Comparison of Chinese and English mathematics teachers' technology use: An analysis from a sociocultural perspective

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Recent research shows that culture affects how individuals think and act. This case study aimed at investigating mathematics teachers' use of technology in their lessons, and to what extent this is related to their cultural experiences of learning. The data was generated from four Chinese and four English teachers through semi-structured interviews where detailed questions are formulated ahead of time. Content analysis of socio-cultural aspects in NVivo was used for the data analysis. The socio-cultural theory was particularly chosen as it helps us to examine how ideas and values are passed down to future generations. The results showed that although the previous teaching experience of Chinese and English mathematics teachers is similar in their group, a Chinese teacher's learning experience is quite different from an English mathematics teacher. In conclusion, these mathematics teachers teach as they are taught. Hence, we suggest further research investigating why this might be the case.

Keywords: case study; in-service mathematics teachers; sociocultural theory; technology use

Introduction

Mathematics education has taken a new direction as education becomes more and more technology-oriented. With recent development in educational tools, mathematics education is transforming from traditional teaching and practice methodology into a technology-integrated structure that focuses on linking mathematics to real-world concepts, considering the socio-cultural development of the individual, and helping to develop mathematical skills such as critical thinking and problem-solving (Killilea et al., 2014; Ministry of National Education, 2022).

A significant portion of the existing research on the role of technology in mathematics education has focused on the effects that technology may have on curriculum content or student learning (Kiru, 2018). On the other hand, there has been limited attention to the relationship between technology use and pedagogy, particularly in relation to impacts on mathematics teachers' professional development.

Some research on mathematics teachers' use of technology has included the following topics (Goos, 2005; Kiru, 2018; Saralar-Aras, 2022):

- Skills and previous experience of teachers in using technology;
- Time and opportunities to learn new technologies;
- Access to the hardware (computers and calculators), software, and computer laboratories;
- Availability of appropriate teaching materials;
- Technical support;
- Support from colleagues and school administration;

- Curriculum and assessment requirements with technology (e.g., online attendance, online quizzes) and how teachers interpret these for students;
- Perceived technology-use to develop different mathematical abilities of students;
- Knowledge of how to integrate technology into mathematics teaching; and
- Beliefs about mathematics and how it is learned with technology.

As can be seen above, research on teachers' use of technology has barely taken into account the sociocultural structure of mathematics teachers' technology experiences. According to influential mathematics researchers, the reason for this is that using technology in mathematics education is under-theorised (e.g., Kearney & Maher, 2012; Lerman, 2001). These scholars argue that the field lacks coherent conceptual frameworks which are able to address the complexity of teachers acting in sociocultural contexts.

Recent reviews of research in mathematics teacher education have emphasised the importance of the social, cultural and institutional dimensions of how teachers learn to use technology and implement various technological activities in their lessons (Kiru, 2018; Killilea et al., 2014). Lerman defined sociocultural approaches to mathematics teaching and learning as involving "frameworks which build on the notion that the individual's cognition originates in social interactions…and therefore the role of culture, motives, values, and social and discursive practices are central, not secondary" (2001, p.4).

Sociocultural perspectives on learning emerged in the early twentieth century as a result of Vygotsky's work. He and his followers proposed that teachers' learning is better understood as increasing participation in sociocultural practices develops their identities as teachers. Vygotsky (1978) introduced the term "Zone of Proximal Development (ZPD)" to describe how an individual's cognition originates in social interaction. Vygotsky claimed that the ZPD occurs when a child's interaction with an adult or more capable peer awakens mental functions that have not yet matured, and thus, lies in the region between actual and potential developmental levels. In a teacher education context, the ZPD can be thought of as a symbolic space where a novice teacher's emerging skills are developing under the guidance of more experienced people. That is, the socio-cultural structure of the countries in which teachers study and/or work deeply affects teachers' professional beliefs, values and attitudes. Therefore, this situation affects mathematics teachers' perspectives on the use of technology in their lessons (Goos, 2005; Kiru, 2018).

Considering the socio-cultural context of the education of mathematics teachers, the purpose of this case study was to look into how Chinese and English mathematics teachers use technology in their classes and how this relates to their socio-cultural learning experiences.

Methods

The design of this study is a case study. Case studies are studies in which one or more cases are examined in-depth with most of the time qualitative and sometimes mixed methods (Cresswell, 2003; Yin 2012), and the perceptions and views of individuals involved in this situation are reflected (Gall et al., 2007, Yin, 2009). In this study, the case was the technology experiences of four Chinese and four English in-service mathematics teachers who were teaching in English colleges.

Participants

The participants of the study were eight mathematics teachers, who were teaching in colleges in England (16- to 18-year olds). The characteristics of the participants are presented in Table 1.

Table 1. Information about participants

Participant codes	C1	C2	C3	C4
Gender	F	M	M	F
Experience (in years)	10	5	3	2
Pseudonym	E1	E2	E3	E4
Gender	M	F	F	M
Experience (in years)	10	8	24	10

As seen in Table 1, a total of eight in-service mathematics teachers were interviewed within the scope of the study. Four of the teachers were male (two Chinese and two English) and four were female (two Chinese and two English). The teacher with the lowest experience had two years of teaching experience, and the teacher with the highest experience had 24 years of teaching experience.

Data collection tools

The data were collected using open-ended semi-structured interview questions. In this context, three demographic questions were asked. These were their genders, teaching experience, and educational backgrounds). Other questions were about the teachers' previous experiences with technology use in classrooms during teacher training, and their own use of technology in their classrooms.

