Chapter 9

Summary of findings, and recommendations to promote the judicious integration of ICT

One theme which consistently emerged from the study was that teachers' use of ICT for teaching does not automatically mean that technology is being used in ways which benefit learning. This chapter summarises and interprets the main findings of the study and, based on these interpretations, offers recommendations for the case study setting of the school at which I conducted my study. Many of these recommendations are likely to be useful for other settings, and a model has been presented showing relationships emerging from the conceptual framework of the study which suggest generalisable and more widely applicable insights. However, before the findings and recommendations of the study can be generalised to other settings, the limitations of the study must be acknowledged. The chapter thus starts off by outlining limitations of the study.

9.1 LIMITATIONS OF THE STUDY

Creswell defines limitations as *"potential weaknesses or problems with the study that may have affected the results*" (Creswell, 2012, p. 199). He suggests that setting out the limitations of a study can help with judging the extent to which "*the findings can or cannot be generalised to other people and situations*" (Creswell, 2012, p. 199). Although I undertook a number of steps to enhance the credibility of this study (see Chapter 3, Section 3.4, starting on page 81, which deals with the methods used to improve rigour) limitations are often beyond the researcher's control. The following potential limitations were evident in the study.

9.1.1 Researcher subjectivity

During the first phase of the study participant observation was used to collect data about the factors affecting teachers' use of technology at the case study school. Fraenkel et al. (2012, 458) point out that "*in qualitative research, much depends on the perspective of the researcher*" and that "*all researchers have certain biases*". In Chapter 3 (see page 84 and Table 6 on page 87), I acknowledged a bias towards teachers using ICT for teaching, which may have clouded my interpretation of events, although a number of techniques were used to minimise the effect of this or any other biases which may have been present. Firstly, data from the researcher's log was triangulated with data from the teacher interviews conducted during the first phase of the study, wherever possible, to strengthen the interpretation of the findings (see discussion on page 85 in Chapter 3). Secondly, where any uncertainty existed about the interpretation of what teachers had said, member checking was used to improve the interpretation and minimise the effect of any biases (see page 86, in Chapter 3). Thirdly, reflective comments on my observations in my log (as discussed on page 75), were used to contribute towards what Schumacher and McMillan (1993) refer to as "*disciplined subjectivity*" which can help to reduce researcher subjectivity:

> *Other researches become aware of their subjectivity during data collection and write a memo or keep a reflex journal. The memos alert the researcher when he or she begins formal data analysis.* (Schumacher & McMillan, 1993, p. 392)

Fourthly, the study was conducted over a sufficiently long period of time (two years for each phase of the study) to allow the interpretations of events to be confirmed (see discussion on page 85 in Chapter 3). Schumacher and McMillan explain that "*extended time in data collection allows the researcher to corroborate data and to identify sources likely to produce artificial, contrived, or biased information*" (Schumacher & McMillan, 1993, p. 393).

9.1.2 The threat of "subject effects"

Schumacher and McMillan (1993) point out that participants in a study "*often change their behavior simply because they understand they are 'subjects', and sometimes these changes affect the results"* (Schumacher & McMillan, 1993, p. 178). These researchers also suggest that "*subjects in most studies will also want to present themselves in the most positive manner"* (Schumacher & McMillan, 1993, p. 178). Subject effects such as these could undermine the credibility of research findings. The teachers interviewed in this study were aware of the nature of my research, and thus might have answered the questionnaires and interview questions to provide the responses they thought I was looking for. It is also possible that they answered questions in a way which showed themselves in a good light. The threat of subject effects was reduced, firstly, by triangulating the data from my log with data from the teacher questionnaires and interviews, wherever possible, to strengthen the interpretation of the findings. This was useful, for example, in picking up the inconsistent results reported by one teacher for the questionnaire *Teachers' computer use before and after DigiDays*, which did not correspond with the usage she mentioned in her interview (see case study 6 for Teacher 19 on page 263 in Chapter 7). Secondly, throughout this thesis issues of validity relating to the various instruments have been addressed to improve confidence in the inferences drawn from the data collected (see discussion on face validation on page 85, Chapter 3). Thirdly, as mentioned in 9.1.1 under "researcher subjectivity", the study was conducted over a sufficiently long period of time (two years for each phase of the study) to allow the interpretations of events to be confirmed (see discussion on page 85 in Chapter 3).

9.1.3 The limitations on generalisability of case study findings

Flyvbjerg (2006) points out that, according to conventional wisdom, case studies are not considered useful for generalising to wider situations. This is because case studies typically focus on a single context-specific situation, often with a small number of participants, which makes it difficult to transfer the findings to other situations (Cohen et al., 2000; Fraenkel et al., 2012). The literature suggests several ways in which this limitation can be minimised. One way is to use detailed descriptions to facilitate comparisons by other individuals wanting to consider the relevance of case study findings to their situations (Fraenkel et al., 2012). While conducting my research, specifically when recording entries in my researchers log, and when writing up this thesis, I made use of "*thick description"* (Mertens, 2005, p. 256) to describe the setting and interactions of my study as fully as possible (see Section 3.4.1, on page 83). Mason (2002) points out another way of generalising from qualitative research is to do so on the basis of the theoretical findings. Mason argues that by describing what has happened in one situation and explaining why it happened in the specific case "*you can try to widen the resonance of your argument by asking questions about the lessons for other settings*" (Mason, 2002, p. 196). A model of the findings can be used to make the findings more broadly applicable or, as

Schumacher and McMillan describe it, to allow "*the extension of the understandings"* (Schumacher and McMillan, 1993, p. 394). Models are useful in this regard, since they are simplified representations of theories, which is *"beneficial, because we can ignore less relevant or unimportant details, and instead focus on the most interesting or important facets*" (Coll & Lajium, 2011, p. 4). Models can be used to counteract the following potential drawback of case study research: "*theorists working from case data can lose their sense of proportion as they confront vivid, voluminous data"* (Eisenhardt, 1989, p. 547). A model of the findings from this study is presented later in this chapter (see page 347).

9.2 SUMMARY AND INTERPRETATION OF FINDINGS

The summarised findings are presented according to the categorisation proposed by Ertmer (1999) (see Chapter 2, page 34) of 'external' and 'internal' factors affecting teachers' use of computers. Ertmer refers to factors affecting teachers' use of computers which originate within teachers as 'internal factors', and external factors as those beyond teachers' control, usually relating to factors operating in the institution, for example, the provision of resources by the institution. The conceptual framework derived from the literature (first presented in Chapter 2 but repeated in Figure 81 on page 346) includes a third level of factors (operating at the learner level). In both the literature review and my study both the number of learner-level factors which emerged, and the frequency of mention, was low, and consequently I have not included this level in my summary.

9.2.1 External factors which emerged from the study

The study is divided into two phases – before and after the introduction of the innovation promoting the use of ICT. The innovation proved a watershed event in terms of the provision and usage of ICT at the school because as part of the innovation the school's Executive Committee set about improving the availability of ICT resources and promoting ICT usage.

