A CASE STUDY OF A SECONDARY MATHEMATICS TEACHER'S CLASSROOM PRACTICE WITH WEB-BASED DYNAMIC MATHEMATICAL SOFTWARE

Ali Simsek

UCL Institute of Education, London, UK

ali.simsek.15@ucl.ac.uk

The broad purpose of this research is to gain a holistic understanding of teachers' integration of digital technology into classroom practices. This research examined a case of a secondary mathematics teacher's classroom teaching in England in which a web-based dynamic mathematical tool, the Cornerstone Maths software, was used in the teaching of geometric similarity. One of the contemporary theoretical frameworks, the Structuring Features of Classroom Practice (Ruthven, 2014), guided my research with its five different components related to the integration of new technologies into classroom practice. Classroom observation and semi-structured post-lesson teacher interview was employed for data collection. The analysis shows how the teacher used the dynamic mathematical software to teach geometric similarity in terms of five underlined features of classroom practice within the framework.

Keywords: secondary mathematics teachers, classroom teaching practice, dynamic mathematical technology, the SFCP framework

INTRODUCTION

Over the last two decades, the mathematics education community has paid increasing attention to the integration of digital technology into classrooms, aiming to exploit the full potential of technological developments into mathematics pedagogy. To date, there has been a considerable amount of research focusing on digital technology integration in the mathematics classroom. While some studies have concentrated on the impact of particular technologies on students' understanding of mathematical ideas (Saha, Ayub, & Tarmizi, 2010), others have focused on the interactions between teachers and students, and technological tools (Mason, 2014). Due to the fact that technology integration is a complex process that encompasses various relations that are not easily describable and analysable, researchers have started to focus on teachers and their integration of digital technologies into classroom practice (Clark-Wilson et al., 2014). More recently, there appears a need for further research investigating holistically the process of incorporating digital mathematical tools into classroom practice so as to both develop a more comprehensive understanding of the process of integration and improve the emergent theoretical frameworks (Artigue, 2010).

In this sense, through a contemporary theoretical framework (the Structuring Features of Classroom Practice) (Ruthven, 2014), my research [1] seeks to develop a better comprehensive understanding of dynamic geometry software (DGS) integration into classroom teaching, in respect of how a new web-based dynamic tool, the Cornerstone Maths (CM) software, interacts with various features of classroom practice in the hands of a secondary mathematics teacher teaching geometric similarity. Therefore, this present study aims to address the following research question:

- How does a secondary mathematics teacher's integration of dynamic mathematical technology into classroom teaching to promote students' understanding of geometric

similarity interact with the five factors of classroom practice identified in the SFCP framework?

THEORETICAL FRAMEWORK

The SFCP framework was chosen as the most appropriate theoretical model for this study as it has potential to help comprehensively analyse the teacher's classroom practice using digital technology through its productive lens that focuses directly on five structuring components of classroom practice, namely: working environment, resource system, activity structure, curriculum script, and time economy.

Since this framework promises "a system of constructs closer to the lived world of teacher experience and classroom practice" (Ruthven, 2012, p.100) that other frameworks mostly neglect, it is particularly helpful in elucidating the gap between the potential of digital technology use outlined by research and the reality of teachers' use of digital technology in classroom practice and also in understanding how and why mathematics teachers use digital technology in classroom teaching to support students' understanding of mathematics (Bozkurt & Ruthven, 2016). However, I should note a limitation with regard to the SFCP framework, which is that the ideas which lead to the development of the components of the framework partly emanated from research studies which are non-specific to mathematics education. Despite this fact, I employed this framework to guide my research.

Working Environment

The incorporation of digital technology into teaching practice makes a number of demands on teachers in working environments, which involve changes of location and physical layout, modification of classroom organisation and routines. Teachers are required to make sure that the general technical infrastructure available in the working environment functions properly, that students, tools and materials are wisely arranged and that students are seated appropriately for individual and group work.

Resource System

The incorporation of digital technology into teaching practice might lead to difficulties for teachers in terms of building a coherent resource system of compatible didactical elements. Teaching with digital technology thus entails establishing suitable techniques and norms and handling double instrumentation, where technologies already in use can efficiently perform alongside new digital technologies. The employment of new digital technologies also calls for an environment in which students are allowed to familiarise themselves with core techniques and to explore a wider range of technical possibilities.

