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Introducing tablet computers to a rural primary school: an Activity Theory case study

Abstract

This paper reports on a case study investigating the introduction of tablet computers into a rural primary school in Oman. The school is unusual in that it is in an economically-disadvantaged, mountainous region which is prone to flooding. There is little infrastructure, with no internet and there is a high turnover of staff. The project to introduce tablets was a personal initiative of the head teacher who needed to convince the Ministry of Education, her staff and parents of the pupils. The study used Activity Theory to explore the introduction of the tablet computers, seeing the school and the classrooms as Activity Systems. The Activity Theory analysis made it possible to see how changing one aspect of an Activity System, by introducing new mediational tools, affected the agents, the community, the rules and the division of labour. The study found that the tablets changed the working culture of staff in the project and the behaviour and responsibilities of the pupils.

The significance of the study lies in the fact that the school was such an unlikely setting for such an innovation and the consequent effects such as staff collaboration and partnership between teachers and pupils – which might have been standard practice in an affluent urban setting – constituted radical changes in the culture of the school and classrooms. The study also innovates in the use of Activity Theory to examine all components of the System in order to understand the unexpected impacts of an innovation such as tablet computers in education.

Key words

country-specific developments; elementary education; evaluation methodologies; improving classroom teaching; pedagogical issues

Highlights

Touchscreen tablet computers are introduced into schools for a variety of reasons

An innovation such as tablet computers has a range of impacts in the classroom

Analysing all aspects of the classroom identifies the full range of impacts

Introducing new classroom tools can be a catalyst for change in practice

Even with little infrastructure, teachers can find creative ways to implement change

Introduction

This case study explores an educational innovation, the introduction of tablet computers to a school, and its impact upon the various elements of the classroom Activity System. Digital technologies are often introduced to educational settings on the assumption that they will have positive impact, for example on learner engagement and motivation, which will enhance learning. As Selwyn, (2017) shows, there is little evidence directly linking digital tools with 'better' learning and subtle agendas often underlie these innovations. Rationales for introducing new technologies may include the desire to promote (non-pedagogic) change, the belief that digital skills are essential for modern life; the potential for using digital tools for teaching (non-computing) subjects and the perceived need to train future programmers (Hawkridge, 1989).

In this case, the innovation was led by a headteacher in a disadvantaged, mountainous region of Oman, far from conurbations, taking advantage of a Ministry of Education (MoE) initiative to introduce tablet computers. She believed that tablets could replace pupils' heavy book bags, improve their digital skills and develop learner autonomy. Although the school was an unlikely candidate for such an initiative, the personal vision and drive of the headteacher led to the provision of four iPads and fifteen Windows tablets. The MoE had agreed that a researcher could follow the introduction of tablets and, and as this school was the chosen site for the MoE it was thus the site of the research study.

The most recent information about the use of digital technologies in Oman is a survey conducted in 2016 by the Information Technology Authority of the Sultanate of Oman (ITA, 2019). The report does not say how the families (5,351 households) were selected other than that samples were chosen to be representative of the population. Furthermore, the report does not clearly show differences between urban and rural areas. The survey showed that 86% of households have access to the internet, mostly through mobile phones. Only 21% have broadband internet. 38% of participants cited lack of skills as the reason for not accessing the internet whereas 14% cited their high prices

and lack of time. 12% said that slow connection speeds prevented them from using the internet. According to the survey, the top 3 activities when using the internet are 96% social media, 73% video downloading and 41% voice calls. In the governorate where this research study was conducted, 88% of households had internet access although parent interviews and the school experience on which this study reports, indicate that this digital technology use is much lower in the school catchment area than in the governorate as a whole.

