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Teaching with technology: a lesson from social participation in an online learning community

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ABSTRACT

Online learning communities (OLCs) offer opportunities to help teachers engage better with technology and develop new skills through a participatory social process. This study investigates the potential of an OLC for advancing teachers' professional learning in integrating technology into their instructional practices. Drawing on two case studies of teachers, this study provides empirical evidence of how participation in an OLC affected the teachers in their professional learning journeys. Findings reveal that social interactions over the OLC provided learning opportunities for teachers who experimented with new technology tools and gradually gained confidence in sharing their practices. However, teachers rather felt *ewuh pakewuh* [uncomfortable] in openly expressing their views in the public OLCs. Instead, teachers preferred to have informal discussions in smaller closed OLCs. The study affirms that OLCs provide teachers with a social learning experience where they can collectively engage with each other to generate new teaching and learning ideas.

Introduction

The evolving internet and social media tools have transformed the way teachers learn, communicate and interact with each other. Teachers are turning to online social interactions to learn new skillsets to meet their individual, professional and technical needs. One of the many ways to help bring about a collective professional learning experience for teachers is through setting up online learning communities (OLCs). The OLCs offer teachers professional support and peer guidance, and provide them with a forum where they can collaborate and give each other constructive feedback whilst sharing their practices in small informal groups (Duncan-Howell, 2010; Trust, 2012). The OLCs enable teachers to reflect on newly learned practices, engage with each other over recent pedagogical developments and keep abreast of changes that are occurring in the field of education.

Technology is able to empower teachers and students to become more receptive to learning. Baskerville (2012) suggested that technology should be applied in an opportunistic manner, that is, teachers and students should use personal learning experiences to draw meaningful insights. For example, an exploration of digital media for information can help them develop effective approaches in teaching and learning, and in the construction of first-hand knowledge. This in turn will build their enthusiasm and intellectual curiosity as together they raise pertinent question, which can be reflected on collectively in an interactive environment. With technology becoming a big part of our everyday lives, schools need to integrate technology appropriately in classrooms for teaching,

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otherwise students may become disassociated from teaching and learning activities (Lim et al., 2013).

Teachers have an important role to play in successful integration of technology in classrooms. Their role is not only to help students construct knowledge, but also to structure student engagement with technology by supporting students in practising high-level cognitive skills and taking ownership of their learning (Abidin et al., 2018). For futuristic technology integration in classrooms, teachers must have a good understanding of technology applications so that they can facilitate meaningful learning technological interventions in classroom teaching and enable their students to create content that is relevant to real-world situations (Ertmer & Ottenbreit-Leftwich, 2010). Since teachers are key figures for successful integration of technology, preparing teachers to use technology appropriately is an essential component of educational reform efforts (Angeli & Valanides, 2009; Somekh, 2008). Given the importance of the role of teachers in bringing about technology integration in classroom instruction, this study sought to investigate teachers' professional learning journey in an OLC within a sociocultural learning frame. The aim of this study is to interpret how OLCs can contribute to the increased use of technology in classrooms and how OLC participation affected teachers' professional practices. Our key question posed is: How did participation in an OLC afford professional learning for the teacher in their use of technology in the classroom?

Theoretical underpinnings

Teacher learning does not always take place in formal professional development programmes; it also occurs in informal settings (for example, participation in social learning interactions). In such instances, teacher learning can take place through participation in teacher communities or over conversations held in various sociocultural contexts that may have occurred in the teachers' lives. Lerman (2013) built on and extended the work of Vygotsky (1978) and followers in conceptualising teacher learning as being better understood as changing participation in social practices.

Teachers are now increasingly turning to OLCs to satisfy their professional or personal needs (Anwaruddin, 2015). Teachers participate in an OLC to share resources, solve problems, develop working strategies and improve their teaching performance (Zhang et al., 2017). Preece (2001) defined an OLC as 'any virtual social space where people come together to get and give information or support, to learn or to find company' (p. 348). Ke and Hoadley (2009) described an OLC as 'a virtual learning environment in which the process of learning takes place outside the boundaries of face-to-face contact, typically online' (pp. 488–489). Drawing on these definitions, an OLC is any virtual learning environment where people typically participate online for exchanging ideas to facilitate shared learning.

Some researchers (e.g., Ke & Hoadley, 2009; Tu & Corry, 2002) have argued that an OLC affects how individuals apply appropriate information to knowledge construction as it enables collaboration among them; therefore, OLCs enhance professional learning rather than just information sharing. Tu and Corry (2002) identified four basic components of OLC: community, learning, network and technology.