Activity Structure

The incorporation of digital technology into teaching practice presents some changes in the format of activities and creates new classroom routines. Teachers are therefore obliged to develop new structures to encourage interaction between students, teacher, and new technological tools and to identify appropriate (re)specifications of roles, in order to exploit new technological resources.

Curriculum Script

The incorporation of digital technology into teaching practice requires teachers to develop a curriculum script through a loosely ordered model of aims, resources and activities for teaching a particular topic, the treatment of potential emergent issues, and alternative paths of action.

Time Economy

The incorporation of new digital technology into teaching practice has implications in terms of the use of time in the classroom since there is a time cost related to the innovation itself (Ruthven, 2014). That is why, in order to reduce the "time cost" in classroom practice, teachers are required to recalibrate their timing for digital technology-enriched classroom practice.

RESEARCH CONTEXT

The qualitative case study approach was employed in this research to gain a comprehensive understanding of how the teacher uses a particular dynamic technology in classroom teaching. This method enabled me to understand the case by highlighting why things happen as they do, and allow me to interpret findings through "an in-depth investigation of the interdependencies of parts and of patterns that emerge" (Sturman, 1994, p.61).

The Cornerstone Maths project

The present study concerns with one of the Cornerstone Maths (CM) project teachers' use of the CM software in the actual classroom teaching. The project was devised at the University College London Institute of Education in England. This multi-year project aims to raise mathematics teachers' awareness of the potential benefits of digital technologies to ensure that these technological tools are routinely employed by them in the classroom for effective teaching and learning of mathematics. It covers three web-based dynamic units pertaining to "hard-to teach and learn" topics within Key Stage 3 of England's new National Curriculum (geometric similarity, linear functions, and algebraic patterns and expressions). The project provides secondary mathematics teachers with professional development alongside resources such as web-based dynamic mathematical software, student workbook and teacher guidebook (see Clark-Wilson & Hoyles, 2014 for more detailed information about the CM project).

The term CM software is used in this paper to refer to a new DGS tool. This software was designed as web-based DGS (Clark-Wilson, Hoyles, & Noss, 2015), drawing on the design affordances of DGS. Apart from common functionality with DGS (e.g. dragging, measuring), the CM software also offers other functionalities such as the ratio checker by which students can compare the ratios of the lengths of the corresponding sides of two geometric figures to determine if the figures are mathematically similar.

Participant

A secondary mathematics teacher from the active community of teachers formed by the CM project appeared to represent a suitable case for this study because those have started to integrate the CM software and its materials into their classroom practice after involving in the professional development course provided. A secondary mathematics teacher who has experience in teaching using digital technology was identified for my case study research through the project coordinator, Alison Clark-Wilson. Having agreed to participate in my research, the teacher scheduled the teaching of geometric similarity with the CM dynamic tool within his mathematics classroom setting during the school term (2015-2016). I will call the teacher as Joseph (pseudonym name) here forth.

Joseph was a reasonably experienced teacher in terms of teaching mathematics with digital technologies. He had 4-5 years of mathematics teaching experience in a secondary school in London. He was also responsible for developing schemes of work and lesson plans in line with the curriculum objectives of the school. He was following a Masters' degree in mathematics education especially to improve his competencies in exploiting the mathematical fidelity of available digital

technologies. This indicates that Joseph is rather enthusiastic about benefiting from digital technologies to enhance students' understanding of mathematics.

Data Collection

Classroom observations took place in times scheduled in advance with Joseph in his classroom (two separate lessons in different days). An observation protocol was designed based on five elements of the SFCP theoretical framework and employed in the research. My primary focus of observation was on Joseph's integration of the CM software into his classroom teaching rather than on his students. He was informed of the focus of the observation. The audio recorder was placed somewhere in the classroom to be used as support in my writing up of some aspects of the observations.

Following the observations, semi-structured post-lesson interview was conducted with Joseph. An interview protocol with more and less structured questions was developed according to each of the components of the SFCP framework to ensure the questions covered all of the components. The interview lasted about 40 minutes and was digitally audio-recorded. A laptop computer was also used during the interview to enable Joseph to articulate his thoughts on the CM software activities in the dynamic environment.

