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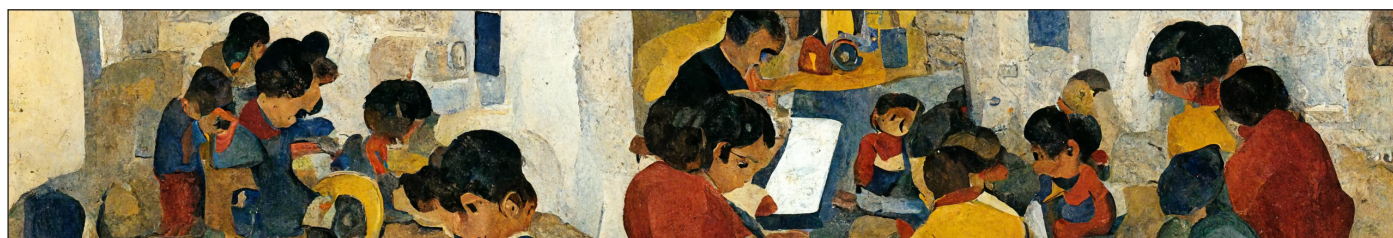
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Investigating the impact of digital resources on pedagogy in a Maltese kindergarten classroom through an activity theory approach

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Abstract

Technology in all its aspects has inevitably had a huge impact in education and is moulding the way we teach and learn. Children from a very early age come to school already immersed in this digital world. Educators are thus challenged into rethinking and reshaping their pedagogies to effectively integrate digital tools and resources, a change which is a complex process. This study investigates the impact of technology, in the form of various digital resources, from the perspective of a Maltese kindergarten educator (KGE). It will delve into if and how such technologies are transforming teaching practices as the mediating tools in order to stimulate and motivate active learning. Activity theory (AT) as the main theoretical framework is used to examine and analyse the pedagogical activity and the tensions within this specific sociocultural context. Activity theory enables the capture of the whole classroom dynamics of activities taking place, underlining how technology in its various forms acts as a multimodal tool enabling teaching and learning. Participative classroom observations are the main research instruments used to elicit findings and bring to light challenges and opportunities technology poses in such a context. The KGE's role as facilitator in the interactions taking place is studied in view of the whole dynamics of this activity system. The study has demonstrated the crucial role of activity theory to surface the social interactions, tensions and their development in this particular context to bring about transformation. Technology as a mediating tool in this activity system, brings

about change in pedagogy. Activity theory has also uniquely provided practical examples to show the framework applied successfully in a Maltese kindergarten classroom.

1. Introduction

In recent years, technology in all its aspects has taken a very dominant position in society at large including in education. Information and knowledge are ubiquitously available (Nisser et al., 2020). Children in kindergarten, who are at the very beginning of the educational spectrum, come to school already immersed in a society and culture which uses technology extensively, thus influencing the way they interact with the world. Consequently, with technological tools readily available in the classroom, and having children who are used to this digital interface, educators are challenged into re-thinking, reviewing and re-shaping their pedagogies to effectively integrate digital tools and resources, a change which is a complex process. Such tensions and conflicts could be catalysts into bringing about change and transformation in teaching practices. Activity theory, discussed below, provides an appropriate framework to holistically encapsulate and bring to light challenges and opportunities technology poses in such a context.

1.1 Local context, my role and purpose of the study

In Malta, children enter kindergarten at the age of three, where they spend two years of pre-primary education (kindergarten) before beginning their formal schooling. The first year of formal primary education is referred to as year one and continues up to year six when children are aged nine to ten. Kindergarten and years one and two are commonly referred to as the Early Years. In recent years all state schools have been equipped with a multitude of digital resources and tools such as Interactive Whiteboards (IWBs), virtual learning environments (VLEs) and other digital resources in a very short time, consequently overwhelming teachers and firing up much resistance and frustration.

At the time the study was carried out, my role in Maltese primary schools was that of an eLearning support teacher (eLST) now more commonly known as Digital Literacy Support Teacher. This entailed supporting all primary school educators, including kindergarten educators (KGEs) in their curricular integration of technology in the classroom. What I observed in certain kindergarten classes was that whilst there was limited training and professional development, some KGEs were still integrating technology in such a way that it was transforming teaching and learning at this very early stage.