Tablet computers in education

Affordable, easy to use touchscreen tablet computers with downloadable apps have been available since the introduction of the iPad in 2010. Much research focuses on attitudes to these technologies (e.g Dündar and Akçayır, 2014; Khlaif, 2018; Ifenthaler and Schweinbenz, 2016; Villani et al., 2018; Lu et al., 2014) and while this can be revealing, it only captures one element in educational systems. Like all educational change (Fullan, 2008; Wedell, 2009), introducing new technologies impacts in complex ways, mediated through affordances of the technologies and the attitudes and abilities of the people involved. Several studies have found that tablets improved learning but also had drawbacks. In the systematic review of tablets in schools, conducted by (Haßler et al., 2016), twelve out of 33 studies were methodologically rigorous and, of these, nine showed positive effects and three showed no difference in learning outcomes. Haßler et al. included only studies in which tablets had been successfully introduced but noted that in several cases implementation was unsuccessful due to factors such as poor project management or technological problems. Yanikoglu et al. (2017) found that tablets motivated primary school pupils to improve their handwriting but increased teachers' workload cf. Vrasidas (2015) finding that digital tools slowed the teaching process. Fokides and Atsikpasi (2017) found that tablets enhanced the learning of (botanical) knowledge but did not reduce scientific misunderstandings whilst in Volk et al. (2017) tablets improved the teaching of mathematics but the speed of the app meant that weaker students had fewer opportunities to observe and learn from more expert learners. Volk et al also showed teachers had to manage student conceptualisations of tablets as devices for playing games or engaging with social media. Several studies have raised concerns related to those in Volk et al. (2017) about potential negative impacts of mobile technologies on factors such as learners' concentration (Ditzler et al., 2016) and reduced awareness of the non-digital world (Dunn et al., 2018). The complexity of these effects requires an holistic view of what happens in the school or classroom and led to an Activity Theory analysis to answer the question "What impact might the introduction of tablet computers have on the Activity System of a school?"

Activity Theory

Activity Theory provides a philosophical framework for analysing forms of individual and social developmental processes that are interlinked (Kuutti, 1996). When studying tablet introduction into the school system, it was important not only to look at how individual teachers or pupils used tablets, without the wider context. The Activity System must be taken as a whole. What is perceived as a minor change may result in disturbing the whole Activity and may go beyond that to another Activity.

The Activity Theory lens provided an holistic view of the introduction and impact of introducing tablets. Activity Theory evolved from the ideas of Vygotsky in the 1920s (Vygotsky, 1978; Engeström and Kerosuo, 2007; Leont'ev, 2018). The core unit of analysis is the Activity or Activity System, which (Kaptelinin and Nardi, 2012: 12) gloss as a "unit of life." An Activity System comprises a set of mutually determining elements: principally, a Subject, typically an individual, who is trying to achieve a purpose or Object, leading to an Outcome, within a Community. (Capitalised terms have technical meanings within Activity Theory). Subjects use physical, social or psychological Artefacts to achieve their Object with the relationship between Subjects and the Community organised by a system of Rules, the articulation between the Community and the Object mediated by a particular Division of Labour. An Activity System is commonly represented by the diagram in Figure 1.

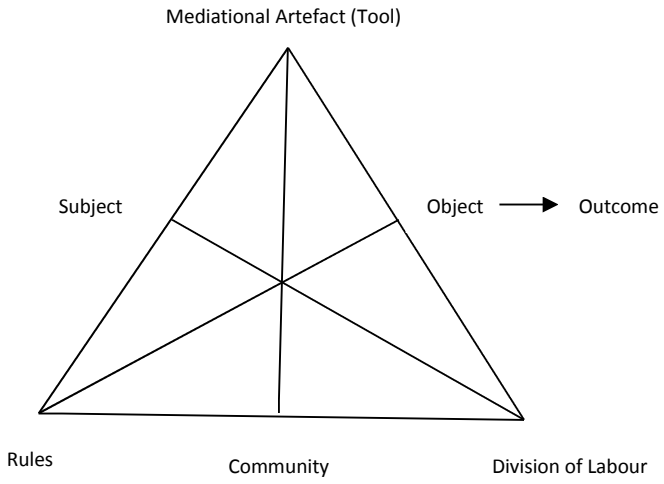

Figure 1: Activity System (Engestrom, 2000)

An Activity does not simply come into being but draws on the histories of the individuals, the community and previous Activities. An Activity may have Contradictions, which (Kuutti, 1996: 34) describes as "a misfit within elements, between them, between different activities or between different developmental phases of a single activity". Contradictions drive the process of

Transformation as the elements of the Activity change in response to the introduction of new elements and as individuals question and reform pre-existing norms.

Activities are comprised of Actions, which consist of Operations. However, Activities may be nested so an Action within one Activity may be viewed as a (smaller) Activity in its own right, which can then be broken down into its own set of Actions and Operations. Operations are the smallest possible units of Activities.