RESULTS

The findings are presented according to five structuring features of classroom practice, namely: working environment, resource system, activity structure, curriculum script, and time economy, respectively.

Working Environment

In the two sessions, which I observed, Joseph was covering for his colleague who was on maternity leave at the time. The lessons took place in a classroom regularly used by his colleague. In the class, there was an interactive smart board along with an ordinary whiteboard and teacher's main computer. There were rows of tables and chairs at which students sat. The students used laptops and iPads at their tables, with each device being shared by two students.

In the interview, the teacher, Joseph, stated that the U-shaped classroom layout is the best layout for him in terms of the provision of computers. He was, however, not able to teach in the computer room where computers are placed in a U-shape, since the computer room had been booked by his colleague. Joseph claimed that the U-shape classroom arrangement allows teachers to better monitor students' screens and facilitate group work with the students in the middle of the classroom.

> I would like to have computers all-round the sides. It means that I can see more easily what is on their screens from where I am standing. I think that is the most flexible arrangement because groups, they can sit in the middle. We can do group work and then we go away and use the computers and then come back to the middle.

This result echoes Bozkurt and Ruthven's (2015) findings in relation to the advantages of a U-shaped computer room.

In the first lesson, the students were provided with laptops; however, in the second lesson, Joseph preferred to use iPads instead of laptops due to the layout of the classroom. In the interview, he reported that since he was not able to monitor the screens of the students' laptops during the whole-class lesson instruction in the first lesson, he had to either circulate around the classroom or ask the students to lower the screens of their laptops. He emphasised that, in the first lesson, he could not

ask the students to push the screens of their laptops down, as they would need to log in again, so he decided to use iPads in the second lesson.

> With the iPads, what I like is that you can just put the face down because what is difficult with the students is getting them not to look at the screen and to focus on you when they have these devices. So putting it face down as a way of moving that...which you cannot do so much with laptops because if you lower the laptop screens, you have to log in again. It takes a lot of time so iPads are better from that perspective.

This finding indicated that teachers need to develop fall-back strategies to deal with possible contingencies in technology-integrated classrooms. Joseph turned to the use of iPads rather than laptops for the second lesson, as iPads can be used in a way that made them less distracting for the students especially during plenary discussion. Given that there is a strong connection between confidence in using technology in the classroom and the teachers' experience which supports the use of the pedagogical use of the digital technology (Thomas & Palmer, 2014), it can be claimed that Joseph's experience provided him with the flexibility of choosing the most suitable device at the time.

Resource System

Joseph appreciated both the CM dynamic mathematical software with the structured twelve dynamic investigations with regard to geometric similarity and its two ready-to-use booklets: one was for the students and included tasks and instructions on how to engage with software-based tasks focusing on geometric similarity, and the other was for teachers and contained a wide range of information involving some implementation suggestions related to the tasks and possible student answers. Since he found CM resources sufficient, he did not adapt any other resources for his lessons.

According to Thomas and Palmer (2014), there is still considerable need for classroom resources delivering good ideas for teachers to incorporate into classroom practice. Joseph's case suggests that providing more reliable access to technological resources might be important in terms of promoting their use by teachers in the classroom.

The focus of Joseph's lessons was on determining whether an image is the enlargement of an original shape through numbers and using a scale factor. He took advantage of the dynamic software and the booklets throughout the lessons. For example, in light of the instructions in the booklets, the students were asked to watch an animation, which aimed to enable them to explore what copies are always mathematically similar to the original object by pausing the animation to rotate and translate the shapes to investigate. They were also encouraged to use dynamic measurements and comparisons and the ratio checker. The students used the CM software to discover some ideas, such as "the relationship between mathematically similar shapes", "the scale factor" and "the relationship between corresponding sides", formulating some conjectures and then checked and verified them in the dynamic environment. During his reflections, Joseph mentioned those outcomes as benefits of using CM resources as follows:

> It is the kind of discovering for themselves if the scale factor of two is being doubled or the scale factor of three is being tripled and that actual half [inaudible]. You know, they have constructed the understanding, which I think research shows that this is much more powerful than we are just telling them. Conjecturing both what the impact of scale factor was and then being able to check it and verify it for themselves was, for me, the key aspects of the lessons, which was purely driving by their interaction with the mathematical world.