Community

Tu and Corry (2002) described how notions of communities stem from the concept of communities of practice (CoPs). Wenger et al. (2002) defined CoPs as 'groups of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis' (p. 4). Lesser and Storck (2001) defined a CoP as

> a group whose members regularly engage in sharing and learning, based on their common interests. One might think of a community of practice as a group of people playing in a field defined by the domain of skills and techniques over which the members of the group interact. Being on the field provides members with a sense of identity. (p. 831)

Together these definitions include common concerns, a common set of problems or common interests, and also a process of co-participation and shared learning. OLCs are thus groups of people who collaborate and learn together in online environments through some shared connection based on their common concerns, common interests or common problems within an atmosphere of trust and commitment. OLCs often become favoured learning spaces for many teachers (Anwaruddin, 2015) because they provide opportunities for teachers to make collaborations to support continuous improvement in their professionalism.

Learning

Learning occurs primarily through formal education, but attitudes, knowledge and skills can also be advanced through informal interactions during social activities. Learning is an internal process and can be seen by the forward-looking changes made to the learner's knowledge, beliefs, attitudes and skills (Bereiter & Scardamalia, 2003). The notion of learning comprises two metaphors: the acquisition metaphor and the participation metaphor (Sfard, 1998). The acquisition metaphor views learning as the process of developing concepts and the attainment of knowledge, while the participation metaphor describes learning as a process through which an individual becomes a member of a certain community. Learning in an OLC also encompasses these two metaphors. The acquisition of knowledge takes place through social interactions among community members. Social learning occurs as new members move through the stages of development by interacting with experienced members (Duncan-Howell, 2010). Learning in a community allows people to collaborate in building new knowledge, solving problems and in changing their current practices (Darling-Hammond et al., 2017; Sari, 2012).

Network

A social network in the context of an online learning community can be understood as 'the graph of relationships and interactions within a group of individuals' (Kempe et al., 2015, p. 106). A network in a community does not grow by itself. Fostering active online discussions can generate a 'rolling present' and make the community grow over extended periods through cumulative discussions (Xin et al., 2011). Discussions are appropriate ways to transfer and cultivate knowledge because the connections among community members and the back-and-forth nature of the discussion provide the context for building meaningful information (Hoadley & Kilner, 2005). Xin et al. (2011) contended that it is important to have members who can actively mediate and facilitate online discussions. Through mediating and facilitating functions, social interactions in the OLC can be maintained. However, within the social network, one thing that needs to be considered is a social presence; that is, a person's level of awareness in an interaction and their consequent appreciation of an inter-personal relationship (Tu & McIsaac, 2002). A person with a high level of social presence in online learning environments tends to engage more interactively in the online activities (Tu & Corry, 2002).

Technology

Technology is the medium used in OLCs to connect community members with the available resources. The community members can easily connect and interact with other members as they construct shared knowledge. Each community member has opportunities to make contributions and can quickly find the best resources to support them in the knowledge construction.

Facebook and WhatsApp have attracted considerable attention from educators as they believe these applications have significant potential to enhance professional learning (Barhoumi, 2015; Van Bommel & Liljekvist, 2015). These applications have created a paradigm shift. Such a shift is predicted by the opportunity to gather a range of information about individuals and the ties that bind these individuals together (Chen & Lin, 2014). Several studies related to the use of Facebook,

Messenger and WhatsApp as vehicles for teacher professional development have been conducted (Barhoumi, 2015; Çevik et al., 2014; Van Bommel & Liljekvist, 2015). All these studies suggest that further exploration in this area is warranted. There is still not enough empirical evidence of how teachers' participation in an online learning environment changes their classroom teaching practices.

The context of the study

Teacher learning studies within a sociocultural context have highlighted that learning is an initiation into social practice in which individuals become part of practices, and the practices also become part of them. This study draws upon about two mathematics teachers Edi and Joko (pseudonyms) who were members of an OLC comprising mathematics teachers from different junior high schools in Semarang, Indonesia. Edi and Joko had different skill levels in using technological tools in the mathematics classroom teaching, where Edi was at a rather advanced level compared with Joko, who had relatively low technology skill levels. Both teachers had earlier participated in a technology workshop, followed by a tryout session on the use of technological tools in classroom teaching.

An ethnography case study has been employed to examine and explore teacher learning in an OLC because of its 'intimate nature' (Miller & Russel, 2005, p. 57). Since the first author has knowledge of the local language and access to the school environments, the roles of participant observer and mediator were undertaken by this member of the research team. The participant observer role included immersion in teaching activities in the classrooms (over a period of six months) and social interactions over Facebook, Messenger and WhatsApp, while the mediator role meant ensuring every participant was involved and contributed to discussions in the different online communities (over a 15-month period). Three online learning environments were used as the medium of communication, of which one was a large Facebook group (OLC-FB) with over 420 teacher members, and the other two were smaller communities or closed groups which used instant messaging via a Messenger group and a WhatsApp group (referred to as OLC-IM).

