Chapter 4
Interactivity and Mobile Technologies: An Activity Theory Perspective

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Abstract Expert teachers are pragmatic in their curricular planning and instruction through embedding the use of mobile technologies towards providing their students with meaningful learning experiences. They use technology as a cornerstone within their instructional design. This study examined how pedagogy, professional learning and mobile technologies impact a teacher's ability to utilise a learner-centred interactive approach. Qualitative data were collected and analysed using the six-step activity theory in conjunction with a case study design were data was collected from four teacher participants through interviews, classroom observations and lesson plans. Data revealed that teaching and learning sequences involving mobile technologies were found to have varying degrees of learner–teacher interactivities, ranging from complete teacher control to total learner control. This range of interactivity can serve as a teacher guide to mobile learning design using appropriate pedagogy integrating apps in conjunction with other classroom resources to yield improved student outcomes.

4.1 Background

The concept of interactivity is so widespread that it embraces many facets of society including T.V., websites, online news, games, social networks, drama and mobile devices (m-devices) (Coursaris and Sung 2012; Downes and McMillan 2000; Larsson 2012). In recent years, the concept of interactivity has become firmly

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entrenched within educational discourse with the increased utility of mobile learning devices, such as smart phones and tablet PCs in today's classrooms (Beauchamp and Kennewell 2010; Beauchamp and Parkinson 2005; Holzman 2006; Koolstra and Bos 2009; Larsson 2012; Tanner and Jones 2007; Ting 2013; Toteja and Kumar 2012). Yet, there remains an ongoing debate regarding the definition, theoretical nature, structure and significance of interactivity to student achievement (Coursaris and Sung 2012; Kiousis 2002; Kirsh 1997; Koolstra and Bos 2009; Larsson 2012; Smuts 2009). Although there has been a tremendous growth and potential in the use of wireless handheld mobile devices, the orchestration of mobile learning (m-learning) has still been scarcely explored (Motiwalla 2007).

While interactive whiteboards (henceforth IWB), an example of technology readily available in most classrooms, have been popular for over a decade, their use in conjunction with other mobile technologies is neither widespread nor thoroughly researched (Beauchamp and Kennewell 2010; Haydn 2010; Hennessy and London 2013; Maher 2012). Moss et al. (2007) call for more research to address the issue of how mobile technologies can widely contribute to best practices in multimodal learning experiences (Stokovski 2010). Further, there is a pressing need to examine these from an activity theory perspective using interactivity as a measure (Miller and Glover 2010). Its significance is paramount to preparing twenty-first century learners to thrive and to advancing pedagogies that return the focus to content acquisition 'rather than on searching for the next new technolog' (Elias 2011, p. 143).

Previous studies on mobile learning have predominantly focused on effectiveness rather than its design (Wu et al. 2012), thereby overlooking the need for orchestrating current classroom technologies with new m-devices. Understanding interactivities among technology, students and teachers are necessary to advance this agenda (Ting 2013). Research on interactivity has positioned it as a single point of interaction rather than continuum of teacher- and learner-centred interactivities (Banna 2011). This hybrid approach is invaluable in the design, application and review of teacher pedagogy in relation to classroom mobile learning design. This study attempts to identify the various points of interactivities by examining the teacher–student lived classroom practices with software apps on mobile devices towards achieving their learning goals using the activity theory framework.

4.2 Theoretical Framework

In the area of human–computer interaction (henceforth HCI), there is a dearth of theoretical research (Kaptelinin and Nardi 2012; Kuutti 1996). In recent years, research in 'HCI is afflicted by a Tower of Babel of incompatible, fragmentary terminologies and undisciplined, bricolage design strategies'. Activity theory as a methodological and theoretical tool has grown in importance especially in the field of information systems (Allen et al. 2013) and has much to contribute to situated learning pertaining to hybridising m-learning designs with other e-learning designs

(Peña-Ayala et al. 2014). That is to say, how IWB's can work in harmony with classroom mobile technologies to orchestrate better interactivity. Activity theory embraces interactivity while serving as an interactive teaching–learning approach as it encircles the idea of examining human interactions in achieving their end goal, placing emphasis on sociocultural elements of teaching and learning (Roschelle et al. 1998; Ryu and Parsons 2009; Spikol et al. 2008). As viewed from an activity theory perspective, activity is a valid indicator for measuring learner–teacher interactivity (Miller and Glover 2010). According to Engeström (2001), activity theory provides the ideal ground analysis for 'events in classroom discourse where the seemingly self-sufficient worlds and scripts of the teacher and the students occasionally meet and interact to form new meanings that go beyond the evident limits of both' (p. 135–136).