Activity Theory has been widely used for evaluating the impact of innovations in education. For example, Lewin, Cranmer and McNicol (2018) used Activity Theory to evaluate the introduction of a collaborative digital pedagogy. In this study, the new pedagogy was understood as an Object with concomitant Mediational Tools that introduced new Rules, widened the Community and changed the Division of Labour. Activity Theory enabled the researchers to identify and explore the Contradictions created by the changes in the System. Some of these could be resolved but others showed the need for support at local and national level that would be required for successful introduction of a new digital pedagogy based on collaboration. Goodnough (2018) also explored Contradictions when looking at science teachers' professional development (PD). In this case, the teachers were engaged in a 5-year PD programme. This PD programme also aimed to change pedagogy, in this case inquiry-based learning. The study explored existing Contradictions in the teachers' practice, which enabled the researchers to see how PD might help teachers to resolve the Contradictions. Zheng, Kim, Lai and Hwang (2019) used Activity Theory at classroom level to explore flipped learning. In Zheng et al.'s study, the classroom was identified as a system and the use of Activity Theory enabled them to find Contradictions between all elements of the System and thus to make recommendations about how the implementation of flipped learning could be more effective. All of these studies demonstrate the power of Activity Theory in identifying the tensions that arise when innovations are introduced.

One study that used Activity Theory to explore the impact of digital technologies in the context of rural education is Holen, Jung and Gourneau (2017) who looked at the introduction of individual laptops. Although their study was conducted in the United States, the remote location shared meant that home internet use was expensive and difficult, as was the case in the region of Oman where the current study was based. However, in most other respects the context explored by Holen et al. was completely different, as it did not share the challenging geography, with resulting social impacts, of rural Oman. Nevertheless, Activity Theory enabled Holen at al. to explore all aspects of the system to identify both positive and negative aspects of the innovation.

Research Design

Location

The school is in an isolated mountain region: a challenging place to live and work as it is remote and roads are often closed due to flooding. Few teachers are local and most will apply to be transferred as soon as possible with the result that most staff are either new or waiting for transfer (Al-Habsi, 2009). Teachers willing to work in rural areas are offered rapid promotion so even senior staff may be relatively new to the profession.

Participants

Three class teachers took part in the innovation together with the headteacher and the ICT teacher who was responsible for overseeing the introduction of the tablet computers. All teaching staff in the study were female whilst the ICT technician was male. All names are pseudonyms.

The pupils were all in mixed-gender Grade 4 (aged 9-10) classes of 23-26 children. Lessons were 40 minutes long and the subject areas chosen by the headteacher were mathematics, science, and Arabic.

Equipment

Although the school had four iPads, these were not used during the study. The teachers chose to use fifteen Lenovo ThinkPad touchscreen tablets, with detachable hard keyboards, running Microsoft Windows. Each tablet had a stylus and USB ports for memory sticks and came with pre-installed Windows applications such as Word and PowerPoint. Additional applications could be downloaded from the internet.

All classes were taught in the 'interactive room', equipped with laptop and electronic whiteboard. The school had no broadband but during the study was supplied with mobile modems/routers.

Observation

Eight classroom sessions were observed using a schedule that distinguished between what teachers and pupils did during the lessons (see Appendix One). The schedule was developed through a pilot and additional items were added as needed during the main study. The observations enabled detailed mapping of the classroom Activity System.

Interviews and focus groups

Interviews were conducted with the three individual class teachers, with the head teacher and with the ICT teacher. Focus groups were conducted with pupils and, separately, with parents. Three groups of 5-7 pupils were interviewed. The parents' focus group comprised seven volunteer participants. They were chosen because they had a history of engagement with the school, for example, attending parent-teacher meetings. However, they were not typical of the school population as all were, themselves, teachers with a higher level of education than the majority of parents. All interviews and focus groups were conducted in Arabic.

Analysis

Data coding used a thematic approach with themes drawn from the elements with subthemes arising from the data and refined during the process of analysis.

Ethical considerations

Informed consent was received from all participants, including children, and from parents of pupils. All data are anonymised including the name and precise location of the school. The teachers did not want to be video recorded but audio recordings were made of interviews and focus groups. One of the class teachers asked not to be recorded and so detailed written notes were taken instead.

Ethical approval was received from the University of Leeds and from the Ministry of Education in Oman.