The extent to which teachers make students use digital technologies depends on how teachers view them in terms of advancing students' understanding (Ruthven, Hennessy, & Deaney, 2008). Joseph's experience of teaching with digital technologies and his awareness of the potential of them to enhance students' understanding led him to conduct the lessons in this manner.

Joseph also showed an awareness of the difficulties that the students might encounter when interacting with the CM software investigation activities. At the beginning of the two lessons, he demonstrated some technical features of the software and how the tasks on the booklet should be used along with the dynamic software; i.e. how the lengths of the objectives could be measured and coloured or how the measurements of corresponding sides could be dragged. In the interview, he stated that since he had experienced a problem using the measurement and colouring buttons, he underscored a few technical features for students before starting to teach the main content.

Overall, it can be said that the case indicates that the teacher has not yet integrated CM resources into his resource system. The CM materials are still stand-alone resources for the teacher, which is not surprising because he has only used them in his teaching practices a few times.

Activity Structure

Joseph broke down his lessons roughly into three sections. In the first section, before introducing the tasks, the students were asked to explain what they had learnt in the previous lessons. His aim was to remind the students of the prerequisite knowledge needed for that day's lessons. In the second section, he adapted a sequence of the activities, which allowed the students to discover particular objectives pertaining to the topic in the CM software environment in pairs, through "predict-test-explain" sequences (Ruthven, 2014, p.387). Throughout most of this section, the students used the web-based dynamic tool by engaging with the investigation activities in the booklet. However, to create a whole class discussion, Joseph sometimes asked the students to stop using the software.

In his reflection on the lesson, Joseph stated that when he gives lessons in the computer room, he often selects a couple of students' work to share with the whole class on their screens. He feels that this method is quite powerful to draw the students' attention to mathematical facts.

> In my other [computer] room, what is possible to do is to pick one student's screen and put it up on front of everybody's screen which is really cool because students are more interested in another student's work. They really care more. So, that is quite a powerful thing to do.

He also emphasised the fact that allowing students to work in pairs in the CM dynamic environment helped them learn from one another.

> Having them in pairs like this, I think, helps them [overlap] by making them explain and then one pair can be slower and they can learn from the neighbour. I guess the software provides hints for them when they have a disagreement, they can use the software to check...always check and see the results.

In the third section, the key ideas raised by the lessons were highlighted by Joseph by asking several probing questions to the students. In the students' responses, he paid attention to the appropriateness of the mathematical language they used, to support the development of their mathematical language.

Curriculum Script

Joseph did not prepare a specific lesson plan demonstrating his curriculum script (CS) for these lessons. The classroom observations and post-lesson interview helped me sketch out Joseph's CS on the topic of geometric similarity.

He told that he developed his lesson plan in line with the guidance provided by the CM teacher booklet. The booklet, for example, provided him with the key ideas that students should develop an understanding of in the lessons such as "the heights and the widths of mathematically similar rectangles are related to a common multiplier" and "scale factor is the multiplier by which the lengths in the original shape result in the enlargement". Additionally, the booklet indicated where students might get confused about geometrical facts, for instance, "some pupils may confuse height and width, which does not necessarily affect the relationship between the shapes, but this approach might be confusing in discussion with the whole class. If this happens, you can briefly mention the role of conventions in mathematics".

In his reflection on CS, he drew attention to why such a booklet is useful for helping teachers develop a lesson plan.

> Adapting and using these things [the CM software and the booklets] is quite difficult. And, I mean, teaching in London schools is a lot of pressure to get the results [and to] get through the curriculum. So what is good about the Cornerstone [Maths booklets] is that they help me a lot like think how to use these table things [a part of an activity in the booklet] effectively and I guess the bridging activities are in the big club, you know the focus of attention is on the right things. The hard thinking has already been done for teachers.

This quotation implies that incorporating new dynamic digital technologies into their curriculum script (CS) might be a challenge for teachers for two reasons. The first reason is that teachers are required to teach all the topics mentioned in the national curriculum over the school term, which means that they do not have enough time to devote to designing their CS around digital technology tools. Second, the schemes of learning (SOL) developed by schools do not generally take the use of technologies into consideration, which leads them to have difficulty in integrating digital tools and related resources into lessons. Thus, curriculums should be designed with the use of digital technologies and resources in mind, thus providing teachers with "explicitly designat[ed] topics, problems or investigations to be delivered using specific educational software" (Sinclair et al., 2010, p.67).