This concept is aptly summarised with Engeström's (1991, 1992) activity system model in relation to this study (see Fig. 4.1). It illustrates how the teacher and/or learner is the main focal point that drives all activities, actions and operations in the activity system (classroom) in order to achieve the end goal (lesson goal). Using activity as a unit of analysis, we can explore information behaviour within lived events (Allen et al. 2011). The teacher can pragmatically select apps along with other classroom technologies as a tool to help achieve their lesson goal. According to Engeström (1992), "an activity system does not exist in vacuum" (p. 19). Activities involve human actors, who are motivated towards an *object* (goal)

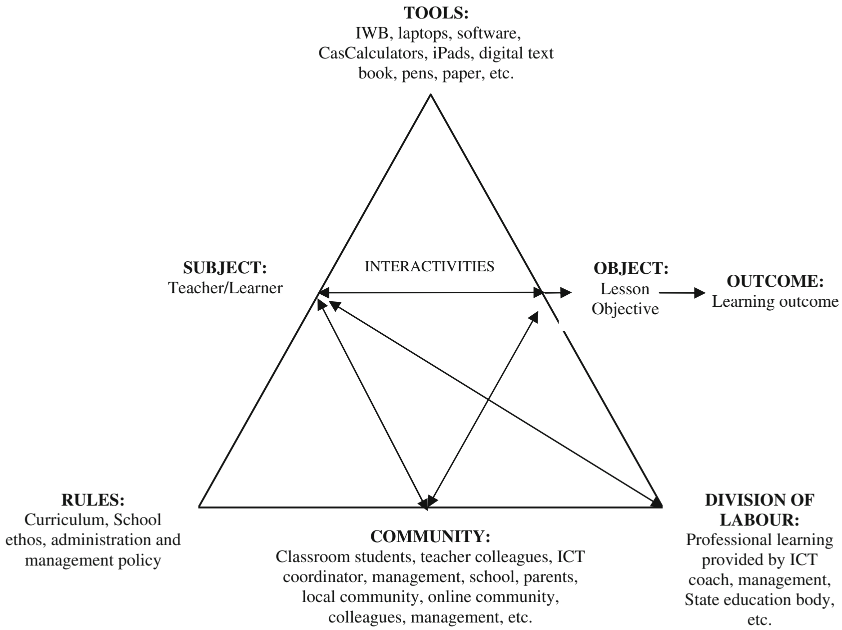

Fig. 4.1 Adapted model of Engeström (2001) Activity System in context of this research study

(Pietsch 2005) with their actions are impacted by *tools*, such as software in their *community* representing learners, parents and school management as shown in Fig. 4.1. The *object* of an activity system is the central characteristic of the system and the belief of goal-directed behaviour is vital to the concept of activity (Engeström 2001).

Therefore activity theory provided a common orientation, structuring method and a map that guided this research inquiry to capture interactivities during software use in complex classroom settings (Roschelle et al. 1998). Activity theory provides a lens for analysing activity and enables its use as a framework for determining the components of the activity system as represented in Fig. 4.1 (Jonassen and Rohrer-Murphy 1999; Karanasios et al. 2013). The various components *subjects*, *tools*, *objects*, *community*, *division of labour* and *rules* in the activity system help identify and explain the activities and interactivities taking place in the classroom. For instance, a classroom observation of this study examining a lesson conducted by a teacher brings to light the various components of the activity system and the diverse motivations and contradictions faced by the actors towards attaining it.

4.3 Review of Literature

Below we review current literature and significance of the concept of interactivity in relation to mobile apps in classroom technologies and how they affect pedagogy and professional learning. Literature gaps point to the need for mobile learning designs to embrace tenets of interactivity for better synthesis of new and current technologies in classroom settings.

4.3.1 Pedagogy

At the outset, it is important to make clear that although this study identifies three tensions, namely, pedagogy, professional learning and digital resources as factors that affect the shape of interactivity, the findings of this chapter focuses on the tensions that occur within pedagogy. Although the applications of mobile learning are widely accepted practice in primary, secondary and tertiary levels of educational settings, yet it still remains underdeveloped in terms of its pedagogical considerations (Park 2011). Central to any study on pedagogical interactivity is the notion that teachers possess the skills to make technology work. Haldane (2007) notes that digital technologies by themselves are not 'interactive' but "merely a medium through which interactivity may, to a greater or lesser extent, be afforded" (p. 258–259). While the software applications and Learning Objects enable interactivity, it is eventually the user of the app who chooses the extent to take full advantage of the software's interactive potential (Alyani and Shirzad 2011). Further, classroom technologies impact student-centred learning in ways previously not feasible

(Hennessy et al. 2010; Miller and Glover 2010) enabling learner interactions that capture experiences in physical and social realms (Ting 2013).