Hardware-related factors

The first phase of the study was characterised by the limited availability of ICT hardware resources at the fledgling school (see Table 8 and Figure 27 on page 94 in Chapter 4). The lack of ICT hardware played a huge role in the low level of ICT use in the school and is likely to have contributed to the small number of teachers (five out of 15 or 33%) who were using computers for teaching during the early part of the study. The limited facilities contributed to problems with accessing the available hardware for use during lessons which discouraged some teachers from using computers (see page 95-97 in Chapter 4). Where teachers could not readily access the computer hardware in the computer lab or SMART Board room because of the need to book those venues, teachers were less inclined to plan lessons in which computers were needed (see page 96 in Chapter 4). The lack of availability of hardware was further exacerbated during the first part of the study by a number of technical problems which resulted in the computers not being 'available' for use during lessons (see page 97-99 in Chapter 4). Problems relating to the provision of hardware thus severely limited teachers' use of computers, and meant that there was little use of computers for tasks which learners would carry out, i.e. 'learner' computer-based tasks.

When the innovation was introduced one of the first steps taken by the Executive Committee was to provide more ICT resources (see Figure 66 on page 212 in Chapter 6). As reported on page 289 in Chapter 7, most teachers were then satisfied with the availability of ICT equipment, although some complained about the lack of availability of equipment for learner use. This meant that while the additional resources associated with the innovation contributed to increased usage of technology for 'teacher-tasks' (see Figure 67 on page 234 in Chapter 7) there were much smaller gains in learner usage (see Figure 68 on page 238 in Chapter 7). Since only two departments (Geography and Afrikaans) had some computers available for learner use, other departments had to use the computer lab. Despite a second computer lab being made available, some teachers still complained about the limited access to the computer labs because Information Technology classes used the venue and it was seldom available for other teachers. The introduction of an online booking system for the computer lab to overcome the problems with the ineffective booking system reported during the first phase of the study also seemed to have had a limited impact, as three teachers were unaware that such a system existed. It is possible that the school's Executive Committee introduced the dedicated technology days or *DigiDays*, on which learners were required to complete computer-based tasks at home, to circumvent the lack of availability of equipment for learner use at the school.

The types of technical problems identified in the first phase of the study persisted during the second phase, e.g. four teachers described the frequent power failures at the school as the major factor discouraging them from using computers in lessons (see page 291 in Chapter 7).

Provision of in-service training

During the first phase of the study, teachers mentioned problems with not having had sufficient training on how to use computers for teaching and learning, and training which did not meet their needs.

During the second phase of the study, teachers were provided with training on how to use *Moodle* in preparation for *DigiDays.* Most teachers felt that they had received enough training on how to use *Moodle*, but at least three teachers felt that they would have benefited from more training. The major issue, however, related to the nature of the training. Excluding teachers who sat on the school's Executive Committee, 11 teachers stated that they found the training useful, while three teachers found the training useful but said they still needed more help. Twelve teachers, however, said that the training had not adequately prepared them to use *Moodle*, citing a number of reasons. For example, four teachers did not understand the technical jargon used by the trainers, two teachers felt that too much information was given at the training sessions for them to assimilate in one go, and another two felt that the trainers went too fast for them to keep up. The net result of this was that not all teachers felt adequately prepared to use *Moodle* on their own on the first *DigiDay.*

Software-related factors

During the first phase of the study the most frequently mentioned software-related factor affecting teachers' use of ICT was the lack of availability of instructional software in the school. During the second phase of the study the lack of availability of computer software did not emerge as a factor influencing teachers' use of ICT. This was attributed to the huge amount of open-source software available on the Internet, and also the tendency for teachers to use learning objects off the Internet.

The major factor influencing the availability of instructional software related more to teachers' willingness to expend the time and energy to find suitable software and to try it out. This would, in turn, be influenced by the teachers' beliefs about the relevance of using ICT for teaching. The school would be required to supply teachers with generic software, e.g. *Microsoft Office*, but the onus is on teachers to find suitable subject-software, or to find out about suitable software available for use in their subject, which the school would purchase for them to use. Thus teachers' beliefs and attitudes influenced their use of subject-specific software for teaching.

Two other software-related problems identified in the first phase of my study persisted into the second phase. During the first phase the unsatisfactory quality of the *EduRom* software, and the lack of ease-of-use of the package, had emerged as a huge problem for the biology and science teachers wanting to use the multimedia package which had been purchased by the school during the early part of the study, which eventually led to the *EduRom* software being discarded (see Chapter 4, page 105). These two factors also emerged during the second phase of the study. The Afrikaans teacher described having great difficulty finding a suitable software package for use in her language lab, while four teachers were discouraged from using *Moodle* because they found it difficult to use. However, some teachers highlighted features of *Moodle* which encouraged them to use it, e.g. being able to comment on aspects of learners work and being able to track when students had submitted work.

Support-related factors

Three major support-related factors emerged from the study.

- **ICT policy and guidelines.** During the first phase of the study there did not seem to be any strategy governing the acquisition of ICT resources at the school, nor the allocation of such resources. With the promotion of the use of ICT at the school innovation it might be expected that the school's Executive Committee had a formal plan of how the innovation would be implemented. There was no evidence, however, to suggest that a formalised written ICT plan guiding the integration of technology existed. Rather the ICT plan appeared to take shape over time, which contributed some frustration among the teachers (see Chapter 7, page 284-285). Another problem relating to the ICT policy is that teachers were not consulted about the ICT initiative, and some teachers felt anxious about implementing the ICT initiative within weeks of being informed about it.
- **ICT culture.** The introduction of the innovation contributed to a school culture promoting the use of ICT, which had not been evident before the start of *DigiDays* (see Chapter 7, page 286). Eight teachers felt encouraged to make more use of technology for teaching by the school promoting the use of ICT. However, three teachers were uncomfortable with the mandated usage and having to do something they might not otherwise have done.
- **Provision of technical support.** During the first phase of the study, two factors affected teachers' perceptions of the level of technical support available in the school. The first was the insufficient number of support staff, which resulted in lengthy response times to calls for help and which discouraged some teachers from using computers during lessons. The second was the low level of helpfulness of the support staff. Some of the teachers were reluctant to approach the support staff for help because they felt they were not receiving the type of help they needed. The innovation attempted to address both of these issues through a survey

conducted among the staff during the first year of the innovation about the level of technical support available at the school. As a result of the findings of the survey an additional support staff member was employed and an online system for logging requests for technical assistance was implemented, with a view to improving response times. As reported on page 287 (see Chapter 7), these actions alleviated, but did not resolve, the problems identified in the first phase of the study. Four teachers' reported frustrations with the logging system and what they considered to be unacceptable response times. Two teachers also mentioned not receiving the type of help they needed from the technical support staff. The type of help needed by different teachers would depend on their level of technological knowledge. For example, two less technologically competent teachers described feeling patronised by the support staff.

Time needed to integrate ICT

During the first phase of the study teachers mentioned problems relating to a lack of time to learn to use ICT, to prepare lessons using computers, and for using ICT during lessons. Teachers participating in the second phase of the study confirmed all of these problems. Firstly, eight teachers said they did not have enough time to learn how to use new programmes. Secondly, 11 teachers indicated that it was time-consuming to prepare lessons using ICT, and that using computers actually increased their workload. Conversely, six teachers indicated that using computers made it easier to find resources. The major area of concern, however, was the lack of time to use ICT in lessons. Eighteen of the 29 teachers mentioned the time required to use computers in lessons as a factor discouraging them from using ICT. Teachers mentioned two types of problems in this regard. Firstly, lessons not being long enough to promote computer usage, and secondly, time lost in lessons due to problems relating to malfunctioning equipment.