Data analysis

Data collected from multiple sources, including field notes, open-ended survey questions, documents and online posts, were collectively managed using NVivo software. Qualitative content analysis was used as a descriptive approach in order to identify codes and subsequent themes. The researchers immersed themselves in the data to probe and interpret the themes that emerged from the data codes. The underlying theories helped inform on relevant categories and the codes were refined iteratively. Checking for consistency of the coding was also undertaken as the coding progressed. After all the data were coded, the subsequent step was to draw conclusions by making sense of the themes or categories identified from the teacher learning activities. Examination of trustworthiness refers to the interpretation and the extent to which the researcher accurately portrays the research participants' viewpoints, thoughts, feelings, intentions and experiences (Johnson & Christensen, 2008). Interpretive validity was maintained by cross-checking and reviewing the themes; further, the use of multiple different data collection methods assisted in triangulation and increased the validity in gauging the extent to which the study's findings matched reality (Merriam, 1998).

Findings and discussion

Three online learning environments were established where all teachers could discuss topics related to their use of technology in the classroom. This form of online communication provided an in-depth look at the teachers' professional learning through a participatory social process.

Social interactions in the online learning community

Social interaction plays an important role in the process of teacher learning within an OLC. Lerman (2001) claimed that increased participation in social interactions contributes to teacher success in building knowledge and improving teacher professional learning. In this regard, the success of teacher learning is related to a combination of individual knowledge and skills, environment, use of tools and ability to work together. The participant teachers and the researcher engaged in social learning interactions as they all partook in the OLC discussions.

The wider group of teachers used the OLC-FB to share experiences and discuss certain topics related to how they integrated technology in the classroom. Their participation gradually improved over time; however, many members remained what Wenger and Trayner (2011) described as lurkers. These teachers sustained a connection to the community but with less engagement. Edi, one of the case participants, also expressed concern:

> I am not accustomed to giving comments directly on Facebook Group. I feel *pakewuh* [uncomfortable] to give feedback in public [a group with the wider community] I am more comfortable to discuss it in person or a private group such as in WhatsApp Group or Facebook Messenger.

Edi's statement suggested that a feeling of *ewuh pakewuh* made him unwilling to speak out his thoughts. The feeling of *ewuh pakewuh* is a personal characteristic of most Javanese people (Wati, 2014). This characteristic creates a feeling of shyness and makes people hesitant in expressing their thoughts or feelings openly. Another research participant expressed: 'I have been reluctant to give critical feedback to other colleagues because I was worried that my comments would offend others. I would rather give praise to the ability of teachers to use technology [in their practices].'

These comments can be categorised as *sungkanan* or *ewuh pakewuh*; that is, participants prefer to give compliments to teachers so as not to upset or antagonise other members of the community. The feeling of *ewuh pakewuh* affected the social interactions of teachers in online environments. It caused the teachers to be reticent about expressing their thoughts or in critiquing their peers in the OLC-FB. They felt that since they were *gurus* (an Indonesian term for teachers), they could not openly raise their doubts to other teachers. *Guru iku digugu omongane lan ditiru kelakoane*, in the Javanese language, means that the speech of teachers is always copied, and their behaviour is always an example (model) for everybody (Artiawati, 2017). This philosophy could explain why the teachers were rather cautious in providing feedback or posting comments on the public OLC. The teachers tried to foster harmonious relationships, and their overly cautious nature in turn made the teachers less engaged in the OLC.

In comparison with the online discussions on OLC-FB (wider community), the teachers in the OLC-IM (smaller community) were more receptive to others' inputs, and they were more comfortable in giving recommendations and providing constructive feedback to each other. Thus, the teachers' participation in the OLC-IM complemented their participation in the OLC-FB because in the latter they had more restrained engagements in the online discussions.

The following excerpt shows a discussion on OLC-FB about Edi's classroom activity. The OLC-FB's members who commented on this entry (Edi, Setyo, Mila, Ira, Yanto and Rini) were all secondary mathematics teachers. Kusno, a mathematics teacher in vocational school, and Toni, a teacher educator, also commented.