Studies show that some innovative and creative teachers attempt to seek digital resources in technologies to suit a learner-centred pedagogical style (see for example, Maher et al. 2012). While some teachers initially use software for teacher-directed activities, they generally move to using it collaboratively shifting towards learner-centred pedagogy (Moir 2014). However, improving access to technology alone does not translate to better pedagogy (Hennessy et al. 2010; Hennessy et al. 2007). Some teachers use the apps to promote 'controlled pre-communicative activities' (Gray et al. 2005, p. 43). That is, the learning funnel is controlled by the teacher, referred to as 'low-level funnelling questioning' (Tanner and Jones 2007, p. 38). What is needed is an 'interactive teaching' approach/pedagogy, which focuses on a dialogic rather than an authoritative interactivity to foster genuine learning (Beauchamp and Kennewell 2010; Hennessy and London 2013). Interactivity can be superficial or deep varying from 'intra-activity', 'surface interactivity', 'deeper interactivity', 'dialogical deep interactivity' and 'full interactivity' based on the teacher–pupil control of interaction (Tanner and Jones 2007, p. 38). Locally and globally, the current push is for a pedagogic change from a didactic to an interactive approach to learning and teaching and interactivity as a concept that drives this change (Miller and Glover 2010). Developing design principle of mobile learning that blend mobile and non-mobile technologies is important for the integration of technology into teacher pedagogy (Herrington et al. 2009). Hennessy and London (2013) aptly summarise "pedagogical change requires pedagogically oriented professional development" (p. 17).

4.3.2 Professional Learning

ICT has the potential to increase student performance and improve teacher pedagogy, however, teacher practitioners struggle to keep pace with the influx of tools within instructional technology in part due to inadequate professional development and training (Clarke and Fournillier 2012; Oigara and Wallace 2012). In many parts of the world, research has depicted that unidirectional investment on hardware such as IWBs without detailed professional development does not automatically translate to effective leaner-centred pedagogical practice (Becta 2003; Halford 2007; Lacina 2009; Moss and Jewitt 2010; Oigara and Wallace 2012; Somyurek et al. 2009). Piecemeal teacher training has long been a 'hit and miss' approach centred on the technical features of the equipment (Hennessy and London 2013; Miller and Glover 2007). What is needed is using software technologies that bolster curricular content in ways that are seamless and promote interactivity between and within teachers and students alike. Professional m-learning design models need to focus on pedagogical aspects of interactivity, rather than effective application of their use to specific technologies. This would enable teachers to be better equipped with the skills that focus on these pedagogical principles of interactivity making it easier to embrace newer technologies in synthesis with available m-devices in today's classroom.

According to Hooper and Rieber (1995), there are five stages of technology adaptation: familiarisation, utilisation, integration, reorientation and evolution. Generally, initial training is provided, but many teachers lack continued professional learning and support, which restricts the use and functionality of apps (Stein 2005a, b). Professional learning takes time; changes in pedagogy are subject to investment, nature and format of professional development (Hennessy and London 2013). Teachers should be allocated time for software application and integration with other classroom resources with emphasis on the principles of interactivity. The lack of professional learning time for teachers to learn how to use and integrate apps into their teaching can be a significant deterrent to interactive classrooms (Hedberg and Freebody 2007). ICT coordinators and ICT specialist teachers used their non-teaching time to assist teachers with curricular integration of apps (Hennessy and London 2013). Teachers need to be given opportunities to follow up these sessions with 'sandpit' time, that is, time to play, construct, trial, revise, collaborate, discuss and refine lesson plans infused with apps at their own pace (Halford 2007). Hennessy and London (2013) suggest formal training received outside the school was beneficial but in-house informal training and professional development conducted by colleagues was more effective and useful. Hennessy and London (2013) state that "technology by itself has no transformative power" (p. 24); however, when supplemented with appropriate professional learning, digital resources and learner-centred pedagogy, they become engines of change for connecting classrooms to outside lived worlds. Providing teachers ongoing professional learning skills focused on tenets of interactivity in the use of m-devices is the key to pedagogical change for successful integration of newer and current classroom technologies.