Activity System analysis

To answer the question "What impact might the introduction of tablet computers have on the Activity System of a School?" the first part of this analysis looks at the Activity of introducing tablets to the school community, looking at the various stakeholder groups: teachers, parents, pupils, the MoE and technical support. The second part explores the impact on classroom practice, considering each classroom as an Activity System in its own right.

One: Introducing tablets to the school

Subject

The Subject of this Activity is the headteacher who had only a few years of teaching plus one year as an assistant head. She had been headteacher for just a few months and her relative lack of experience reflected the disadvantaged location of the school.

Object and outcome(s)

The head teacher's Object was to provide tablets for all the pupils in one class towards the Outcomes of enabling autonomous learning, developing digital skills and reducing the physical load that pupils carried to and from school.

> My vision is that a pupil starts to learn on their own, starts to recognise what they want and to understand why these devices are provided for them. A pupil would then start to get information on their own.

This went beyond learning in the classroom.

> We also want each pupil to have a tablet under their responsibility, so they do not leave it at school but can take it home, interact with it and bring it to school the next day. Pupils should use tablets to replace their bags and books. That is all that we want. Our aim is to get rid of the school bag and make it an electronic bag (Head teacher interview).

The Object was surprising for the head teacher of a remote school. The fact that the request was made reflects the way that the head teacher's lack of experience meant she was not aware of how unusual her request was. The fact that the request was granted perhaps shows the effect that the wider community might have on an individual school Activity System. Teachers all over Oman went on open strike for over two weeks in 2011 and again for over a month in 2014 (Al Zidjaly, 2017). This meant that the MoE was more willing to accede to head teachers' requests but the decision was also in line with MoE policy of supporting the use of technology in primary schools (The World Bank, 2013: 35)

Community

The Community comprised the MoE, the teachers in the school and the regional Educational Office. In line with the Rules relating to local practice, the parents were not a part of the community for this Activity. The head teacher justified excluding the parents because she "considered it to be a project for the school alone".

This was less problematic than might have been expected because at least some of the parents shared the head teacher's attitude.

> Of course, the use of tablets always attracts young pupils in cycle one. I mean that children at this age are attracted by tablets, especially with games that have an educational side. I think it will have an effect on them. It will create a competitive environment between pupils and it will enable them to be creative, because with their

> use of these devices they will have wider space to use technology and apps (Parents' focus groups).

However, this positive view was not reflected in the way the pupils reported their parents' views. The following are from the pupil focus group:

> They don't let me play with the tablet because it distracts my mind and I don't understand the exams [G2].
>
> My parents refuse to get me an iPad because they say someone discovered that they spoil the mind [B2].
>
> Also rumours come and reach our parents who then say we don't want such things to happen for our children. For example, a girl was playing with an iPad and her tongue got twisted …. Yes, rumours. I don't think these are true, because tablets are useful [G3].

This may reflect a difference between the parents who agree to be part of our focus group and the wider parental community or a view that tablets were not suitable for use by children at home. The final quote also reflects the extremely positive view of tablets held by the pupils, with enjoyment being the most comment associate of tablets.

The staff were peripheral members of the Community except for Mariam, the technology teacher.

> She's the teacher supervising the project so she facilitates it, because she already has the experience and she is available in the interactive room as she acts as room keeper (Head teacher interview).

Unfortunately, Mariam had limited time for the project and this created a Contradiction within the Activity System.

> It is true that I'm supervising the project, but I'm a teacher and I have a curriculum to cover, pupils, and classes, so I'm not always free to go there. (Mariam interview)

Mariam also criticised the head teacher's choice of class.

> There are other teachers in the school who take the initiative and can spare time for the project. The problem with the current teachers is that we have to direct them, do this and do that. She knows this. I told her and she replied, "We have already started the project with class 4 pupils and the teachers who teach them are teaching this class." Maybe if we had implemented the project with a different class and different teachers it would have had better success. (Mariam interview)

One reason for the minimal role of the staff was that the head teacher believed they feared technology.

> My role is to change the teachers and take away their technology fear and push them towards globalisation. I should keep up with all technology and try to bring that to the classroom and implement it in a comprehensive way. Try to get courses for the teachers on how to do that. (Head teacher interview)

However, a potential Contradiction arose with externally provided courses

> There is a plan for professional development, several courses, but the problem is that teachers did not attend many of these because of timetable clashes with these teachers' lessons. We wanted to repeat these courses between the two semesters when teachers are usually free but they were busy with exams. No matter how much we try, and we keep trying, there are always challenges, not only within the school but externally too" (Head teacher interview).