Overall, according to Joseph, the students were able to gain an understanding of hard-to-grasp ideas of geometric similarity through the dynamic environment, which the CM software offers, and with the guidance of the teacher booklet. This finding is in agreement with those obtained by Ruthven (2009) regarding the accuracy, speed and manipulative facilities of dynamic software in support of students' explorations of various cases.

Time Economy

One issue arising from Joseph's lessons was that organising the students' access to the web-based CM activities took up a considerable amount of the available teaching time. Joseph asked the students to open the CM web-based activities by typing the CM website address (http://cornerstonemaths.co.uk/) on the board when the software needed to be used at the beginning of the lessons. The students then spent some time accessing the dynamic activities. In the interview, Joseph referred to this issue, observing that as well as getting the technological devices set up, having to choose between student A or B and teacher A or B [2] before accessing the CM activities was time-consuming and confusing for the students.

> I think, one thing [which] is annoying with the CM software is that you have to choose student A, and teacher A. That seems to be confusing to them [the students], because that does not seem to be anything.

His well-established lesson routines also meant that his lessons started, proceeded, and ended in a timely and purposeful manner. He devoted a reasonable amount of time to familiarising the students with the core technical software features that they may need. This enabled him to optimise the didactic return on time investment during the students' interaction with the software.

Furthermore, according to Joseph, the feedback provided by the CM software facilitated the students' learning and reduced the time he had to spend for revising the students' work.

CONCLUDING REMARKS

Through the Structuring Features of Classroom Practice (SFCP) framework, this study investigated a case of classroom practice of a secondary school teacher having experience in using digital technology in the teaching of mathematics.

The key finding related to the working environment was that the teacher valued the U-shape classroom arrangement, as it allowed him to monitor students' screens better; thus facilitating classroom management, and offering the space to conduct group work without using technology. In terms of resource system, the study revealed that teachers may need ready-to-use resources "with good ideas" to assist them to effectively plan and conduct their lessons since they do not have time to prepare such resources themselves for use in technology-embedded lessons. The teacher in this study used a structured activity format and spent time on the students' own discovery of facts in relation to geometric similarity through the use of dynamic activities and on maintaining a balance between individual and group work. Additionally, the teacher mentioned various benefits of using the CM software: the software enabled the students to discover geometric facts through positing and testing conjectures and provided feedback. Thus, it increased the speed of learning by focusing the students' attention on the geometric relationships involved and enabling teachers to devote more time to making students more active.

In terms of the conceptual framework used in this study, it assisted me in analysing the data by making particular aspects apparent and workable. However, I sometimes struggled to decide under which component a piece of data should be examined. Even though this struggle could be caused by the intertwined nature of teachers' classroom practice, I believe that the components of this framework need to be clarified further to avoid the danger of providing researchers with "a coarse-grained tool" (Ruthven, 2014, p.380).

In terms of suggestions for further research, it would be beneficial to carry out longitudinal systematic studies, which explore the use of digital technologies by mathematics teachers, who have varying levels of experience in using technology to teach, because teachers' confidence and competence can influence how teachers use digital technologies in classroom practice (Bretscher, 2014). It would also be helpful for researchers to employ the combination of several frameworks which have different theoretical lenses in parallel, to carry out a much deeper and fruitful investigation of teachers' classroom practice using digital technologies.

Notes

1. This paper was developed based on a part of the author's Master's thesis at the University College London (UCL) Institute of Education.

2. At the beginning, in order to access the CM software activities, students need to select the group of their teacher and then their names.

REFERENCES

Artigue, M. (2010). The future of teaching and learning mathematics with digital technologies. In C. Hoyles, & J.-B. Lagrange (Eds.), *Mathematics Education and Technology-Rethinking the Terrain: The 17th ICMI Study* (pp. 463-475). New York: Springer.

Bozkurt, G., & Ruthven, K. (2015). Expert and novice teachers' classroom practices in a technological environment. In K. Krainer, & N. Vondrová (Ed.), *CERME9 Proceedings of the Ninth Congress of the European Society for Research in Mathematics Education* (pp. 2319-2325). Prague, Czech Republic: Charles University in Prague, Faculty of Education and ERME.