4.3.3 Digital Resources

To include a dialogic rather than authoritative interactivity approach along with the software features focussing on learner-centred interactivity is the key to pedagogical change (Beauchamp and Kennewell 2010, p. 759). Endeavours must be made to make available mobile digital resources such as games that enable active learner–technology interactivity so as to connect students' lived experiences in-class and out-of-class context (Masek et al. 2012; Wong and Looi 2011). Frameworks for evaluating and selecting applications for mobile technologies in learning settings are still at its developing stages (Sharples 2006) and should include and embrace elements of interactivity (Beauchamp and Kennewell 2010). Selecting appropriate applications for m-devices using rubrics and evaluative tools for teachers which focus on their pedagogical beliefs to integrate technology into classroom practices is absent in the literature (Green et al. 2014). Using iterative design models for mobile learning apps focusing on tenets of pedagogical interactivity could be a starting point of change towards this end (Marty et al. 2013).

Access to relevant educational websites and software applications is the first step towards positively impacting student learning in the digital age (Griffin and Woods 2006; Helfrich 2011). Selecting which apps to use must be done carefully and critically as apps having varying degrees of usefulness and age appropriateness (Sam 2012; Wang and Woo 2007). However, finding relevant and appropriate mobile apps are not easily accessible and decisions have to be made based on reviews (Hsu and Ching 2013). Teachers have even resorted to making their own apps using App Inventor due to unavailability of suitable apps (Hsu and Ching 2013). Sharing digital resources amongst the teacher community within and outside their school environment is a useful strategy to overcome difficulties posed by their learning curve (Ross 2011; Stein 2005a, b). Therefore, for successful implementation, efficacious linkages between pedagogical support systems are paramount.

Software applications allow teachers to attain their object; they determine how interactivities and information are transmitted and displayed (Maher 2012; Sam 2012). When choosing app, teachers should give preference to apps that enable active learner–technology interactivity so as to connect students' lived worlds outside of the school context (Masek et al. 2012). Apps provide great potential to facilitate simulative learning and less teacher talk and when used in conjunction with m-devices harness their pedagogical capacity. Interactivities have been found to be highest among learners in instances where simulation-based learning environments were used compared to expository learning environments (Beauchamp and Kennewell 2010). What follows is an investigation of how four classroom teachers selected and used apps within their pedagogical design and instruction, providing a window of the interactivities found from an activity theory perspective.

4.4 Methods

This research investigation utilised a case study design whereby data were collected through classroom observations, teacher interviews, samples teacher lesson plans using apps, journals and other resources used during class over a period of 4 months. A convenience sample was used for school selection, resulting in four teachers opting into the study based on a first-come first-serve criteria. Further, a purposeful sampling technique (Tongco 2007) was used to select lesson plans and software apps used by participatory teachers for data analysis in order to cater to a wide range of interactivities from learner-centred to teacher-centred approaches. Thematic analysis was used to identify emerging themes from field notes recorded from classroom observations and formal/informal interviews with the participant teachers.

An adapted model of the summary of six-step process by Jonassen and Rohrer-Murphy (1999) was used to collect data from an activity theory perspective.

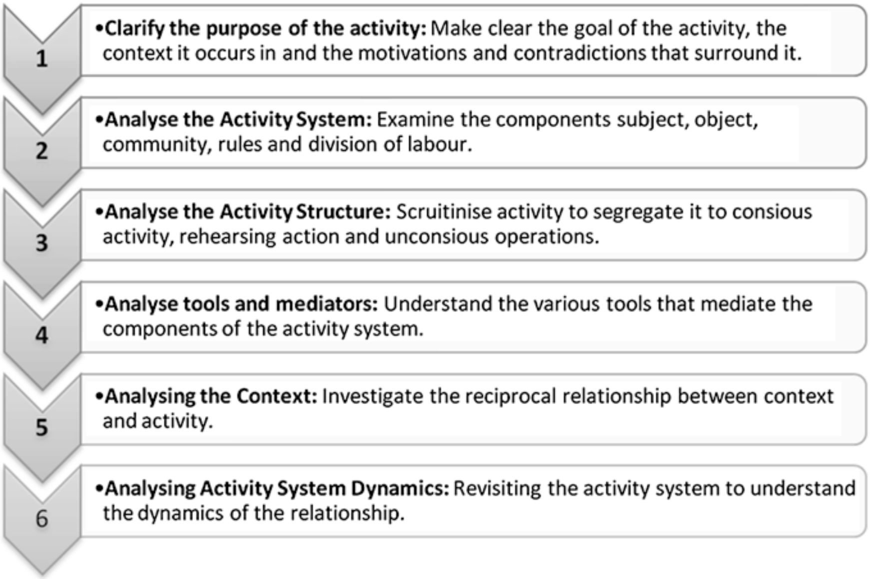

Fig. 4.2 Adapted six-step model of Jonassen and Rohrer-Murphy (1999)