One of the things addressed by the *DigiDays* initiative (which introduced dedicated technology days), was that time was set aside one day a month specifically for using technology for teaching and learning. The initiative thus had the potential to address the problem of the lack of time for using ICT in lessons. However, *DigiDays* created a number of additional demands on teachers' time which the school's Executive Committee may not have taken into consideration in their planning. Firstly, teachers needed time to learn to use *Moodle*. While 15 teachers said that they had been able to load the first *DigiDay* tasks without needing any help, four less confident teachers said that it had taken them lots of time to learn to use *Moodle*. Secondly, teachers needed time to design computer-based tasks or to adapt existing tasks. Thirdly, using *Moodle* on *DigiDays* created additional work – teachers needed time to log on to *Moodle,* to upload their task, and to inform learners that the task had been loaded and by when they have to submit the completed work. Fourthly, some teachers mentioned issues relating to the time needed to retrieve the work in a suitable format to be marked and/ or a suitable format to be presented in learner portfolios of work, where required, which were all time-consuming tasks.

All of the problems relating to the time required for teachers to prepare *DigiDay* tasks would be exacerbated where teachers lacked the necessary technological knowledge and skills. Educational institutions need to be aware of the implications, for teachers, of the time required to integrate ICT in ways that benefit learning.

9.2.2 Internal factors which emerged from the study

During the first phase of the study the lack of resources severely limited the number of teachers using computers for teaching and the ways in which teachers were able to use computers. While the innovation at the school established an 'ICT culture' promoting technology use, the provision of resources and the introduction of the mandated computer usage on *DigiDays* were not sufficient to ensure that teachers used computers for teaching outside of the required usage. In addition, even where teachers were required to use computers on *DigiDays*, not all teachers were able to set computer-based tasks which took advantage of the potential benefits of using technology for teaching and learning. The following internal or teacher-level factors which influenced the extent to which, and the ways in which, teachers used ICT after the innovation, emerged from the study.

Teachers' beliefs about using ICT for instruction

- **Teaching philosophy.** Teachers' teaching philosophy, i.e. their beliefs about teaching and learning, impacted on teachers' use of computers for teaching. The *DigiDay* tasks of ten of the 28 teachers (excluding the IT teacher) displayed a constructivist approach to teaching. Seventeen teachers held more traditional views on teaching, which, in three extreme cases, may have made them reluctant to use computers for teaching. Some teachers' reluctance to use computers might have been influenced by a lack of knowledge about the different technologies available, how to use these technologies, and how these technologies could be used in education to improve learning. This was certainly the case for two of the teachers who appeared to be resisting using computers, but who actually lacked the knowledge and skills to be able to use computers. Teachers who hold more traditional beliefs about teaching may benefit from training aimed at showing them the potential benefits of using technology for teaching.
- **How relevant teachers' perceive ICT to be for teaching and learning.** Teachers acknowledged a variety of benefits of learners using computers. These included learners being able to do things they would not have been able to do off computer (ten teachers), the benefit of learners working on their own (five teachers); learners having access to more resources when using technology (four teachers), the technical skills learners acquired (four teachers).

  The effect of the subject being taught emerged as an important factor affecting teachers' perceptions of the relevance of using ICT for teaching. In English and History where critical discussions were important, some teachers felt computers were not useful for their subjects. However, these teachers did mention some situations where computers were of use. For example, the History teacher who had said that computers were not relevant for teaching in her subject was using them to source documentaries of historical and current events, and used these to initiate discussions. Also, although some language teachers were emphatic about computers not being relevant in their teaching, other language teachers were amongst the most innovative teachers, and were using social media for teaching small routine tasks, e.g. the rules of grammar, and increasing vocabulary. Teachers of Physical Sciences, Life Sciences, and Geography felt that using technology offered a number benefits for learning in their respective subjects. For example, computers could be used to visualise structures (e.g. the three-dimensional structure of molecules, abstract concepts, such as friction, and animation of

processes (e.g. protein synthesis or DNA electrophoresis). The value of geographic information systems like Google Earth, and the large number of animations (e.g. of the effect of erosion or coral reef formation) made ICT invaluable in the teaching of Geography.

In situations where ICT usage is being promoted, such as at the case study school, teachers would need training aimed at showing them when and how computers can be useful, in order to allow them to decide whether such usage is applicable in their particular subject.

Attitudes towards ICT

In Figure 81 on page 346, the category 'attitudes towards ICT' is shown as consisting of the following factors: level of confidence, level of innovativeness, enthusiasm for using ICT, teachers preferred learning style, fear of embarrassment, the loss of status. During both phases of the study, however, teachers' level of innovativeness emerged as the most important factor in this category. Twenty-seven of the 29 teachers from the second phase of the study were arranged on a continuum according to their level of innovativeness, i.e. their willingness to explore new ideas, which influences their disposition towards using computers for teaching. At one end of the continuum, the five teachers (19%) classified as *Innovators* were found to use computers more frequently and in a greater variety of ways. These teachers had been greatly encouraged by the school creating an ICT culture within which they could not only use technology, but also explore novel ways of using technology. However, some of the *Innovators* ran the risk of being 'technological determinists' (using technology for the sake of doing so, rather than always focusing on the potential benefits such usage afforded learning). The remaining 22 teachers were less innovative in that they relied on others to suggest new technological applications to use in their teaching. Two teachers (7%) were classified as *Early adopters* based on their willingness to immediately create opportunities to test and use new software once they found out about it from others. Four teachers (15%) were classified in the *Early majority* category. This group of teachers was willing to test and use software, once told about it, but only when an opportune time presented itself. The largest group of teachers (n=11 or 41%), the *Late majority,* needed to see others using new programmes and doing so successfully before they were willing to use ICT. They thus needed more convincing to try something new than the previous two groups, and seemed to be using computers only because the introduction of the innovation had established this as the norm in the school. In the theory of planned behaviour Azjen describes *subjective norms* as relating to the person's perceptions about the social pressures they are under to perform that behaviour (Azjen, 1991). The last five teachers (19%), the *Laggards*, were reluctant to use computers even when it was mandated, and were not using computers outside of the mandated usage. In the cases of three *Laggards,* teachers' level of innovativeness seemed to have been influenced by their low level of technological knowledge and skill. These teachers would benefit from training aimed at improving their knowledge of the different technologies available, and how their subjects might benefit if computers were used in their teaching.

The findings of this study suggest that teachers' level of innovativeness is related to their other attitudes towards ICT. For example, the two teachers who displayed the highest levels of innovativeness had high levels of confidence and enthusiasm for using ICT and were not afraid of making mistakes or being embarrassed when using ICT during lessons. The two teachers who were placed at the lower end of the continuum of innovativeness displayed low levels of confidence, low

levels of enthusiasm for using ICT, expressed fears relating to the loss of their status because of their lack of ICT knowledge, and fears about managing learners in lessons using ICT. This suggests that identifying teacher' levels of innovativeness by e.g. placing them in adopter categories, and providing differentiated support based on the characteristics of their adopter groups, could help teachers, especially those who do not display a willingness towards using computers for teaching.