The problems with training courses were wider than this. Khawla, one of the teachers in the project, commented

> All teachers need training, not only us, as this is a school project. (Khawla interview)

The limited access to training had a negative impact on the next level of Activity.

Khawla's also criticised the choice of class, mirroring Mariam's comments.

> Why did she choose a grade 4 class, not a grade 5 class? Older pupils are more mature and have better knowledge (Interview with Khawla).

The other teachers involved in teaching the grade four class offered no criticisms and this may reflect the fact that Khawla had much more experience than her colleagues.

Rules

The Rules would normally suggest that the headteacher should first approach the Regional Educational Office, but she made direct contact with the head of the information technology department at the national MoE, obtaining tablets and a promise of support with the internet connection. The tablets were delivered six months later than expected and this delayed their use until the following academic year. The Ministry provided mobile modems/routers, though late delivery meant that a reliable connection to the internet was not available until March.

Regional office support was variable, possibly a reaction to the head teacher's decision to approach the MoE before the Regional Office. Mariam, the technology teacher reported:

> I contacted Mr Khalid who came here from the regional educational office. He took photos and said the room needs furniture. He took one device to check its system and he spoke about the electricity supply and charging problem, saying a carpenter can easily make a charging cupboard that can charge devices easily. I also told him that we needed the internet urgently. When I contacted him again in February and reminded him about these things, he said he had raised my points, supported with photos, to the higher authorities but no one did anything. (Mariam interview)

The lack of an efficient charging system had a disruptive effect on the use of tablets in classes.

The regional office did provide a technician called Ali who visited the school every fortnight and provided advice on connecting the tablets to the internet and ensuring communication between the tablets. Ali also became a part of the Community for the Activities focussing on the use of tablets.

Mediating Artefacts

The main mediating Artefacts were the tablets but also included the modems/routers that were required for the tablets to be used effectively. The late delivery of routers had considerable impact on the use of the tablets.

Division of labour

The introduction of tablets was largely the responsibility of the Ministry of Education. The Regional Educational Office was also responsible for support but this was not always effective, as Mariam's frustration with Mr Khalid described above makes clear. This was another Contradiction within the project: between the formal role of the MoE structures and the lack of action and support from the Regional Office.

Two: In what ways does the use of tablets affect practice in the classroom?

Once the tablets had been introduced, the three classroom teachers began using them in their teaching. The unit of analysis for this stage was the class. In all cases, the Mediating Artefacts included the tablets, keyboards, styli and the smartboard together with the software used in the lesson. In some cases, memory sticks were used to transfer files to the tablets. The standard class Rules in every case included starting and finishing the lesson on time and the expectation that pupils would sit still in their places, stay on task and work without talking.

Two classes are presented in detail: the first lesson taught by Khawla (the one teacher with substantial experience) Safia's second lesson which was the first time that an internet connection

was available. These are followed by summaries of the three lessons taught by Ibtisam which show how classroom practice developed over the length of the study.

Khawla's lesson one (Arabic)

Subject

Khawla had twelve years' teaching experience and lived locally with a long-term commitment to the school. She had misgivings about the project.

> This year we were surprised with the project size and with the class selection. The school didn't have these devices; I don't know how the arrangements were made. Pupils were very happy but they need expertise and as a teacher I don't have the expertise and I'm slow.

Ibtisam and Mariam, the ICT teacher, supported Khawla. The technician was not available.

Object & Outcome

To read a text in Arabic on their tablets silently and then aloud with (intended) Outcomes of developing reading abilities in Arabic and familiarising the pupils with the tablets.

Actions and Operations

1. Independent paired silent reading, which Khawla monitored by asking pupils to choose an appropriate title for the text (14 minutes).

2. Individuals reading aloud whilst listening pupils followed the text on their own tablets using the stylus. The first pupil read aloud from the tablet at the front of the class but Khawla asked the other pupils to read from their own desks. This change in Rule reflected Khawla's desire not to leave the other pupil in the pair alone at their desk or wandering around the classroom (26 minutes).

Division of Labour

Preparation: the three teachers checked that the tablets were charged and transferred the files from the memory stick. Khawla placed one tablet on each pair of desks before the pupils came into the room.

All three teachers supported pupils in the classroom, for example, with finding the text that they were supposed to read.