Two research questions guided this inquiry: What types of learner–teacher interactivities does the teacher facilitate when using mobile learning apps? What teacher tensions affect interactivity within mobile learning app usage? (Fig. 4.2)

4.5 Findings/Discussion

Data analysis revealed that teachers tend to adopt various levels of learner–teacher interactivities in the use of software apps. These interactivities will fluctuate between teacher-centred to learner-centred approaches in classroom with the possibility of a contradictory situation of learner- and teacher-centred interactivity occurring simultaneously. This trend was noticed when observing various interactivities during classroom observations of all four teacher participants. All teachers also acknowledged during their interviews that with the use of apps by teachers and students reflects a spectrum of interactivities rather than one point. Therefore, it would be more appropriate to refer to interactivity as several points or a range of interactivities.

In relation to research question one, *What types of learner–teacher interactivities does the teacher facilitate in the use of mobile learning apps*, a range of points of interactivity were recognised, that is to say the amount of teacher and learner involvement with learning *tools* such as technologies and software applications slides constantly from active learner or teacher participation to passive learner or

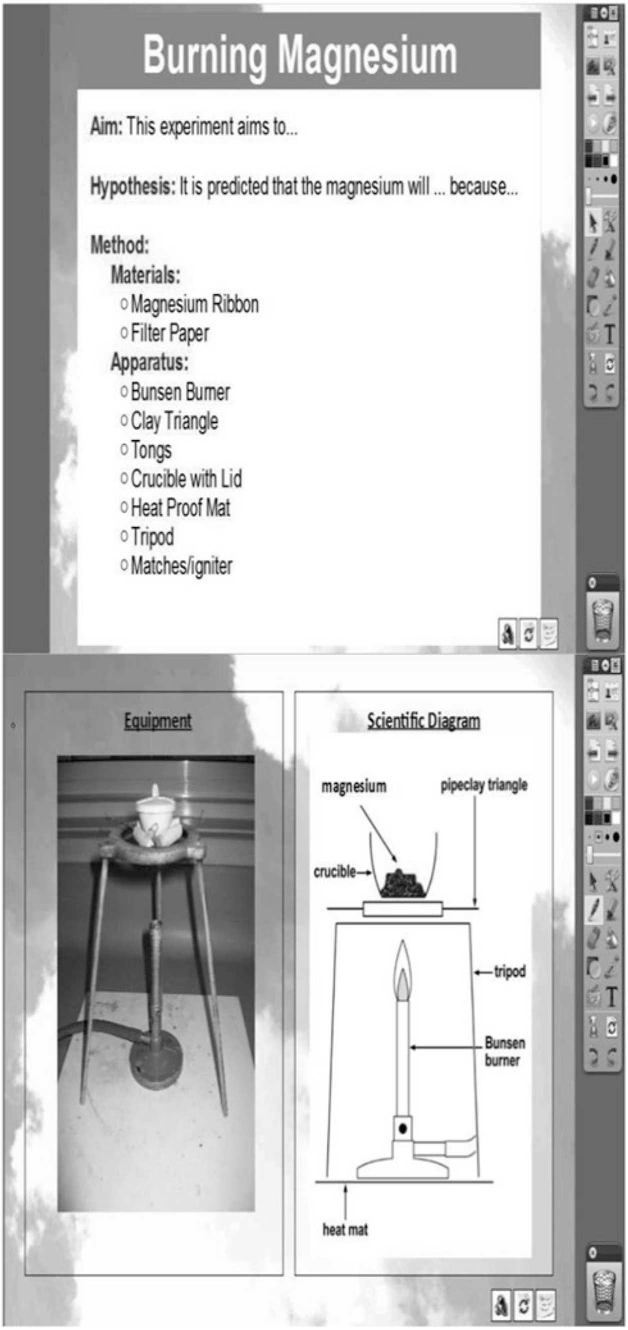

Fig. 4.3 Slides projected using the SlideShark app

teacher participation. During teacher interviews, this finding was regularly reiterated reflecting a continuum of pedagogical interactivities occurring in the classroom. As one teacher participant comments:

> Most lessons, particularly the initial part of the lesson will usually be teacher focused and hopefully moving towards student activity towards the second half of the lesson where to some extent there is a way of them applying the theory or the content. There are lessons that are much more student-focused and there are lessons that are teacher-focused but for me as a rule I would try and have a combination of both within each lesson.