ICT profile

In my conceptual framework (see Figure 81 on page 346), the category 'ICT profile' is shown as comprising six factors – length of ICT experience, ICT use outside of teaching, ICT training, ICT competence, extent of positive experiences using ICT, and difficulty integrating ICT. During both phases of the study, however, teachers' level of ICT competence emerged as the most important factor in this category. ICT competence is underpinned by a knowledge of how to use computers. The findings from the first phase of the study suggested that the more technologically competent teachers were, the more confident they were about using computers in the classroom situation. In the second phase of the study teacher's level of technological competence again emerged as a major factor underlying teachers' use of computers to enhance learning. For example, teachers' level of competence affected the types of *PowerPoint* presentations teachers created, with only seven of the 28 teachers, excluding the IT teacher, being able to create their own complex *PowerPoints*. This meant that the majority of teachers were either using *PowerPoints* supplied by other teachers or were creating only basic presentations consisting of text and pictures, which do not have as much potential to promote the construction of knowledge by learners as complex presentations which use, for example, animations.

The influence of ICT competence on teachers' use of computers for teaching is a complex one, since technological competence influences not only teachers' beliefs about using computers for teaching, but also their attitudes towards using ICT, and ultimately their ability to be able to use computers for teaching.

9.3 MODELLING THE FACTORS AFFECTING TEACHERS' USE OF COMPUTERS FOR TEACHING

At the beginning of my research, unable to find a single existing theoretical framework to guide my research into the investigation of the factors affecting teachers' use of ICT, I reviewed the literature on factors influencing teachers' use of computers for teaching and organised these into a hierarchical concept map which helped direct the investigation (i.e. to target factors to investigate) and structure the data analysis. The map was presented in Chapter 2 (see page 29), but, as stated in the previous section, is repeated here (see Figure 81) to remind the reader of the framework within which the study was conducted.

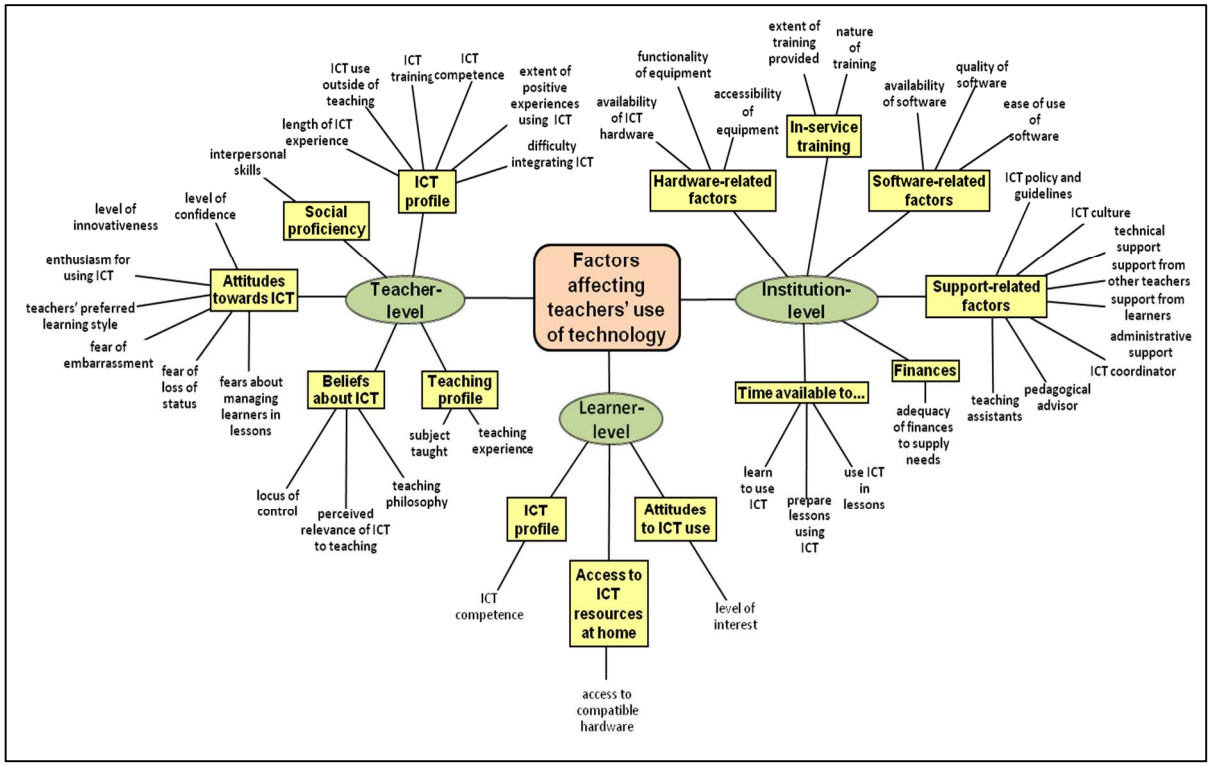

Figure 81. A model of the factors affecting teachers use of ICT

Maxwell (2005) points out that initial frameworks may be fairly diffuse, with large categories, which the researcher should focus over time to "*develop a real theory of what's going on*" Maxwell (2005, p. 54). Eisenhardt (1989) suggests that not all constructs which are identified as potentially relevant at the beginning of a study, and included in a conceptual framework, may necessarily be included in a theory and/ or model which may emerge from the research:

> *Although early identification of the research question and possible constructs is helpful, it is equally important to recognize that both are tentative in this type of research. No construct is guaranteed a place in the resultant theory, no matter how well it is measured.* (Eisenhardt, 1989, p. 536)

As the study progressed I gained new insights into the factors influencing teachers' use of ICT for teaching, the relationships between these factors, and the implications thereof for using technology in ways which avoid technological determinism and promote the judicious use of ICT to maximise the benefits for learning. I used these factors and the relationships between them to develop a model which gives a holistic view of the external and internal factors affecting teachers' use of computers, and which might be transferable to other situations. Developing a model allowed me to represent the most important factors influencing teachers' use of ICT which had emerged from my study in an holistic manner, and to emphasise the relationships between the factors. As explained by Wartofsky (1979, p. 28) a model postulates "*in some systematic way not merely entities, but feasible relations among them*". The model is shown in Figure 82, on the next page.