Contradictions

1. Khawla's awareness that the pupils were excited to be using tablets and her wish not to disrupt the rules of classroom organisation.

2. The number of pupils and the number of tablets
3. Khawla's plan for class-based reading aloud and the pupils' wishes to work independently.
4. Khawla's desire to maintain classroom discipline and the head teacher's vision of learner autonomy.
5. The affordances of touch-screen tablets and their use as electronic books with material scanned from usual textbooks.

Summary

Khawla wanted to be sure how things would work in her classroom before trying them, which affected her use of tablets. She wanted to guarantee that tablets would not disrupt her classroom organisation and she achieved this by inviting colleagues into her class and giving pupils limited control over their tablet use.

Pupils had considerable freedom in the first ten minutes to try the tablets. The switch to the shared but independent work of paired silent reading happened smoothly, at least partly because there were three teachers in the classroom. Khawla used the tablets as electronic textbooks and no use was made of other features of the tablets such as the touch-screens. However, she recognised that children would be eager to use the tablets and this was reflected in her decision to use the devices from the start of the class.

Safia lesson two (Science – dinosaurs)

Subject

Safia supported by Ibtisam, Mariam and Ali (technician)

Object and outcome

Using the internet to research dinosaurs

Actions and Operations

Preparation: the teacher removed the keyboards and then connected as many tablets as they could to the internet.

First task: Safia asked the pupils where information came from and elicited the term "internet" (2 minutes).

Second task: Safia asked the pupils to look for information about dinosaurs using their tablets. Many of the pupils were not able to connect and the aim of the task became the internet connection.

Division of labour

Preparation: this was carried out by Mariam assisted by Safia and Ibtisam. Connecting the tablets to the internet was difficult because this was the first time they had done this. Mariam had taken the advice of Ali and used only one of the school's three routers which meant that it was difficult to connect all fifteen tablets simultaneously. The length of the preparations meant that Mariam and Ibtisam had to ask colleagues to cover their teaching. Once eleven tablets had been connected to the internet, the three teachers placed all the tablets face down on the desks in the interactive room.

First task: led by Safia with enthusiastic participation from the pupils.

Second task: When pupils found they did not have an internet connection, they tried connecting without instruction from Safia or the other teachers. When one pair managed to connect, Safia asked them to come to the front of the class and explain what they had done. Pupils moved constantly from their places to the front, either to show the teacher their connectivity or to seek her support. At one point there were 10 pupils surrounding the teacher and only four of the 20 in the class seated at their desks.

Safia asked the whole class to return to on their seats so that she could coordinate their efforts to solve the connectivity problem. She invited suggestions from the class and each time a pupil made a suggestion she asked them to try it out. One boy suggested that they might get a better signal closer to the router and another that the signal would be better outside the room.

Eventually, the pupils and teachers realised that only four tablets could be connected at one time and Safia organised the pupils to work in larger groups. Some pupils split off from the larger groups to try to connect to the internet. One pair succeeded but then used the connection to search for information about car racing. Safia stopped them and made them stand up for a period of time.

When the bell rang, Safia asked the pupils to put down their tablets. Two pupils helped Safia and the other teachers put the tablets away.

Contradictions

1. The lesson had been planned around use of the internet but good connections were not available and this changed the lesson focus.

2. Once online, pupils could (and did) use the connection to search for information unrelated to the lesson.

3. Pupils moved freely around the classroom, breaking the Rule that they should sit still in place

4. The pupils found getting an internet connection particularly engaging. Only one pair in the class managed to find any information about dinosaurs.

Summary

The pupils were very active, imaginative and persistent in solving the technical problem. Safia displayed flexibility in the face of technical problems and expressed satisfaction with the contributions of the pupils to the lesson. She believed that they had learned about developing and testing hypotheses.

Ibtisam's lessons (Mathematics)

All of Ibtisam's lessons started at 10:35 and were scheduled to finish at 11:15.

Lesson one – Axes of symmetry

Before pupils arrived, tablets, with keyboards attached, were set out on tables. Some were plugged into wall sockets. Pupils started exploring tablets immediately but were told to stop and listen. Ibtisam reviewed the previous lesson, displayed shapes on the whiteboard and used folded paper to demonstrate axes of symmetry. During these phases, pupil gaze moved between teacher and tablets. Some touched the tablets and some talked about them with other pupils.