| 1 | Edi: | Today's lesson was about the relative position of two lines. The teaching strategies began with apperception by using the Plickers app, followed by student groups' discussions about the concepts of parallel lines, crossing lines, and intersecting lines, as well as alternate interior angles, alternate exterior angles, and consecutive interior angles. Afterwards, students gave |

		presentations and we ended with a quiz using the Plickers app. It was enjoyable learning for the students and me.
2	Setyo:	Well done Mr. Edi!
3	Mila:	May I join to learn, sir?
4	Mila:	Mr Edi, if you do such instructional practice again, can I join your classroom as a guest teacher?
5	Researcher:	If you are interested, please join us anytime.
6	Ira:	I want to be a guest teacher too. I am free on Tuesday, Thursday, and Saturday.
7	Yanto:	I want to follow too.
8	Toni:	I was curious about the Plickers app used in the learning activities. I look forward to the video.
9	Kusno:	I am waiting for your recorded video, sir. Perhaps, you can share us the Plickers app the learning scenario. Thank you.
10	Edi:	Anytime Ms. Mila, and Ms. Ira. We are open to members to participate.
11	[Reply to Edi] Mila:	I look forward to getting an invitation, Mr. Edi.
12	[Reply to Edi] Ira:	I am also waiting for your invitation.
13	[Reply] Edi:	Next Thursday, 31 March 2016, at 7–9 a.m., please come to my school.
15	[Reply to Edi] Ira:	OMG, I missed your comment.
16	Edi:	Thank you Mr. Toni, and Mr. Kusno. I am still a newbie with the Plickers app. This app is very effective to be used for learning.
17	Rini:	Wow, I want to learn as well. Could you tell me how to do that?

Edi was the first member to comment on the entry. He gave detailed information about the material and what he had done in his lesson (line 1). Edi's first comment triggered other members to respond. Some of them (Mila, Ira, Yanto and Rini) wanted to learn and collaborate with Edi (lines 3, 4, 6 and 17). Two members (Toni and Kusno) were curious about the teaching process in using the tool and indicated that they were looking forward to viewing the recorded video on the OLC-FB (lines 8, 9). Evidence provided in the comments and ideas related to the pedagogical knowledge indicate the emergence of what (Wenger, 1998a, 1998b) termed 'joint enterprise' within the discussion. The production of joint enterprise led to a shared repertoire among members of the OLC-FB. Edi's information about his lesson (line 1) exemplified a shared repertoire in which Edi produced a story of his teaching experience. The story became a shared resource for others to use, learn from and implement in their teaching practices.

Evidence from Edi's actions also showed that he extended his role by not only being a member of the OLC-FB but also by acting in a way that energised and nurtured the community (lines 10, 13). The dynamic discussions on the researcher's entry also provide evidence that the teachers built what Borko et al. (2008, p. 419) termed a 'professional vision' and gave impetus to other teachers to question and learn about teaching.

The following discussion was held on the Messenger group by Edi, Udin and Joko to discuss some technical issues faced while implementing certain technological tools.

1	Edi:	To those who have used the Socrative app, are there any problems faced? Yesterday, I used the Plickers app. There is a problem related to internet connection.
2	Joko:	Yesterday, I used the Socrative app sir. There is a problem with internet connection.
3	Udin:	For Plickers. Is the scanning process run smoothly, Mr. Edi? Tomorrow, I am just getting started tomorrow. I am going to use the Plickers app, like what you did.
4	Edi:	Yesterday, I used the Plickers app. Preparation that must be done: (1) Make sure that the internet is fine; (2) The connection between the Plickers app on the smartphone and laptop is good; (3) The Plickers card must be distributed

before the lesson is started; (4) when scanning students' responses make sure that the students hold the card correctly as instructed.

In this discussion, Edi and Joko shared experiences and revealed technical issues they faced in the implementation of technological tools into their classrooms (lines 1, 2). Both Edi and Joko expressed concerns that issues with internet connections decreased the tools' performances. Udin, in line 3, asked about Edi's experience in using the Plickers app. Edi responded by mentioning some factors that must be taken into consideration when using the Plickers app (line 4).

These social interactions illustrate the mutual engagement and show that responses were thoughtful and raised awareness of any technical issues that came up during the implementation of the technological tools. These shared stories were of benefit to teachers who were intending to use the same tools. Udin, for example, wanted to use the Plickers app and model his use on what Edi did.

Lessons from the experiences of Edi and Joko

Edi and Joko are mathematics teachers in different junior high schools. While Edi had more experience working with technology than Joko, Joko had more experience of teaching than Edi. At the time of this study, Edi taught Grade 7, while Joko taught Grade 9. Each classroom in Edi's and Joko's schools was equipped with a data projector and a screen; however, these schools did not have proper in-house technical support (so, in the event of a technical issue, a third party was called to resolve the problems). At their schools, the students were not allowed to bring mobile devices, except for learning purposes. Comprehensive terms and conditions were set by the school authorities for using these devices (for instance, students could use their mobile phones in a classroom only when their teachers requested it. Afterwards, their mobile phones were collected by their homeroom teachers).

The experiences of Edi and Joko have been elaborated in this section to illustrate how participation in the OLC enhanced teachers' professional learning in the use of technology in mathematics teaching practices.