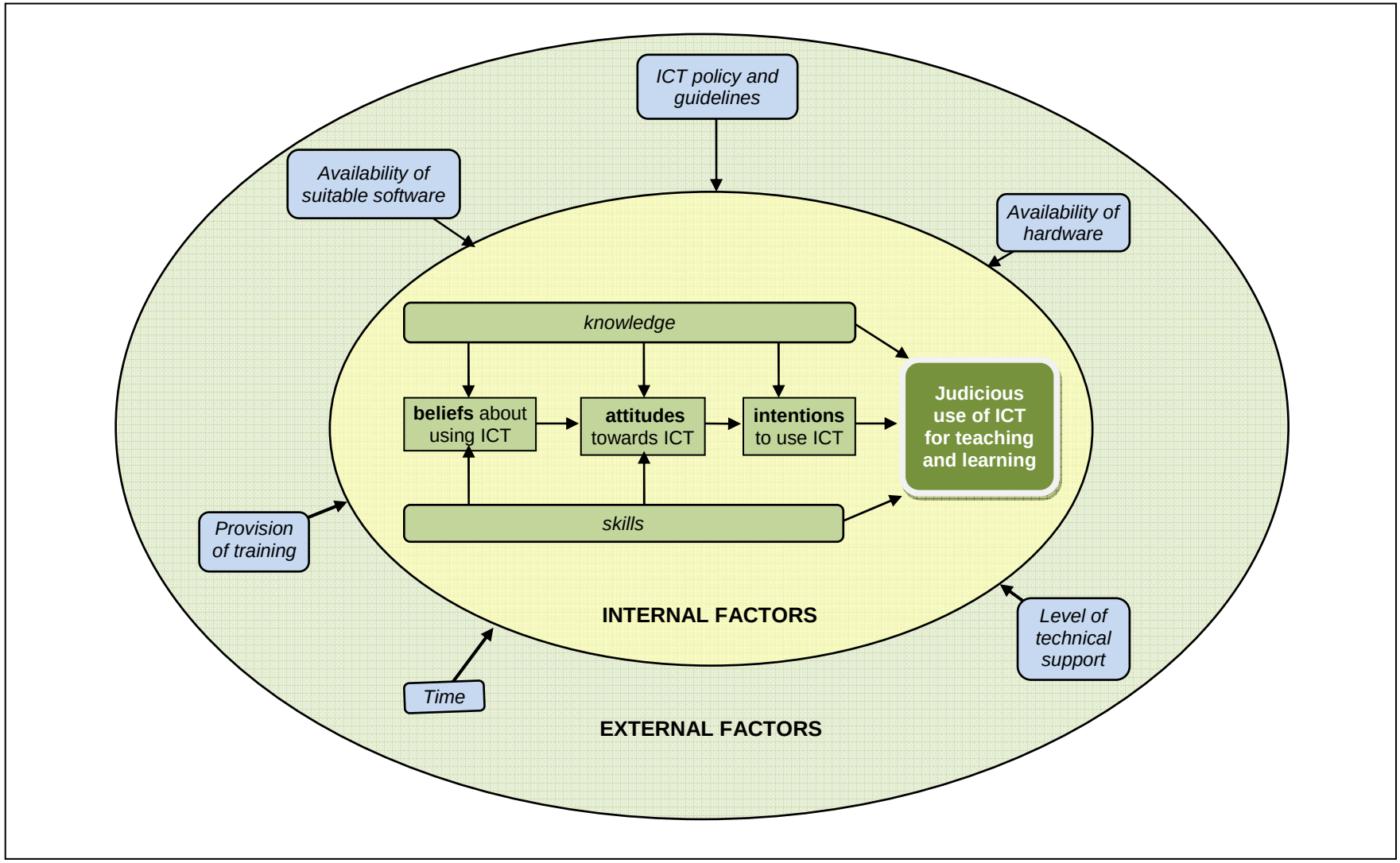

Figure 82. A model of the external and internal facors affecting teachers' use of ICT

Because the internal factors affecting teachers' use of ICT are key to successful use of ICT for teaching, these have been placed in the centre of the model, emphasising the importance of these factors and the relationships between them on teachers' use of ICT. The model emphasises not only the usage of computers, but the **judicious** usage of computers, i.e. the discerning selection of technologies and technological applications based on their ability to help learners construct their own knowledge, particularly for teaching specific topics. This is because not all topics lend themselves to being taught using computers.

Because it emerged from the study that teachers' beliefs and attitudes strongly influenced the extent to which, and the ways in which, they used computers for teaching, the relationships between the internal factors are based on the theory of planned behaviour (Ajzen, 1991). This theory has been applied to a number of other studies investigating teachers' use of ICT (e.g. Mojgan, Abu Bakar, Su Luan, Samak, & Fooi, 2009; Roca et al., 2006; Sadaf et al., 2012; Terzis & Economides, 2011). According to the theory of planned behaviour (Ajzen, 1991) an individual's beliefs underlie the attitudes they display towards a particular behaviour. An individual's attitudes are related to their behaviour through behavioural intentions, defined as "*... plans of action in pursuit of behavioural goals"* (Ajzen & Madden, 1986, p. 45). In Chapter 4 a simplified version of the theory of planned behaviour was presented (see Figure 28 on page 120). It is this version of the theory showing the linear relationship between the beliefs teachers' hold about the usefulness of ICT for teaching, their attitudes towards using ICT for teaching, and their actual ICT usage, which has been placed at the centre of the model shown in Figure 82. However, two additional teacher-level factors not considered in the theory of planned behaviour emerged from my study and have been added in the centre of the model. Teachers' ICT **knowledge**, and their ICT-related **skills**, were found, in the study, to have impacted directly on their ability to use ICT in meaningful ways, but also acted indirectly by influencing their beliefs about the relevance of using ICT for promoting learning and their attitudes towards using ICT in their teaching. These two factors have thus been added to the *beliefs, attitudes* and *behaviours* which are central to the model of planned behaviour.

There are many factors beyond teachers' control which will impact on their use of ICT. Although many of these are prerequisites for effective use of computers (i.e. they should come first as without them teachers cannot use computers in their teaching), I have discussed these factors second, because they are beyond the control of the teacher, hence the reference to them as 'external' factors. Six factors beyond the control of the teacher emerged from the study. I place these factors in the outside circle to represent the fact that they are external to the limits of the teacher's control. These factors could probably be true of any school and are generalisable.

One of the external factors is the ICT policy and guidelines, which played a very important role in establishing the ICT culture in the school, but which needed to be more clearly articulated and communicated to teachers. Had teachers had a better idea of the reasons why the school was implementing the innovation and why teachers were being asked to take on additional work, and had they been convinced that the school had clear pedagogical reasons for asking them to make these changes, more teachers may have been encourage to expend the time and effort necessary to make the changes to benefit learning.

The provision of hardware is the next external factor placed in the model. At the most basic level schools need to provide hardware resources for teachers to use in their teaching. However, schools need to ensure that hardware is in working order and is accessible to teachers to use during lessons.

The level of technical support available to teachers is the next most important external factor. Long response times to requests for technical support, unresolved technical issues and the unhelpful attitudes of some technical support staff discouraged teachers from using computers. This is a complex issue as schools may not always be in a financial position to employ sufficient technical personnel to be able to resolve technical issues as quickly as teachers would like so that disruptions to planned lessons are minimised. The need for sufficient and adequate technical support is something school leaders would have to consider when implementing an ICT innovation.

A crucial external factor is the provision of ICT training. In my study the lack of technological knowledge of some teachers contributed to low levels of ICT proficiency. Firstly, this prevented them from using computers effectively for the mandated usage on *DigiDays*, and, secondly, this discouraged them from using computers for teaching outside of the mandated usage. The 29 teachers displayed a range of ICT competencies, thus the one-size-fits-all approach to training provided by the school was not useful for all teachers, suggesting that a differentiated approach to training aimed at addressing teachers' particular needs would have been more beneficial. This is an area which schools can target to better support teachers to use computers in ways which effectively enhance learning. Providing teachers with ICT training aimed at supporting them according to their needs could make them better perceive the potential benefits of using technology and help them to adopt a more positive attitude towards integrating technology into their teaching. The need for more training and differentiated training aimed at meeting teachers' specific needs was a recurring theme in this study, and is a repetitive theme emerging from other research in the field (see e.g. Loogma et al., 2012).