At 11:02 pupils were asked to open a Word document on the tablets but some needed help from teachers. Pupils completed the task in pairs (identifying and counting axes of symmetry). They were excited and competitive, talking loudly – not only with partner but also with other pupils. The first pair to finish ran to Ibtisam who raised the tablet to show to the class. Not all had finished by 11:15 but the lesson ended on time.

Lesson two – 2D Shapes

Tablets (with keyboards) were set out before the lesson. Pupils started exploring tablets on arrival but were told to stop. Some did not obey or started again so Ibtisam threatened to remove the tablets. She used the whiteboard to explain shapes and angles but pupils continued to be distracted by tablets and several times were angrily reprimanded. At 11:07 Ibtisam gave a five-minute PowerPoint presentation, summarising input.

At 11:12 pupils were directed to open a Word document on the tablets but the bell rang almost immediately. Pupils were dissatisfied and continued working. Pupils talked together about how to complete the task and helped each other with technical issues including the virtual keyboard, which two girls found by accident and which was easier to use than the hardware keyboard. The teacher asked individual pupils to come forward and write answers on the whiteboard. The lesson ended at 11:30 (fifteen minutes late).

Lesson three (2D and 3D shapes)

Tablets were prepared before the lesson but placed in a cupboard rather than on tables. Ibtisam reviewed the previous lesson, demonstrated 3D shapes with physical objects and explained differences between flat and solid shapes.

At 10:50, Ibtisam asked pupils to fetch tablets and connect to the internet. Nobody was able to connect so Ibtisam gave verbal instructions, including the password, to the class. She and Mariam (the ICT teacher) moved between groups for 15 minutes whilst pupils talked loudly. As no connection was available, she opened a Word document on a laptop connected to the whiteboard and asked pupils to fill a table about the similarities and differences between a cone and a cylinder. One child needed to switch the laptop language from English to Arabic and another pupil helped. Several pupils then tried to change language on the tablets although they were not using the devices. At 11:15, pupils were asked to switch off the tablets but before doing so one child raised the tablet to take a photograph of the table on the whiteboard, demonstrating autonomy within the Object of the lesson.

Differences between the lessons

Four changes can be noted over the three lessons: set-up, timing, pupil satisfaction and teacher attitude. In the third lesson, tablets were not available until needed so pupils were not distracted. Less time was given to introductory activities and more to the tablet-mediated task so pupils did not show the dissatisfaction evident in lesson two, even though the task was again uncompleted. Although the pupils still talked loudly when they had problems and called for help, Ibtisam was more tolerant and did not become angry. She simply and quietly asked pupils to set the tablets aside and presented an alternative task.

Discussion

The study explored the impact of tablet computers on the Activity Systems of a rural primary school in Oman. In this setting, the teachers were inexperienced both in the profession and in using digital tools for learning. The pupils had little, if any, experience of using tablets either at home or in school and so unlike the students in Volk (2017), did not come to class with the preconception that tablets are for entertainment. However, when tablets were placed on desks before pupils entered the classroom, the children reasonably expected that they would be used throughout the lesson. Only one of the teachers in the study had substantial teaching experience and, despite her belief that she

lacked the knowledge to teach with digital tools, she was the only teacher who understood that pupils would expect to use the tablets from the start of a lesson.

The Contradictions between the teachers' understanding of how tablets should fit into their lesson plans and the children's view of the tablets was one of the factors that, unexpectedly, consumed class time. Another time-consuming factor was the difficulty in connecting to the internet. Vrasidas (2015) noted that teaching with digital tools could be more time-consuming than traditional methods and this proved to be the case here. Vrasidas (2015) also noted that teachers (in his case, in Cyprus) tended to lack access to good-quality digital resources. In the Omani school this was exacerbated by the lack of an internet connection – teachers could neither download additional apps nor could they use online resources in class. The teachers were resourceful in using the tablets without internet access, for example, when Khawla loaded scanned material from the textbook to the tablets. However, it is doubtful that this approach added value to the lesson beyond the increased enthusiasm of the pupils.

There was a Contradiction between the teaching culture of the school and the demands placed on teachers by the introduction of a new technology without training or support. This changed the way that the teachers worked – particularly Ibtisam, Safia and Mariam who operated as a team in the classroom. The tablets also had an impact on other staff who were not involved in the project but had to cover Mariam's classes. The three teachers worked together before and during the lessons.