Data analysis

The data were analysed by the content analysis in NVivo. The audio recordings of the interviews were transferred to the computer environment and a transcribed. In the second stage of the analysis, the data were coded. In the light of the codes that were defined in the third stage, the data were analysed using socio-cultural theory. The socio-cultural theory was chosen specifically because it allows us to investigate how ideas and values are passed down to future generations (Berk, 2007; Mahn & John-Steiner, 2012). Results were presented in two themes: teachers' previous experiences with technology use from their own education, particularly during teacher training, and their own use of technology in their classrooms.

Findings

The results showed that all participating Chinese mathematics teachers reported learning through videos/Internet sources and Office tools during teacher training. The following is an example quote from the interviews, which shows how participating Chinese teachers experienced technology during their teacher training:

> C4: Integrating technology was an integral part of my education. It [technology integration] really depends on the schools you are studying in China, which part of China you are studying, whether it is a rural area or an urban area, also who is teaching to you et cetera. I studied in a big city, hence we used computer rooms, and our instructors used various technologies, examples from the Internet, and Office tools mostly, Office Word and PowerPoint. We also had courses that include technology [during teacher training] where we used some technological assessment tools like Mentimeter.

These teachers then mostly chose to use similar technologies, only one of them named an alternative technology, which was Mentimeter. The same teacher, quoted above, for example, said the following when it came to how she integrated technology into her classrooms:

> C4: First of all, in my lesson, I like to use videos very much. I embed these videos into my PowerPoint presentations so there is no search on the Internet to distract my students. I believe that integrating such videos is very helpful and gives students a great sense of realistic education. Sometimes they are time-consuming but I still like videos. Moreover, I use Mentimeter-like programs; again, they can be time-consuming to create but students enjoy answering such questions using technology, and I find them quite useful, especially at the end of the lessons.

Whilst this was the case for the participating Chinese mathematics teachers, English mathematics teachers who learned with statistical tools and dynamic geometry environments (DGEs) during their teacher training preferred to integrate alternative technologies, e.g., Autobot, Mr Carter, and GeoGebra. The following is an example that presents the general view of technology integration experienced by participating English teachers in their educational background:

> E1: In my undergraduate, when we were doing the dissertation, we had to use our statistical or technological software to help us analyse the data. Also, you know, the lecturers used to use PowerPoint videos, used to use an online platform, Blackboard Learn Yeah. So that kind of stuff at undergraduate level at master's level. Sort of statistical software and tools. You have MATLAB. If you use all those. And in terms of the PGCE, it was more they're showing us, you know, like, GeoGebra, it's a website and a free website. It's got a graphing tool so you can show students that instead of the drawing is a lot more accurate. And it causes a lot of discussion because you can very quickly, you know, within seconds, five, six crops and say, okay, what's happening here? That kind of stuff? And so yeah, it's a lot more, I would say, as technology advances, it's a lot easier.

As seen from the quote, different from participating Chinese mathematics teachers, English teachers experienced a greater number of educational tools in their educational backgrounds, including teacher training. Then, they used a greater number of technologies in their classrooms similar to their instructors. For example, E1 said the following about her technology integration into her classrooms:

> E1: So I mainly use GeoGebra for graphs, any kind of graphs, you know, like a quadratic graph, the cubic graph. But it's really important for stuff like, you know, this is x squared, this is minus x squared. What's happening? You know, here it's a minimal point, here. It's the maximum point. These are reflections, that kind of stuff. I also use Mr Carter a lot for algebra. You need to make a login. It's 39 pounds for the year. But what's really nice here has different questions. So if I show you say you're teaching factorization, for example. And say like, sometimes you're teaching a topic and the students understand you very well or they don't. Yeah, so you have like, it has different questions like bronze, silver, and gold as the hardest. So this will be something like this x squared plus five x plus six and then you know that factorise two x plus two, x plus three. For example, this one will be like two x squared plus six x squared [shows the screen]. Sometimes you propose something, and then students find it very easy. So this is a quick way you can just put it on the board [change the level to silver or gold] and you know, it saves you history.

Discussion

A research study was conducted on the ways in which Chinese and English mathematics teachers use technology in their classrooms and how this is related to their sociocultural learning experiences. The results showed that Chinese and English

mathematics teachers use and learn technological tools intensively during teacher education. This could be because of the ZPD as the pre-service teachers learnt from their better peers/ experts (instructors) as Loughran (1997) reported in their chapter. Another result found in the present study was that Chinese mathematics teachers reported learning through videos/Internet resources and Office tools during teacher training, while English mathematics teachers said they preferred to integrate alternative technologies, e.g., Autobot, Mr Carter, and GeoGebra with statistical tools and dynamic geometry environments. Another result obtained was that English mathematics teachers more frequently use technological tools in lessons compared to Chinese mathematics teachers and they tend to use different kinds of technological tools in mathematics. These support the previous studies which reported that there is a stress on teaching with technology in England, and that it was observable in teachers studied in England and teaching elsewhere (e.g., see Teo et al., 2018). This could also be related to the English mathematics programmme's technology emphasis (Department for Education [DfE], 2013a, 2013b). From the sociocultural theory perspective, it is seen that socio-cultural structures in China and England shaped participating teachers' beliefs about technology and its role in mathematics education, and possible connections in mathematics lessons.

Conclusion

To conclude, our results showed that the culture observed to be affecting teachers' practices. Regardless of being Chinese or English, all participating teachers were found to use educational technologies in their classrooms in ways that they learned from their own teachers during teacher training.

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