Edi's case study

In the initial implementation of technology, Edi chose the Plickers app. He said: 'I choose the Plickers app because students do not need to bring mobile phones. The internet connection can be optimised.' These reasons illustrate how Edi considered that the availability and accessibility of technology were crucial aspects in the context of technology integration. Edi prioritised optimisation of internet connections for the smooth running of the implementation of technology in the classroom.

In the OLC, Edi was the most active member. He was not only a learner in the OLC but also acted as a mediator to keep social interactions in the OLC flowing. Edi acknowledged that his participation in the OLC helped him to improve his knowledge of teaching with technology. He explained:

> The OLC gives me benefits especially in the learning process of the use of technological tools in the classroom. I can improve my knowledge about how to implement the things [technology-based teaching practices] that have been performed by the four teachers.

The OLC added value and made Edi relate better to the technological materials he could use to support students' learning. Edi perceived the benefits of his participation in the technology workshop and the OLC. Edi's participation in the OLC also helped change his classroom practices and made him a more reflective practitioner.

The following fieldnote describes introduction of two mobile apps – Smart Protractor and GPS-Field Area Measure – by Edi. Smart Protractor is an app to measure the angle and slope of an object, while GPS-Field Area Measure is a map measurement app useful for outdoor activities, like gauging

the area, distance and perimeter of any object. Edi conducted outdoor classroom activities using these apps. This is illustrated in the following classroom activity:

> The students worked in groups. Each group had a map [of the school area] and a student worksheet. Edi selected three places that must be visited by the students. These three places were already marked on the map. The students were also asked to read the guidance provided on the student worksheets. When the students visited the first place, they had to find a solution for the first mathematics problem. Likewise, when they visited the second and third places, the students had to solve the second and the third mathematics problems, respectively. Each mathematics problem mentioned what app should be used to find the solutions. The students left the classroom and started to complete the student worksheet. Firstly, all the student groups entered the school hall to complete the first mathematics problem. They measured the perimeter of one of the sections of the roof of the school hall using the GPS-Field Area Measure app. The instructions for finding the solution were included in the student worksheet. The second mathematics problem involved measuring the angles of one of the windows in the school hall. The students took measurements with the Smart Protractor app. The last mathematics problem was about the perimeter and area of the school football field. Representative students from each group walked around the field and made sure that the GPS-Field Area Measure app recorded their trail. The third problem was quite challenging because some groups had intermittent internet connection issues. Consequently, the app could not record the trail properly and the students had to repeat it two or three times to get a good trail. To deal with this issue, Edi let the students use manual mode. In manual mode, the students only selected the field area on the digital map as requested on the mathematics problem, and the app displayed the perimeter and area of the field […] Edi supervised the students' outdoor classroom activity intensely as he made sure that the students used the apps properly, and they followed the instructions carefully […] The students went back to the classroom after all tasks were finished, and Edi discussed the results.

Edi had never performed outdoor classroom activities using technology before. His outdoor classroom activities in this lesson show evidence of his growing confidence to leverage the technological tools and integrate them into a pedagogical strategy that promoted student engagement and rich learning of mathematics. Further, Edi showed in this lesson that he was open to new ideas and able to experiment with a new strategy and that he wanted to achieve improvements in his teaching methods. He exhibited what Sang et al. (2010) called a high level of self-efficacy in the use of technology for teaching practices.

Post-observation, Edi was still participating in the OLC-FB. He continued to share and update stories on his ongoing teaching activities with technology. He also conducted independent classroom action research to examine the students' communication skills and to improve student learning outcomes. He used Edmodo and the Plickers app as learning tools. He explained that his pedagogic research was a follow-up to his participation in this study, stating:

> In this modern era, teachers are always asked to adjust themselves to technological progress. If we are sceptical about technology, we will be left behind. I am committed to continuing to develop innovative learning with technology that brings improved student learning.

Edi's statement emphasises that his positive attitude towards technology had spurred him on to continue using a range of different technological tools to promote mathematical learning. It also provides evidence that he knows that technology is part of the modern world needed for twenty-first -century learners.

Joko's case study

In the first trial of using a technological tool, Joko chose the Socrative app. He opined: 'I chose the Socrative app because of its simplicity of operation.' Joko suggested usability was one aspect that should be considered in the selection of appropriate apps. He used the Socrative app for formative assessment. Because of limited availability of mobile devices, sharing devices was considered an appropriate teaching strategy that fitted with Joko's classroom condition.

Joko's participation in the OLC positively motivated him. He stated that:

> The videos [posted on the OLC-FB] gave me inspirations, improved my insight, and aroused curiosity. I think the OLC is effective for teacher professional learning as we can update everything with the community. Teachers in the OLC encouraged me to be a more professional teacher.

