have provided teachers who were battling to find time to use ICT for teaching with an opportunity to do so. However, given teachers' concerns about time, *DigiDays*, on which learners and teachers were given a day off school once a month and learners had to complete computer-based tasks, either at home or at school, might exacerbate the situation. It appears that teachers might have been concerned about the implications of losing teaching time because of formal lessons being suspended on *DigiDays* as soon as the idea of the innovations was introduced to them, as one teacher suggested:

... people weren't so opposed to, those that were opposed ... they weren't so opposed to DigiDay itself, or the digital use in school, they were opposed to the DigiDay ... you know, especially the senior teachers ... losing teaching time. (Teacher 27)

Although it appears that some teachers might well have anticipated difficulties with losing teaching time by not having formal lessons on *DigiDays*, teachers may not have foreseen a number of other time-related issues which arose as a result of *DigiDays*.

- **Time needed for teachers to learn to use *Moodle*.** The time teachers need to learn how to use *Moodle* would depend on their level of ICT confidence and competence. Thus, as discussed on page 293-294, whilst some teachers indicated that it had not taken them long to

learn to use *Moodle*, others had problems. Fifteen teachers said that they had been able to load their first *DigiDay* tasks without needing any help, except for some of them having to consult the notes they had been given during the training session. These were all teachers who reported feeling comfortable using ICT (e.g. Teachers 15, 33, 35 and 37). However, other less competent teachers said that it had taken lots of time to learn to use *Moodle*. Teacher 23 had never loaded anything onto *Moodle*, while more than a year after the start of the innovation Teacher 21 said “*I still don’t feel comfortable using Moodle*”. Teacher 29 commented:

Because Moodle’s something new, it takes me ages to figure out and I make mistakes, etc, and when you’re under pressure, with marking and that, I actually haven’t got the time to ... to pfa then. Then you tend to just sideline it. (Teacher 29)

Teacher 28 pointed out that some teachers still did not know how to even log on to *Moodle*, more than a year after the innovation had been introduced, which he attributed to the design of the *Moodle* interface:

*... there’s lots of teachers who **still** don’t know how to log on to Moodle ... so... and it’s because once you are logged on you don’t know really where to go on that ... on the homepage, you know?* (Teacher 28)

- **Time needed to use Moodle on DigiDays.** Some teachers pointed out that it in addition to the time needed to set work for learners, using *Moodle* on *DigiDays* requires time for teachers to log on to *Moodle*, upload their document, inform learners that it has been loaded and by when they have to submit the completed work. This created additional work for teachers:

And like with, with Moodle, because ... it definitely does take more time, because where ... whereas before you just had ... you know ... a worksheet that you could give them, now you load it onto Moodle, then you’ve got to wait for them to send it in, then you’ve got to get it there, print it ... whatever, whatever. So it does take more time ...but I think in the long run it probably should save time. (Teacher 2)

It’s much more time consuming than walking into the class and saying “Right, put your work on my desk, let’s go. Open up your books”. (Teacher 21)

Teacher 25, the only teacher who had set a quiz on *Moodle*, said it took very long to upload:

... to upload it, probably [took] eight hours ... (Teacher 25)

This time-consuming process would have to be a consideration for teachers wanting to use a quiz as a *DigiDay* task. Besides the time needed to load tasks onto *Moodle*, teachers would also need time to retrieve learners’ documents and either print them out to mark, or mark them online. Each scenario would involve additional work for teachers. The length of time required to mark learners’ work on *Moodle* has already been discussed on page 312.

What teachers were using their DigiDays for

Since teachers were essentially given the day off on *DigiDays*, I investigated how some of them were using that time. Most teachers indicated that they tended to personal matters if they needed to, but mentioned using the day to catch up with work, especially marking. Some teachers stayed at home if they were not on duty in the computer lab on a particular *DigiDay*, although they still monitored the work coming in on *Moodle* at home:

... I’ve been at home and I’ve had my laptop open and waiting for kids to send messages through or waiting for stuff to be uploaded. The first two DigiDays I tried to mark most of the work that was coming through ... on that particular day, but I actually find that besides doing other schoolwork I was able to just do my personal stuff in-between as well. (Teacher 36)