Using the app, *SlideShark* by Brainshark, Inc., one participatory teacher displayed a slideshow from her iPad onto the IWB to demonstrate to students explicit directions for the science experiment, a visual model of what would look like, and then follow up pictures from each group's work (see Fig. 4.3).

Although the same slides were used at different junctures, the level of learner–teacher interactivity varied from complete teacher control to learner control and also resulting in a juxtaposition of both at one given time depending on the use of technology. For instance, during the first use of the slide the classroom teacher was in control of the teaching–learning process adopting a didactive teaching approach. However, when using the same slides at the second time, although in appearance the teacher was adopting a similar approach, the students were more learner-centred as they were in control of the technologies and tools they were using.

The spectrum of interactivity occurs with the use of SlideShark and the IWB ranging from teacher-centred, learner-centred, juxtaposition of learner and teacher-centred coexisting simultaneously and a blended approach either inclined towards active teacher control or learner control. Each of these categories and its features are discussed below using additional classroom-based examples.

4.5.1 Teacher-Centred Interactivity

Some teaching and learning processes are focussed on teachers and their authority of learning process (Tanner and Jones 2007), as they are actively involved and instrumental in classroom orchestration (Beauchamp and Kennewell 2013). This structure results in learners playing a more passive role in the activity system. Examples of this type of interactivity found from data analysis include: teachers controlling apps adopt an instructivist pedagogy; performing activities such as delivering theoretical knowledge with or without the use of embedded software in the technologies; providing overt instructions with or without the assistance of tools in the activity system, providing information using websites, expressing their opinions and inclinations and describing situations and scenarios. As the teacher exercised control over the use of the SlideShark app during the delivery of lesson object 'Ionic bonds', the teacher uses the iPad in conjunction with the app to explain this concept while learners are listening to instructions and demonstration of software applications by the teacher. The activity is controlled and exercised by the teacher. In a short moment, thereafter, teaching the same concept the teacher brings forward two learners to the IWB to drop, drag and attach 'ionic bonds' with other learners in the classroom providing feedback and suggestions. This example demonstrates how in a matter of few minutes complete teacher control can shift to learner control. Similar instances of this would be the teacher using the app in conjunction with the IWB as an expert to explain a mathematical concept while learners listen and thereafter apply that knowledge while using iPads or Cascalculators.

4.5.2 Learner-Centred Interactivity

The characteristics of this category of interactivity are opposite to teacher-centred interactivity and skew the interactivity towards the learner. Learners are more in control of their learning, while teachers are guided by learners to attain the learning goal. One of the teachers encouraged her students to use the app, *Geoboard* by The Math Learning Center, which can be used on almost any m-device (see Fig. 4.4). While the learners worked individually on making shapes and calculating area, the teacher's role involved facilitating, scaffolding, prompting with open-ended questions, observing, initiating discussions, enabling critical framing, learning from student observation, inquiring, and supplying feedback. Representatives use a selected iPad connected to the IWB and display the shapes, asking their peers questions for testing their knowledge. This illustrates how learners can lead the class in collaborative contributions to learning goals; learners conducting mathematical shape manipulation using necessary *tools*; and learners working independently on user-friendly and freely available software apps.

4.5.3 Blended Interactivity

In this category, both the learners and teacher are involved during the teaching–learning process and the level of interactivity can be slightly more inclined towards teacher- or learner-centred interactivity depending on the activity conducted. Multiple teachers utilised the app, *Twiddla by Expat Software,* to brainstorm and visually display graphics and print onto a blank canvas. This app essentially combines the functionality of an IWB with an iPad or mobile phone, allowing both the teacher and students' use to contribute to the overall classroom learning experience by overlaying mathematical formulas, graphs and lines (see Fig. 4.5). In this example, the teacher is, more or less, in control of IWB, while the students give verbal contribution and use Twiddla to relay input from their groups. That is, learners will be using the app while the teacher also facilitates its use and application by scaffolding the learning process. In this instance, the *tools, activities*, *actions* and *operations* in the activity system are juggled between learner and teacher orchestration, and in accordance to the lesson's objectives.