The concept of technological pedagogical content knowledge, developed by Mishra and Koehler (2006), has implications for the types of professional development which could be provided for teachers integrating ICT into their teaching. According to Mishra and Koehler (2006) teachers need to combine three different types of knowledge in order to use technology effectively for teaching, as shown in Figure 83 (repeated here from Chapter 2, page 55, for convenience).

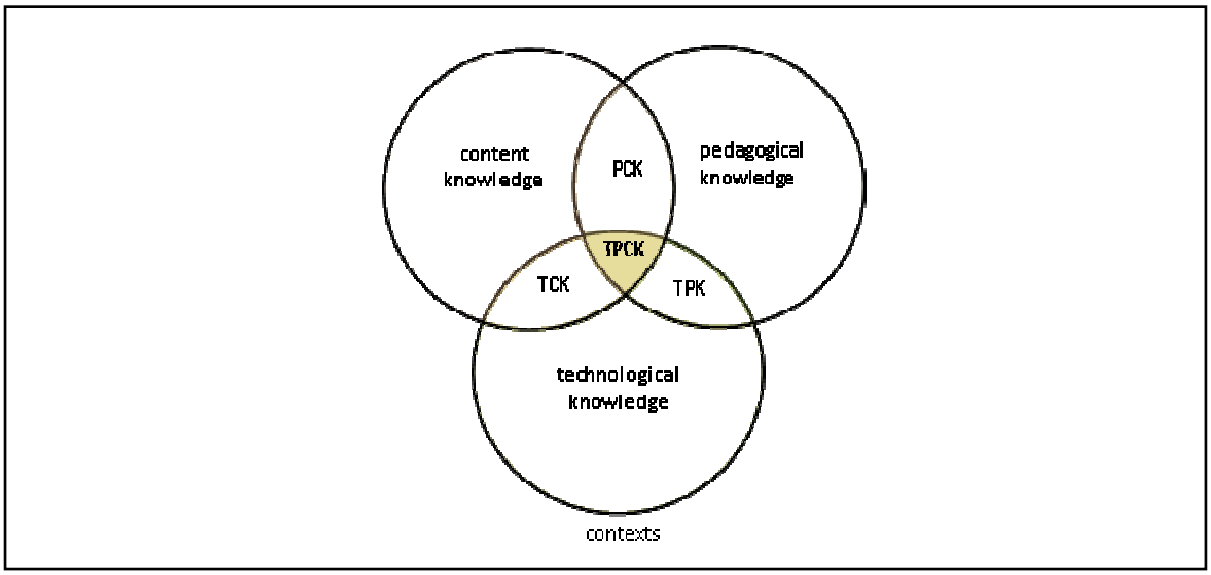

Figure 83. Diagrammatic representation showing the pedagogical knowledge, content knowledge, and technological knowledge components of technological pedagogical content knowledge (Mishra & Koehler, 2006)

Firstly, teachers need **technological knowledge (TK)**. This means they need to know about the different types of digital technologies available and how to use them, what software tools are available, how to install and remove software, and how to install and remove peripheral devices like printers and scanners. This technological knowledge can be learned independently, but must eventually be used in conjunction with the second type of knowledge, **pedagogical knowledge (PK)**. Pedagogical knowledge refers to teachers' knowledge of the pedagogical strategies available to them for teaching their subject. Most teachers should already have this type of knowledge. The third type of knowledge required is **content knowledge (CK)**, which is knowledge of the subject matter to be covered, which competent teachers should already have mastered. Teachers need to be able combine their technological knowledge and their pedagogical knowledge into **technological pedagogical knowledge (TPK)**, i.e. how to select appropriate technologies to use for with certain pedagogical strategies. Swan and Hofer describe **technological pedagogical knowledge (TPK)** as knowledge about how teachers match "*the affordances of the technology with their instruction"* (Swan & Hofer, 2011, p.79). This was an area of knowledge which was revealed in my study to be lacking, and which could be targeted by ICT trainers. Teachers also need to be helped to develop **technological content knowledge (TCK)**, i.e. they need to know how to connect "*the use of technology with the content of their curricula*" (Swan & Hofer, 2011, p.79). This is another area of deficiency revealed in my study, and which could be targeted by ICT trainers. Equipping teachers with these types of knowledge would allow the intersection of content knowledge, pedagogical knowledge, and technological knowledge to form **technological pedagogical content knowledge (TPACK)** which will allow teachers to use appropriate technologies and combine these with appropriate pedagogical strategies to effectively teach a particular topic of work.

The effective integration of these types of knowledge into classroom teaching would require teachers to be able to apply this knowledge, i.e. they must have the necessary ICT skills (abilities). Thus teachers need both knowledge and skills to be able to use ICT effectively for teaching.

The complexity of the different types of knowledge teachers need to combine and apply in order to be able to teach effectively with ICT suggests that generic training sessions, such as the ones teachers at the case study school were supplied with, is unlikely to meet the very different needs of all teachers, to equip them with the specific knowledge and computer skills different individuals needed to be able to prepare *DigiDays* tasks which used computers effectively, in ways which promoted meaningful learning. Rather, teachers need differentiated training based on their individual needs (knowledge and skills they lack) to allow them to develop the requisite knowledge.

Figure 84 suggests a potential approach to training to help teachers develop technological pedagogical content knowledge (TPACK), to promote effective ICT integration. Not all the knowledge areas would be the responsibility of the ICT trainers, since they cannot be expected to provide teachers with the necessary content knowledge or teaching strategies (pedagogical knowledge) (see white boxes in Figure 84). The green boxes in Figure 84 represent the types of knowledge trainers should be providing teachers with to help them develop technological pedagogical content knowledge (TPACK). For some teachers this would involve supporting teachers to be able to select appropriate technologies to match particular teaching strategies (TPK) and to match technologies with the content of their curricula (TCK). In my study some teachers were not aware of ways in which computers can be used together with pedagogical strategies, to enhance learning, and would benefit from TPK training. Others did not see the relevance of computers for teaching their particular subject, and would benefit from training which showed ways in which this could be achieved when teaching specific content areas. Finally, training in combing all aspects for teaching would promote teachers' developing technological pedagogical content knowledge or TPACK.