There is acknowledgement from political stakeholders (see e.g. Ministry for Education and Employment, 2012) of the importance of introducing digital technologies in early childhood education, re-affirmed by Hansen (2008) “Clearly, technology within literacy instruction has the potential to benefit young learners” (p. 110). Despite technological developments in the classroom, local research to inform policies and practice is very limited, especially in the kindergarten classes. This motivated me into researching how technologies enhance or transform teaching practices during these early years to promote the good practices which other KGEs could adopt.

1.2 Why activity theory?

Existing literature/research has not been sufficient in demonstrating the lived reality of a kindergarten classroom with all its complex interactions. I needed a framework which could help to identify the activity tensions influencing the teaching methodology within this socio-cultural context. Activity theory provided this practical framework into analysing this under-researched area by bringing to light the challenges educators face in integrating technologies in a kindergarten classroom. Activity theory highlighted the interactions, associated activities and how tensions can also bring about change and transformation. Activity theory is not simply a methodology wherein a strategic approach is employed to analyse and understand a specific context, but it allows for an understanding of how the knowledge is socially co-constructed together through the interaction/mediation with tools. The learning processes were studied by analysing the interactions of human activity with technology thus focus on the whole dynamics. Such research where kindergarten scenarios are studied using the activity theory framework are very rare or non-existent in Malta. Therefore, through this study, I attempt to demonstrate how activity theory surfaces all the complexities and dynamics while also giving a voice to KGEs.

1.3 Research questions

- RQ1: How do digital tools impact teaching practices and activity within a Maltese kindergarten classroom?
- RQ2: How do teachers perceive digital tools mediating between them and their goals/objectives in ways that hinder, enhance or transform pedagogy?
- RQ3: What are the tensions and contradictions encountered, if any, when using such technology, and how do teachers attempt to resolve such contradictions?

1.4 Definitions

Throughout this paper I will be referring to technology and digital resources/tools interchangeably. My understanding of the term technology integration will not simply refer to the implementation and superficial use of a technology, the hardware and software, but specifically the curricular integration, which is the embedding of technology within the curriculum making it more meaningful (Hutchison et al., 2012).

The term 'teacher' will also be used interchangeably with KGE and educator. The term 'educator' has a wider definition, describing any teaching staff within the school including Learning Support Educators (LSEs).

2. Literature review

In view of technology as a tool which is transforming pedagogical practices, that is, the way teachers teach, this literature review sets out to explore and research how teachers capitalise upon technology as a mediating tool between subjects (teachers and students) and goals or objectives within a classroom environment, to enhance and transform their teaching practice. Bligh & Flood (2015) define the term mediation as something which implies that it is not immediate but that something is in between. In activity theory this mediation can happen between persons/tools/artefacts. It is by studying this impact of technology that we can better understand its dynamics.

2.1 Technology in the early years

It is important to primarily note the emphasis in this study of technology integration in these early years because I believe it is crucial that children are exposed to technologies as learning tools as early as possible. Hundeland et al. (2014) point out that becoming familiar with technology at an early age enables them to become competent participants as "the upcoming generation is in need of skills and competence regarding digital tools, their affordances and constraints" (p.2).

Research conducted on children up to age six has shown that they are already very actively engaged with interactive technologies and media before they start attending formal schooling (Rideout et al., 2003). It is also crucial to understand that certain skills need to be presented to the children at this very early stage.

The OECD (2017) report establishes the fact that the brain's sensitivity to developmental areas is at its peak during these early years and thus lays the foundations for future skills development and learning. "Investments in high-quality early childhood education and care...are key for children's long-term learning and development" (p. 17). The social and intellectual development of children at this age is evidently more malleable, and thus exposure to technology could have a much more significant impact (Rideout et al., 2003, p. 3). As evidenced, technology may be the stimulating factor in motivating and exposing children at the right time, strengthening their ability to learn and retain that learning. Yet the most determining element is the teacher, who is central to enabling and facilitating this learning. It is hence the role of the KGEs to expose young children to technologies as learning tools in their classrooms. Therefore, if teachers are not given adequate professional development opportunities as well as training, they will fail to seize the potential of technology in their pedagogy at this critical time.