Bozkurt, G., & Ruthven, K. (2016). Classroom-based professional expertise: A mathematics teacher's practice with technology. *Educational Studies in Mathematics*, 94(3), 309–328.

Bretscher, N. (2014). Exploring the quantitative and qualitative gap between expectation and implementation: A survey of English mathematics teachers' uses of ICT. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The Mathematics Teacher in the Digital Era: An International Perspective on Technology Focused Professional Development* (pp. 43-70). Dordrecht: Springer.

Clark-Wilson, A., & Hoyles, C. (2014). Blended learning and e-learning support within the Cornerstone Maths Project. In K. Maaß, B. Barzel, G. W. Törner, E. Schäfer, & K. Reitz-Koncebovski (Ed.), *Proceedings of the Conference hosted jointly by the project mascil (mathematics and science for life) and the German Centre for Mathematics Education (DZLM)* (pp. 158-166). Essen: WTM.

Clark-Wilson, A., Aldon, G., Cusi, A., Goss, M., Haspekian, M., Robutti, O., & Thomas, M. (2014).The challenges of teaching mathematics with digital technologies – the evolving role of the teacher. In P. Liljedahl, C. Nicol, S. Oesterle, & D. Allan (Eds.) *Proceedings of the Joint Meeting of PME 38 and PME-NA 36* (Vol. 1 pp. 87-116). Vancouver, Canada: PME.

Clark-Wilson, A., Hoyles, C., & Noss, R. (2015). Scaling mathematics teachers' professional development in relation to technology -probing the fidelity of implementation through landmark activities. In K. Krainer, & N. Vondrová (Ed.), *CERME9 Proceedings of the Ninth Congress of the European Society for Research in Mathematics Education* (pp. 2333-2339). Prague, Czech Republic: Charles University in Prague, Faculty of Education and ERME.

Mason, J. (2014). Interactions between teacher, student, software and mathematics: Getting a purchase on learning with technology. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The Mathematics Teacher in the Digital Era: An International Perspective on Technology Focused Professional Development* (pp. 11-40). Dordrecht: Springer.

Ruthven, K. (2009). An investigate lesson with dynamic geometry: A case study of key structuring features of technology integration in classroom practice. *Proceedings of the Sixth European Conference on Research on Mathematics Education*, (pp. 369-378).

Ruthven, K. (2012). Constituting digital tools and materials as classroom resources: The example of dynamic geometry. In G. Gueudet, B. Pepin, & L. Trouche (Eds.), *From Text to "Lived" Resources: Mathematics Curriculum Materials and Teacher Development* (pp. 83–103). New York: Springer.

Ruthven, K. (2014). Frameworks for analysing the expertise that underpins successful integration of digital technologies into everyday teaching practice. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The Mathematics Teacher in the Digital Era: An International Perspective on Technology Focused Professional Development* (pp. 373-393). Dordrecht: Springer.

Ruthven, K., Hennessy, S., & Deaney, R. (2008). Constructions of dynamic geometry: A study of the interpretative flexibility of educational software in classroom practice. *Computers & Education, 51*(1), 297-317.

Saha, R. A., Ayub, A. F., & Tarmizi, R. A. (2010). The effects of GeoGebra on mathematics achievement: Enlightening coordinate geometry learning. *Procedia Social and Behavioural Sciences, 8*, 686-692.

Sinclair, N., Arzarello, F., Gaisman, M. T., Lozano, M. D., Dagiene, V., Behrooz, E., & Jackiw, N. (2010). Implementing digital technologies at a national scale. In C. Hoyles, & J. B. Lagrange (Eds.), *Mathematics Education and Technology-Rethinking the Terrain: The 17th ICMI* (pp. 61-78). New York: Springer.

Sturman, A. (1994). Case study methods. In J. P. Keeves (Eds.), *Educational Research, Methodology, and Measurement: An International Handbook (* 2nd ed.) (pp. 61-66). Oxford: Permagon.

Thomas, M. O., & Palmer, J. M. (2014). Teaching with digital technology: Obstacles and opportunities. In A. Clark-Wilson, O. Robutti, & N. Sinclair (Eds.), *The Mathematics Teacher in the Digital Era: An International Perspective on Technology Focused Professional Development* (pp. 71-90). Dordrecht: Springer.