Joko's words indicate his recognition of the value of participation in social learning environments where different teaching practices shared by his peers had inspired him. Joko added that participation in the OLC helped him in his personal learning process, and he now felt more confident to experiment with new technological tools. He said: 'I am getting more confident to use technology, and I am no longer afraid to invite the teachers from other schools also to use technology for their learning.' Joko also perceived the effect of teaching videos posted on the OLC-FB for his practice: 'the videos [of teaching activities using technology] posted on the Facebook Group [OLC-FB] is practical and can be accessed anytime when we want to revisit our practices. The videos contribute to improving teacher professional learning.' Joko's statement provides evidence that viewing a video of a teacher using technology can be regarded as a tool for facilitating sustained examination of his practices.

Joko's classroom activities are illustrated in more detail in the following fieldnote:

> Joko was teaching about equations of straight lines. He started his lesson by giving an example of a straight line in a real context. He played footage from the movie 'Taxi'. In the footage, there was a taxi running on a straight road. Joko then posed a question: 'Do you see the trajectory formed by the taxi? What is the shape of the object?' the students responded, 'a straight line' […] Joko responded again, 'Yes, correct! From this footage, you can see that mathematics is useful in everyday lives' […] Joko then explained the equations of straight lines using PowerPoint. He also demonstrated how to draw a straight line and how to find the equation of a straight line using GeoGebra. After the demonstration session was done, Joko distributed student worksheets) consisting of three mathematics problems.

> The students were asked to use GeoGebra to find the solutions to the questions. Joko grouped the students into 16 groups of two students. Joko observed the student groups' activities […] At the end of the lesson, Joko conducted mathematics exercises. He selected mathematics problems related to the straight lines equations from the archives of national mathematics exams. Joko used the Socrative app for mathematics practices for national exam preparation.

At the beginning of the study, Joko explained that he had never conducted technology-based teaching practices, and in the first trial he used only the Socrative app. In this lesson, Joko showed his confidence using four technological tools: PowerPoint, GeoGebra, the Socrative app and Windows Media Player. Joko also gave students opportunities to engage with technological tools to find mathematical solutions while completing student worksheets. He also transferred learning through a demonstration of links between school mathematics and real-world problems.

Evidence from this classroom activity shows that Joko had implemented what Ertmer and Ottenbreit-Leftwich (2010) called high-level technological use. Joko, with constructivist beliefs, could effectively use the technological tools to support his teaching practices by maintaining a dynamic student-centred focus.

Post-observation, Joko was still continuing the use of technology in the classroom and participating in the OLC. He used the Plickers app for teaching and learning. Joko had not used the Plickers app during the classroom observations; he had used the Socrative app all the time. Joko and his colleague collaborated to conduct classroom action research to examine the effectiveness of the technological tool (the Plickers app) for student assessment. Joko provided peer coaching to help his colleague on the correct use of the Plickers app before his own classroom action research was conducted.

At the beginning of the study, Joko appeared to lack experience in teaching with technology. Through his engagement in the OLC, he had grown in the ability to use technology for his teaching practices. Joko also confirmed that he needed time and space for this learning process to happen before making his practice public.

Conclusions and implications for future research

This study has illustrated through rich descriptions of two case studies how teacher participation in an OLC provided them with many peer learning opportunities in transforming mathematics classroom practices with technology. The study is significant in the way it provides empirical evidence which can in turn inform similar future studies on how participation in OLCs can assist teachers in their professional learning journeys.

The teachers were more open and receptive when engaged in the smaller community (OLC-IM) rather than in the wider community (OLC-FB). However, their participation in the OLC-IM complemented their participation in the OLC-FB. Many members of the OLC-FB tended to stay on the fringes and engage less in online discussions. They felt no obligation to actively engage in the discussions. Further, the feeling of *ewuh pakewuh* made them hesitate in openly disagreeing with their peers in the online discussion forums.

Evidence from Edi's and Joko's case studies have illustrated that social participation in OLCs offers opportunities for teachers to get support, advice, feedback and collaboration so that they can efficiently stay up to date on the latest technological tools, improve their skillsets and gain confidence in the use of technology in their classroom teaching. OLC can be used as a means for teachers to grow their professional learning in using technology for teaching practices. However, teacher participation plays a central role in the success of their professional learning. The OLC has the potential to facilitate teachers to share their teaching experiences and problem solving, as well as help them get expert professional support. Teachers can provide meaningful insights and contribute to teaching ideas, thereby assisting each other in improving the quality of teaching with focus on technology use in mathematics classrooms.