The head teacher's vision was that tablets would make the pupils more autonomous in their learning. This did occur although not in the way that the headteacher had envisaged. The lack of internet meant that pupils were not able to seek out information for themselves. However, there was some evidence that pupils were starting to take more responsibility for their own learning as, for example, when one pupil used the camera to photograph the smartboard. The pupils also became more active participants in the Activity System of the classroom when it came to solving problems created by the tablets. This was particularly evident in Safia's second lesson when, instead of the planned focus (dinosaurs), the lesson became an investigation into how tablets could be connected to the internet. The teacher felt afterwards that the pupils had learned something about the process of scientific investigation even though the planned learning outcomes had not been achieved.

The project demonstrated that, as argued by Fullan (2008) and Wedell (2009), the attitudes and abilities of participants are crucial in educational change. Khawla's reading lesson was successful because her considerable classroom experience enabled her to predict how the children would respond to the tablets and to plan for this, Safia's science lesson was successful because she was

able to accept the pupils as partners in solving the problem of connecting to the internet. The study shows that the factors that facilitate effective use of technology are complex and include not only motivational constructs such as technology acceptance but also situational understanding of the Activity System and flexibility when elements of the System change.

This study demonstrated the challenges of using tablets in a school without good internet access. The choice of Tool was significant in that the Lenovo Windows tablets came with pre-installed software that could be used offline and also allowed the use of USB sticks to transfer files so they were not entirely reliant on direct downloads. Although this was not planned, the outcomes might have been different had the school been supplied with additional iPads, which are more internet dependent, rather than the Windows ThinkPads.

It is difficult to categorise impacts of the implementation as either positive or negative. For example, the difficulty with connecting to the internet could be seen as negative but it had positive effect in that class as it enabled pupils to practice solving problems through trial and error.

Conclusions

When tablets were introduced into a rural primary school in Oman there were impacts on every part of the Activity System. This is consistent with Activity Theory, which argues that all elements of an Activity are interrelated and that a change in any individual aspect affects all components. Tablets were a new type of Mediating Artefact and changed the Community, Rules and Division of Labour. In at least one instance there was a complete change in the Object of the Activity.

The first impact on the Rules happened even before the tablets arrived in the school, when the head teacher approached the MoE rather than the local office. The introduction of the tablets was not straightforward, especially with regard to the internet connection needed for full use of the devices. However, this was one of the greatest catalysts for change in that it allowed the pupils to share the Labour of getting the tablets online and to do this they needed to change the Rules about sitting quietly in their seats.

Teachers were nervous about introducing the tablets and so, they started working collaboratively – a change in Rules, Community and Division of Labour. For both pupils and teachers, the tablets became a locus of social interaction – which neither group had previously experienced in the classroom. Teachers also demonstrated flexibility with regard to the Rule about lesson time, sometimes allowing pupils to continue after the lesson had officially finished.

The main changes seen here – collaborative teaching and greater pupil involvement – might be considered normal practice in a more urban or affluent setting. However, the remote, rural and

conservative context of this school affects not only the quality of services but also the ways that people think, how they raise their children and how they want their children to be educated. Teachers commuting along unpaved mountain roads see the school as a short-term posting rather than a long-term commitment.

This was a small-scale, time-limited project. Further research is needed to determine whether a change such as introducing tablets has long-term impact on classroom practice and if there are related effects in the homes of pupils. Further research is also needed to determine whether the tablets have a long-term impact on pupil learning.

The teachers needed to work together as a mutually supportive network, especially as little assistance was available from outside the school. At times, other teachers had to cover classes that should have been taken by project participants. It would thus have been difficult to introduce tablets across the school without this pilot project. For schools planning similar innovations, this study demonstrates the need for a small-scale introductory stage and for more support than might be anticipated.

This school would not have been an obvious choice for a Ministry wanting to trial new technologies due not only to lack of infrastructure but also because it is too remote for regular official visits. Nevertheless, the vision and determination of the headteacher meant that this unlikely school became a test site for educational innovation. The significance and originality of this research lie in demonstrating, how, even with few resources, regular floods and inexperienced teachers, educational innovation can be introduced successfully and can lead to changes in practice. The Activity Theory analysis shows exactly where those changes are situated thus demonstrating how the rigorous application of Activity Theory can contribute to the understanding of educational change and provide a starting point for further development.

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