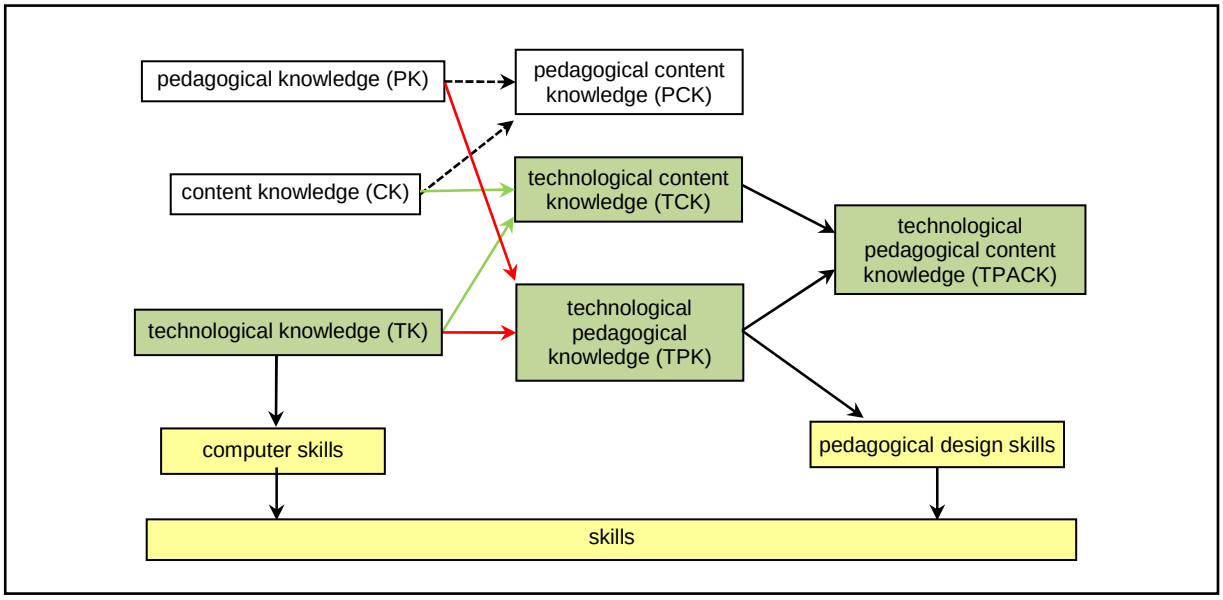

Figure 84. An approach to ICT training aimed at promoting the development of TPACK

The yellow boxes in Figure 84 represent teachers' skills. The first of the two smaller boxes represents ICT skills (their ICT competence) and shows how this is directly influenced by the level of technological knowledge. Furthermore, teachers need assistance in pedagogical design (designing suitable learning tasks for promoting higher cognitive thinking) for more meaningful learning of content

knowledge, skills which are directly influenced by their pedagogical knowledge, as well as their technological pedagogical knowledge. A combination of skills in the two areas represented by the two smaller yellow boxes indirectly affects teachers' general application of such skills for classroom teaching (shown in the larger yellow box). The influence of ICT competence on teachers' use of computers for teaching is a complex one, since technological competence influences not only teachers' beliefs about using computers for teaching, but also their attitudes towards using ICT and ultimately their ability to be able to use computers for teaching.

The fifth factor beyond teachers' control is time. Time is, arguably, the one resource, that most schools cannot easily provide, but school leaders need to be aware of the possibility that mandated computer usage increases teachers' workload. The teachers in my study complained about the extra work-time it took to set computer-based task for *DigiDays*, to learn how to use *Moodle* and also to either mark learners work on computer or to print out learners work for marking. Teachers who were less technologically skilled found that it took them longer to do all of these things, which discouraged them from using computers. One way in which schools could minimise the impact of the time needed to use computers for teaching is to equip teachers with adequate technological knowledge and technical skill so that they are able to use computers efficiently. Where teachers have adequate ICT knowledge and skills to be able to use computers effectively, this may make them feel more positive towards using computers for teaching.

The final external factor in the model is related to the provision of software. An important finding from my study is that teachers will not use software that does not meet their needs in terms of the practices and the content required by the curriculum, and the pedagogical design of the software. While schools could be expected to provide teachers with generic software, the onus would be on teachers to identify more specialised subject-related software suitable for use in their teaching. This factor would be mediated by teachers' willingness to spend the time and effort to find the software based on hard relevant they think using technology is for their teaching and their attitude towards using technology for teaching.

9.4 RECOMMENDATIONS FROM THE STUDY

Loogma et al. (2012) refer to an 'innovation gap' which may exist between early and later categories of adopters, especially in the early stages of an innovation. According to these researchers "*innovations may "work" rather destructively, having a differentiating effect on the potential group of adopters, and later adopters are more likely to discontinue using ICT in education"* (Loogma et al., 2012, p. 810). Based on the obstacles to ICT usage identified in my study, a number of recommendations are suggested to avoid an innovation gap from developing which could might lead to less innovative teachers and/ or less skilled teachers not being able to use computers where such usage could benefit learning, or using computers in ways which do not improve learning. However, these recommendations are based on logic and have not been empirically tested to see whether they will have an impact, so need to be considered with caution.

9.4.1 Recommendations to the case study school

The actions the school could take to promote teachers' use of computers include:

- Informing and educating the school leaders about which factors promote teachers usage of computers and potential obstacles to ICT usage, which they can target. In this regard the model could be useful in showing them the complexity of interacting factors which affect the successful implementation of computers in teaching and learning, so they can plan to address potential problem areas. They also need to be made aware of the problem of technological determinism, and the need to consider how to help teachers avoid the unjudicious use of ICT.
- The impact of a lack of a clearly articulated ICT plan, which meant that the ICT innovation at the school took shape as problems were encountered, suggests that a logical recommendation would be the formulation of a clear written ICT plan detailing the school's objectives for integrating ICT and the reasons underlying these objectives, and that this should be formulated in conjunctionwith teachers, and the final plan clearly comminicated to the teachers.
- Based on the finding from my study that teachers' levels of innovativeness influenced the extent to which they used computers and the ways in which they used computers, a preliminary analysis of their levels of innovativeness could be carried out, e.g. by classifying them into adopter categories using the diagnostic method consisting of the questionnaire and associated key (see Chapter 8) to allow for differentiated support based on teachers' individual needs.
- The analysis of the *DigiDays* tasks set by teachers in the first 18 months after the innovation showed that not all teachers had the necessary knowledge and skills to be able to design effective computer-based tasks which promoted meaningful learning in their subject. The school should aim to provide sufficient training that is explicitly designed to help teachers use computers effectively in their teaching. Possible areas which could targeted for training aimed at promoting the judicious use of ICT have been added to the model of external and internal factors affecting teachers' use of computers (see red boxes in Figure 85), based on the suggested approaches to training shown in Figure 84 (on page 351).
- Some teachers placed in the *Late majority* group extended their computer usage outside of *DigiDays* based on seeing what other teachers could achieve when using technology for teaching. Teachers' beliefs and attitudes towards using computers may be improved by seeing how others use them effectively, and this could encourage them to spend the time and effort to be able to use technology in similar ways.
- Some teachers in my study were discouraged from using computers by not receiving the type of technical support they needed, by long response times, and also by the unhelpful attitude of the technical staff. The school should look at further improving the level of technical support available to teachers to promote ICT usage.
- Teachers should be encouraged to evaluate software before purchasing it and provided with appropriate tools and training on what to look for in suitable software (e.g. sufficient interactivity to make the software more than just an electronic page-turner).