Because this study is limited to two case participants, its generalisability is constrained. However, the findings showed that teachers with different levels of skills and different amounts of experience in working with technology had benefited from this model of an OLC. Notwithstanding the limitations, this study can be a stepping stone for further research on teacher professional learning through OLCs in promoting the use of technology in the classrooms. It was evident in this study that the OLC-based model enabled secondary school teachers to develop their professional competencies, increased their self-efficacy and gave equal opportunities for teachers to develop themselves. It is important to extend this knowledge base beyond secondary schools. We encourage others to trial similar studies.

Disclosure statement

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Notes on contributors

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Prof. Roberta Hunter is a Professor of Pasifika Education Studies in the Institute of Education at Massey University, Auckland, New Zealand. She developed her love of maths through watching her Cook Islands mother measuring and making geometric patterns for intricate tivaevae (fabric art) patterns. In the 2020 Queen's Birthday Honours, she was appointed a Member of the New Zealand Order of Merit, for services to mathematics education.

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References

Abidin, Z., Mathrani, A., & Hunter, R. (2018). Gender-related differences in the use of technology in mathematics classrooms: Student participation, learning strategies and attitudes. *The International Journal of Information and Learning Technology*, *35*(4), 266–284. https://doi.org/10.1108/IJILT-11-2017-0109

Angeli, C., & Valanides, N. (2009). Epistemological and methodological issues for the conceptualization, development, and assessment of ICT–TPCK: Advances in technological pedagogical content knowledge (TPCK). *Computers & Education*, *52*(1), 154–168. https://doi.org/10.1016/j.compedu.2008.07.006

Anwaruddin, S. M. (2015). Teacher professional learning in online communities: Toward existentially reflective practice. *Reflective Practice*, *16*(6), 806–820. https://doi.org/10.1080/14623943.2015.1095730

Artiawati. (2017). The work-family interface in Indonesia. In K. Korabik, Z. Aycan, & R. Ayman (Eds.), *The work-family interface in global context* (pp. 215–235). Routledge.

Barhoumi, C. (2015). The effectiveness of WhatsApp mobile learning activities guided by activity theory on students' knowledge management. *Contemporary Educational Technology*, *6*(3), 221–238. https://doi.org/10.30935/cedtech/6151

Baskerville, D. (2012). Integrating on-line technology into teaching activities to enhance student and teacher learning in a New Zealand primary school. *Technology, Pedagogy and Education*, *21*(1), 119–135. https://doi.org/10.1080/1475939X.2012.659887

Bereiter, C., & Scardamalia, M. (2003). Learning to work creatively with knowledge. In E. D. Corte, L. Verschaffel, N. Entwistle, & J. V. Merriënboer (Eds.), *Unraveling basic components and dimensions of powerful learning environments* (pp. 55–68). Elsevier Science.

Borko, H., Jacobs, J., Eiteljorg, E., & Pittman, M. E. (2008). Video as a tool for fostering productive discussions in mathematics professional development. *Teaching and Teacher Education*, *24*(2), 417–436. https://doi.org/10.1016/j.tate.2006.11.012

Çevik, Y. D., Çelik, S., & Haşlaman, T. (2014). Teacher training through social networking platforms: A case study on Facebook. *Australasian Journal of Educational Technology*, *30*(6), 714–727. https://doi.org/10.14742/ajet.615

Chen, C.-W., & Lin, C.-S. (2014). Building a sense of virtual community: The role of the features of social networking sites. *Cyberpsychology, Behavior, and Social Networking*, *17*(7), 460–465. https://doi.org/10.1089/cyber.2013.0530

Darling-Hammond, L., Hyler, M. E., & Gardner, M. (2017). *Effective teacher professional development*. Learning Policy Institute.

Duncan-Howell, J. (2010). Teachers making connections: Online communities as a source of professional learning. *British Journal of Educational Technology*, *41*(2), 324–340. https://doi.org/10.1111/j.1467-8535.2009.00953.x

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42*(3), 255–284. https://doi.org/10.1080/15391523.2010.10782551

Hoadley, C., & Kilner, P. G. (2005). Using technology to transform communities of practice into knowledge-building communities. *ACM SIGGROUP Bulletin*, *25*(1), 31–40. https://doi.org/10.1145/1067699.1067705

Johnson, B., & Christensen, L. (2008). *Educational research: Quantitative, qualitative, and mixed approaches* (3rd ed.). Sage Publications.