Fig. 4.4 Still image of Geoboard app showing an example of creating digital shapes and calculating area

4.5.4 *Juxtaposition of Teacher- and Learner-Centred Interactivity*

Sometimes teachers and learners have simultaneous access and control over mobile technologies. Here, learners will use *tools,* such as laptops, CasCalculators and software applications alongside teachers using IWBs. While teachers are in active control and use of their IWB, learners are in control of other classroom technologies. There is a coexistence of teacher-centred and learner-centred interactivity concurrently working in the classroom, resulting in a juxtaposition of pedagogies and interactivities. The teacher generally will be in control of the class with the use

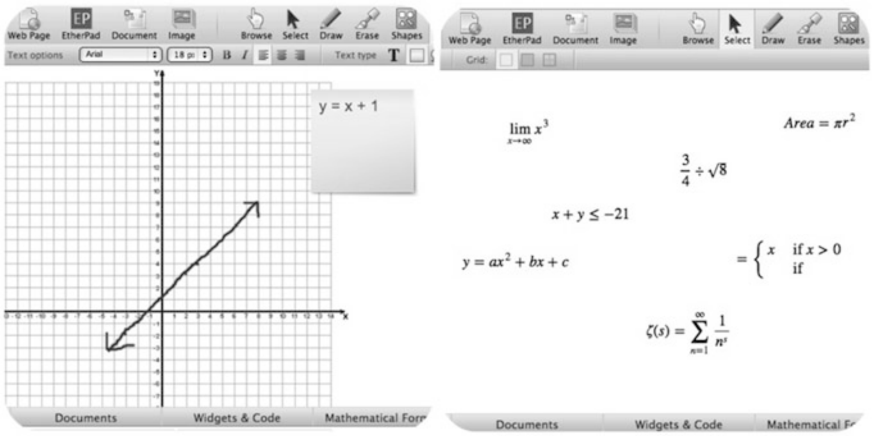

Fig. 4.5 Twiddla app showcasing teacher and student collective input

of the IWB and the related software applications using a teacher-centred approach; the learner will simultaneously be using other classroom *tools* and artefacts, such as laptops, iPads and software, applying his/her socioculturally and historically situated practices to attain the goal by using constructivist pedagogy.

Using the app, iPoe by iClassics Productions, S.L., one English teacher-embedded interactivity within her poetry lesson, an area that is often challenging for teachers to bring alive to reluctant readers. By combining visual imagery, motion and brilliant graphics, iPoe, encourages students to experience poetry rather than just read about it. This participatory teacher had her students use their iPads afterwards to write similarly themed poetry, of which some student samples would be displayed by the teacher onto the IWB for whole class sharing.

This juxtaposition of interactivity results in a position where the teacher is adopting instructivist pedagogy, while the learners are applying constructivist pedagogy in the learning process. This brings about a harmonising effect between the teacher and the learner in relation to interactivity rather than discord sometimes experienced at other stages of the interactivity spectrum. Harmony is experienced as a result of a hybrid of pedagogies being achieved. Another example of this type of interactivity was found when using the Hoodamath website, as learners were in full control of their iPads and the teacher using the IWB led discussions on the concept ‘similar triangles’. In this instance, the learners explored the online game and learning by comparing similar triangles using their prior knowledge, while the teacher used the IWB at the same time explaining concepts related to this topic.

It is clear that the level of interactivity between learners, teacher and technology in classroom settings is constantly changing to reshape and develop to meet the learning objectives. In fact, the precept of Engeström’s theoretical framework is that activity system is constantly developing (Engeström 2010; Kaptelinin and Nardi 2012). This dynamic series of activities comes together to form the many points of