It was nice not to have to get up and go to school. We stayed ... I stayed here and we were told we had to check, every hour or so, on Moodle if there’re any problems, any queries. There had to be a skeleton

staff at school ... (sighs) it was wonderful ... loved it. I sat at home and I ... just caught up with marking.
(Teacher 2)

Most teachers said they came into school on *DigiDays*, which was borne out by what I witnessed when I visited the school on two *DigiDays*. I observed that teachers came and went throughout the course of the day, either to do the stint in the computer lab, or to work in their classrooms. Most tended to spend an hour or two at the school:

... I've been here every single DigiDay ... I just feel more comfortable knowing that I'm here if the kids want to contact me. (Teacher 25)

For most part, I've come in because my son ... needed to come in, but then, obviously, we eventually got him a computer and ... and then he would also work off-site ...but even if he stayed at home, I would come in because I volunteered and I wanted to do it. (Teacher 40)

Well, I volunteered for every one ... every DigiDay this year, bar one. (Teacher 33)

Like Teacher 2 (see earlier comment), a number of teachers referred to using the day off to catch up on their marking:

... I must say, I use it as a 'catch-up marking' day. I really do ... (Teacher 24)

Absolutely, do prep ... or backlog or come in and mark my ... mark the visual diaries that are too heavy to carry home. (Teacher 19)

Only two teachers explicitly stated they regarded the *DigiDay* mostly as a 'free day', although the comment by Teacher 14 suggests he was not the only male teacher scheduling a game of golf on a *DigiDay*:

Then I stay at home (laughs) ... whatever I feel like doing. (Teacher 34)

Well, myself and a couple of the ... the other men staff, we go play golf. (Teacher 14)

While some of the teachers spent *DigiDays* at school either catching up on lesson preparation or marking, and others opted to stay at home and work, some teachers used the time to schedule appointments or as leisure time. The manner in which teachers chose to spend their *DigiDays* seemed to be in keeping with their general attitude towards teaching, as revealed in the teacher interviews. For example, Teacher 40 (see case study 10, on page 271), who was judged to be a judicious user of ICT based on his perceived benefits that a certain type of technology application would offer learning, said he volunteered for every *DigiDay*. In contrast, Teacher 14 (see case study 2, on page 254), who appeared to have a very apathetic attitude towards using ICT for teaching, was one of the teachers who played golf on *DigiDays*. Fundamentally, there would be no problem with teachers scheduling non-work related activities on *DigiDays*, providing they were up-to-date with the work, or would catch up with the work at a later date. The real question surrounding the issue of time and *DigiDays* would be whether teachers had set meaningful tasks which benefited learning and justified the suspension of formal lessons on *DigiDays*. Based on the varying potentials of the *DigiDays* tasks collected over the first 18 months after the innovation, it would appear that not all *DigiDays* tasks would justify the time being spent on *DigiDays*. Rather, the school should have made better provision for preparing both teachers and learners more effectively for *DigiDays* by providing appropriate training for teachers based on their individual needs and more comprehensive training for learners.

7.5 CONCLUDING REMARKS

This complex chapter reported on the changes in teachers' use of computers after the innovation promoting the use of ICT for teaching and learning. It first reported on the changes in computer usage for the 29 teachers as a group. In keeping with findings from other studies that organisations need to provide computer resources for use in teaching and learning, computer usage increased when more

resources (hardware, software and technical support) were available, and because teachers and learners were required to use computers on *DigiDays*. However, an analysis of 33 computer-based tasks set by teachers for *DigiDays* showed that not all teachers were setting computer-based tasks which took full advantage of the potential benefits of using ICT for teaching and learning. Secondly, the chapter reported on the changes in computer usage for individual teachers. Thirteen teachers were selected for an in-depth investigation of the factors underlying their computer usage. The 13 case study teachers were represented on a scattergram based on how they were using ICT, and possible reasons underlying why different groups of teachers were using computers in a particular way were explored. Finally the chapter reported on the factors which emerged from the teacher interviews conducted during the second phase of the study as influencing teachers' use of ICT after the innovation. The factors reported on in this chapter are included in a holistic model of the factors affecting teachers' use of ICT, which is presented in the final chapter of this thesis.