Ke, F., & Hoadley, C. (2009). Evaluating online learning communities. *Educational Technology Research and Development*, *57*(4), 487–510. https://doi.org/10.1007/s11423-009-9120-2

Kempe, D., Kleinberg, J., & Tardos, E. (2015). Maximizing the spread of influence through a social network. *Theory of Computing*, *11*(1), 105–147. https://doi.org/10.4086/toc.2015.v011a004

Lerman, S. (2001). Cultural, discursive psychology: A sociocultural approach to studying the teaching and learning of mathematics. *Educational Studies in Mathematics*, *46*(1/3), 87–113. https://doi.org/10.1023/a:1014031004832

Lerman, S. (2013). Theories in practice: Mathematics teaching and mathematics teacher education. *ZDM*, *45*(4), 623–631. https://doi.org/10.1007/s11858-013-0510-x

Lesser, E. L., & Storck, J. (2001). Communities of practice and organizational performance. *IBM Systems Journal*, *40*(4), 831–841. https://doi.org/10.1147/sj.404.0831

Lim, C. P., Zhao, Y., Tondeur, J., Chai, C. S., & Tsai, -C.-C. (2013). Bridging the gap: Technology trends and use of technology in schools. *Educational Technology & Society*, *16*(2), 59–68. https://www.jstor.org/stable/10.2307/jeductechsoci.16.2.59

Merriam, S. B. (1998). *Qualitative research and case study applications in education*. Jossey-Bass.

Miller, H., & Russel, L. (2005). Methodological issues and practices in ethnography. In G. Troman, B. Jeffrey, & G. Walford (Eds.), *Methodological issues and practices in ethnography: Studies in educational ethnography* (Vol. 11, pp. 57–72). JAI Press.

Preece, J. (2001). Sociability and usability in online communities: Determining and measuring success. *Behaviour & Information Technology*, *20*(5), 347–356. https://doi.org/10.1080/01449290110084683

Sang, G., Valcke, M., Braak, J., & Tondeur, J. (2010). Student teachers' thinking processes and ICT integration: Predictors of prospective teaching behaviors with educational technology. *Computers & Education*, *54*(1), 103–112. https://doi.org/10.1016/j.compedu.2009.07.010

Sari, E. (2012). Online learning community: A case study of teacher professional development in Indonesia. *Intercultural Education*, *23*(1), 63–72. https://doi.org/10.1080/14675986.2012.664755

Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, *27*(2), 4–13. https://doi.org/10.3102/0013189x027002004

Somekh, B. (2008). Factors affecting teachers' pedagogical adoption of ICT. In J. Voogt & G. Knezek (Eds.), *International handbook of information technology in primary and secondary education* (pp. 449–460). Springer.

Trust, T. (2012). Professional learning networks designed for teacher learning. *Journal of Digital Learning in Teacher Education*, *28*(4), 133–138. https://doi.org/10.1080/21532974.2012.10784693

Tu, C.-H., & Corry, M. (2002). Research in online learning community. *Electronic Journal of Instructional Science and Technology (E-jist)*, *5*(1), 1–11. https://ascilite.org/archived-journals/e-jist/docs/Vol5_No1/chtu.pdf

Tu, C.-H., & McIsaac, M. (2002). The relationship of social presence and interaction in online classes. *American Journal of Distance Education*, *16*(3), 131–150. https://doi.org/10.1207/S15389286AJDE1603_2

Van Bommel, J., & Liljekvist, Y. (2015). Facebook and mathematics teachers' professional development: Informing our community. In K. Krainer & N. Vondrová (Eds.), *Proceedings of the ninth congress of the European society for research in mathematics education* (pp. 2930–2936). Charles University in Prague.

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental processes*. Harvard University Press.

Wati, R. (2014, December 30). *The effect of cultural ewuh pakewuh bureaucracy toward significance accounting fraudulency in the government: The perception of government internal control apparatus Sragen area inspectorate*. https://doi.org/http://dx.doi.org/10.2139/ssrn.2698509

Wenger, E. (1998a). Communities of practice: Learning as a social system. *Systems Thinker*, *9*(5), 2–3. https://thesystemsthinker.com/communities-of-practice-learning-as-a-social-system/

Wenger, E. (1998b). *Communities of practice: Learning, meaning, and identity*. Cambridge University Press.

Wenger, E., McDermott, R. A., & Snyder, W. (2002). *Cultivating communities of practice: A guide to managing knowledge*. Harvard Business Press.

Wenger, E., & Trayner, B. (2011, December 28). *Level of participation: Multiple ways to engage in social learning*. Wenger-Trayner. http://wenger-trayner.com/project/levels-of-participation/

Xin, M. C., Glass, G., Feenberg, A., Bures, E. M., & Abrami, P. (2011). From active reading to active dialogue. In F. Pozzi & D. Persico (Eds.), *Techniques for fostering collaboration in online learning communities: Theoretical and practical perspectives* (pp. 300–318). IGI Global Publishing.

Zhang, S., Liu, Q., & Wang, Q. (2017). A study of peer coaching in teachers' online professional learning communities. *Universal Access in the Information Society*, *16*(2), 337–347. https://doi.org/10.1007/s10209-016-0461-4