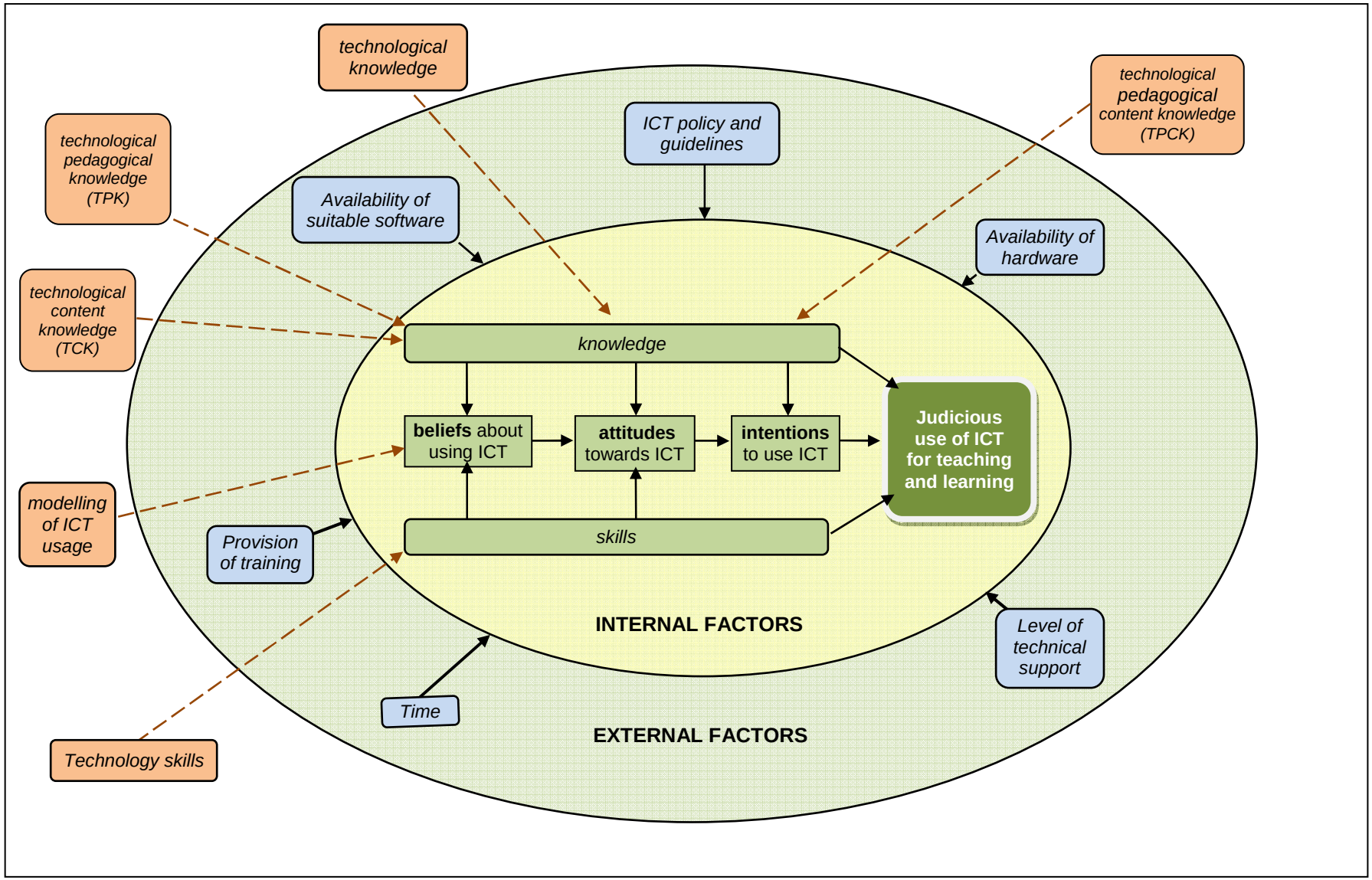

Figure 85. Recommendations for areas which could be targeted for training based on teachers' needs

9.4.2 Recommendations to other schools

The model can be used by other schools to learn about the factors which have been found to be obstacles to teachers' use of computers. Other schools may also want to take heed of the above recommendations made for the case study school and consider the following:

- In my study, the fact that teachers were not consulted about the ICT innovation contributed to anxiety among the teachers when the innovation was introduced and to frustration for some teachers when the innovation was not implemented as they had been told it would be. Other schools wanting to implement ICT innovations should consider consulting with teachers to develop a shared vision of ICT integration before introducing an innovation. Teachers are more likely to adopt an innovation they feel they have been involved in planning.
- Conduct a needs analysis of what resources specific teachers feel they need for use in their subject, before spending money on ICT resources which might not be used if they don't meet teachers' needs.
- Investigate individual teacher's willingness to use computers for teaching. A diagnostic tool such as the questionnaire and key developed for use in this study could be useful in this regard to classify teachers into adopter categories and to help schools formulate an ICT strategy, especially with regard to identifying what sort of support teachers might need and planning training based on individual teachers' needs.

9.4.3 Recommendations for further research

Researchers could use the model of factors affecting teachers' use of computers I developed (see Figure 82 on page 347) to identify factors worthy of further research. During the course of my study I observed certain aspects of how teachers are using computers that did not form part of my study. These gaps suggest areas for further research:

- In my study I developed a model of the factors affecting teachers' use of computers. It would be worth applying this model to a different school to see whether the model holds up in a context other than the one in which it was developed.
- Further investigation of the reasons underlying teachers' usage of computers in particular ways is warranted, so that training programmes based on teachers' needs can be implemented, to see whether that might have an impact on their uptake of ICT for teaching.
- Further investigation could be carried out into the impact of classifying teachers into adopter categories based on their levels of innovativeness, and providing training based on the characteristics of the different adopter categories, on teachers use of ICT for teaching. The diagnostic method consisting of the questionnaire and key for classifying teachers into adopter categories developed in the study, which has yet to be tested in other settings, could be used for this purpose.

9.5 CONCLUDING REMARKS

The findings from the study led to new insights, captured in two models. Firstly, during the software evaluation aspect of the study a model for the context-based evaluation of multimedia software was developed (see Chapter 5). Secondly, the aspect of the study investigating the factors affecting teachers' use of ICT led to the development of a model of the external and internal factors affecting teachers' use of ICT, based on the theory of planned behaviour (Azjen, 1991). Both models represent new contributions to the field of research into ICT use in education. In addition, the grouping of teachers into categories based not only on their behaviours but on the reasons behind their behaviours offers a new perspective on supporting teachers to make more effective use of ICT (see Chapter 7) and has implications for the differentiated type of training individuals might need, based on their reasons.

A number of new instruments were developed during the course of the study. Firstly, a quick and easy method for identifying adopter categories using a four-item multiple-choice questionnaire associated with a dichotomous key was developed. The method is based on Rogers' (1962, 2003) adopter categories, but uses a broader set of characteristics than just rate of adoption to classify teachers into adopter categories. The idea behind placing teachers into adopter categories is to be able to tailor support based on teachers' specific needs, thereby promoting the uptake of ICT for teaching. Finally, four qualitative checklists were developed during the software evaluation aspect of the study. The qualitative checklists allow evaluators to provide reasons for their scores and rankings, thus making it easier for others to understand the rationale behind the evaluations. This information might be informative for software developers.