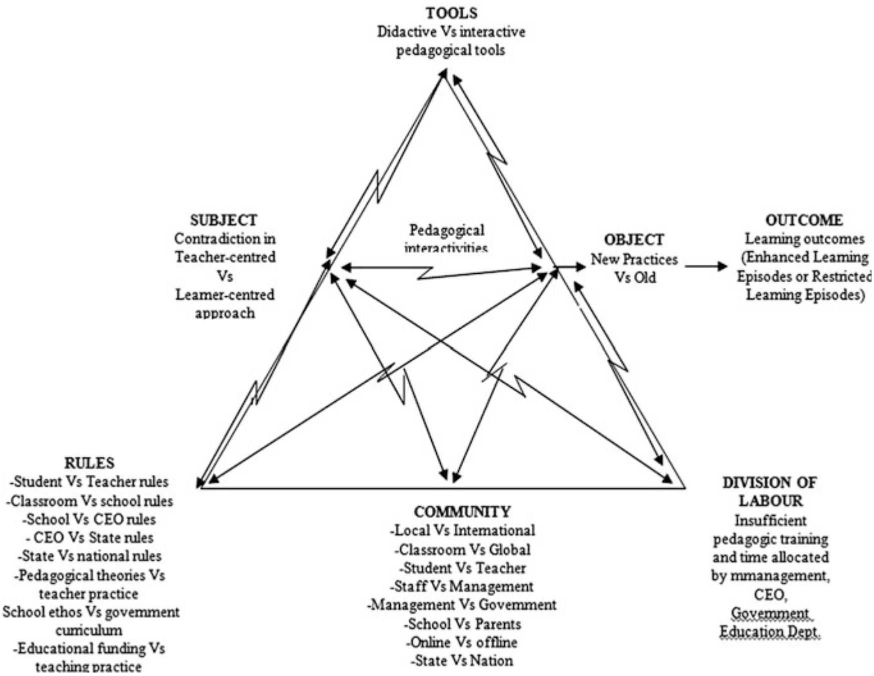

Fig. 4.6 Pedagogy as an activity system tension

interactivity possible within teaching and learning contexts which is represented in the Engeström's activity theory as shown in Fig. 4.6. The pedagogical tensions faced by teachers in the activity system. Here the teacher is constantly faced with the tension of making pedagogical choices of having a leaner or teacher-centred approach to teaching. The components such as the *rules, community, division of labour* and *tools* either facilitate or hinder the teachers' pedagogical approach and thereby influence the shape of interactivity. For instance the teacher has the tension of constantly having contradictions between the rules of the classroom, school and Catholic Education Office (CEO, the Australian governing body for Catholic schools) which affects the pedagogical choices. Many activity systems similar to the below figure helped the researcher identify and analyse in step two of the theoretical framework.

4.6 Conclusion

Using activity theory as a theoretical framework for this inquiry into the interactivities found when teachers and students use digital technologies and apps, this study sought to scrutinise, clarify and describe the many relationships between the learner, teacher and technology. The key findings of this study may be summarised as: first, interactivity in the classroom is not a single point of interaction that represents teacher-centred (didactive) or learner-centred (interactive) interactivity but rather a spectrum or continuum of points that represents many shades of learner–teacher interactions. The learner–teacher interactivity is ever-fluctuating when apps are used in conjunction with other m-devices. Second, when software apps are used in conjunction with other classroom technologies, there can be a coexistence of a learner-centred and a teacher-centred approach, resulting in a hybrid teaching and learning style. This juxtaposition of interactivities is more often made possible with the use of m-devices resulting in a tool kit of pedagogical practices. Third, the coexistence of learner and teacher-centred teaching–learning styles harmonises the inbuilt contradictions that could exist within their interactivity. Fourth, the spectrum points of interactivity are dynamic and ever-changing over time and can fluctuate so dramatically that the likelihood of two learning episodes, keeping all factors constant, are minimal, thereby making the contours of the interactivity unique and unpredictable. Teachers have to constantly work on short and long-term changes to keep up with this changing nature of the context and shape of interactivity. And finally, a variety of teacher tensions affects teachers' app usage along with other classroom technologies and the level of interactivity in lessons.

Given the inconsistency, voids in existing literature, and novelty of the concept of measuring interactivity in relation to teacher, learner and classroom technologies in the field of ICT, there is ample opportunity for research amongst scholars to clarify, append, amend, improve and make relevant this concept in our twenty-first century learning environments. There are many factors directly and/or indirectly influencing the shape of interactivity in relation to teacher pedagogy. For instance, the study observed there are tensions encountered by teachers in finding and preparing digital resources that are content relevant and interactive; teachers constantly resorted to teacher-centred approaches in order to cover vast amounts of curricula and in turn, impacted interactivity; teacher attitude and its relationship to the shape of interactivity; availability and access to m-devices and supported apps; developing an instrument to measure various levels of interactivity for reliable and valid data collection and analysis. The juxtaposition of learner- and teacher-centred interactivity appears to constantly reoccur when apps are used in conjunction with m-devices. Therefore, the need for studies to determine these occurrences and their influence on the orchestration of interactivities between apps and m-devices and their impact on teacher pedagogy m-learning design has invaluable potential for future scope of research in this area.

One of the most important considerations for selecting apps to use in the classroom is the element of interactivity. Betcher and Lee (2009) point out that "if you don't learn to tap into the interactive aspect of technology, you may as well not use [it]" (p. 68). The proliferation of mobile technologies (Toteja and Kumar 2012) provides more potential to tap into the interactivity and integration of the apps within pedagogical planning and delivery (Churchill et al. 2014). However, in order to achieve this feat, it is important that teachers can understand interactivity and determine the factors that influence them. Using activity theory as a lens provides a prominent starting point towards unearthing new discoveries related to context and collaborative learning and its interactivity with m-devices and software applications (Owen 2009). This study suggests that it is a difficult path; one that is not without challenges. It requires researchers, teachers, learners, policy makers, governments and others alike to play a significant role in supporting teachers towards overcoming these tensions related to bolstering interactivity in their classrooms.

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