The educational system and policies in Malta do not deny the importance of exposing children of kindergarten age to the use and integration of educational technologies within classrooms, yet how much of this is actually put into practice is another matter.

2.2 Technology integration in the classroom

Research highlights computer integration in education as assisting the development of learning and effective teaching. Through technology teachers are able to create a visually rich and interactive learning environment within their classrooms (Moos & Marroquin, 2010).

Engagement with digital tools has shown to support the learning process as the children become participants in the activities and interact with the tools (Hundeland et al., 2014). The author observed this when the children created a simple slideshow together, the engagement was evident as they were motivated by the visual display and use of the computer, interacting through the technology. Hundeland et al. (2014) gain insights into how the IWB is used as a mediating and multimodal tool, engaging children in mathematics in a kindergarten classroom. Through active participation and manipulation of the tool the children make meaning of abstract mathematics aided by the visual displays.

The IWB, which is the main digital tool used in all Maltese classrooms, is at the heart of improving student learning in view of its affordances to active participation. It is a tool supporting whole class teaching, it is in effect a mediating artefact in interactions between teacher and children (Lewin

et al., 2008,). The authors draw on research carried out to evaluate the impact of the IWB both in teaching and learning in primary schools in England. They found that young children were highly motivated by its use as they are able to demonstrate their knowledge to the whole class. The research also highlights its best use when the teacher has been using the IWB for at least 2 years. The IWB then becomes embedded in their pedagogy as a tool to assist their interactions with children. It must be noted here that teachers in Malta have limited technical and pedagogical support unlike the teachers reported by Lewin et al. who had more training and support.

Integrating technology presents certain challenges resulting in teachers who refrain from using the technology available or do not utilise the tool to its full potential. This reality is sustained by Plowman and Stephen (2003) "ICT has been brought into educational environments as a useful supplement to existing resources. Its use does not transform practice, however, and pre-school practitioners tend to perpetuate existing ways of working whilst accommodating the new technologies" (p.149). I personally experienced this first hand and through this research hope to gain more insight into these challenges and how they are overcome by Maltese teachers who have successfully integrated technology into their practice.

Lin (2012) not only acknowledged this truth of teachers shunning technology, but went further as to propose a model for computer integration to assist teachers. The model was based on previous studies and analysis of data from Taiwan's kindergarten classes. Examples of use of the model assisted teachers in the application of technology.

The teacher's role has transformed with the advent of technology merging from mere sole providers of knowledge to facilitators in the learning (Ertmer et al., 2012). This transformation has been identified in the teacher observed, Her role in the activities has taken a 'back-seat' and children are more on the forefront of their own learning. "Both literally and metaphorically teachers have to learn to 'stand away' and allow children to fully engage in interaction" (Lewin et al., 2008).

Participation is key in these activities as it "provides the fundamental mechanism for learning" (Sutherland et al., 2009). In addition, Sutherland et al. stress the role of the teacher as crucial in bringing together the activity. The teacher controls the classroom, scaffolding learning and interacting with students accordingly (p. 45). The active participation of children confirms this, highlighting the

importance of the teacher's expertise in managing activities to be of any benefit.

Lin (2012) maintains that a successful integration of technologies does not depend on the quantity used but choosing to use appropriate technology at the right time and place. Throughout their report Luckin et al. (2012) demonstrate a wide range of digital technologies which support learning in various aspects. It is thus worth studying practices to utilise the full potential of these tools. Accordingly, this study focuses more on the teacher's practices and pedagogy than on the children themselves. It attempts to further investigate the potential of integrating digital technologies in kindergarten in such a way as to enable active and participative learning. The existing literature mainly focuses on primary schools but rarely on kindergarten classrooms. In addition, examples of the use of technology are mostly based on the IWB (Kent, 2006; Kim et al., 2013; Lewin et al., 2008; Mumtaz, 2000; Zevenbergen & Lerman, 2007), with few researchers examining the numerous other digital resources which can be used with or without the IWB.

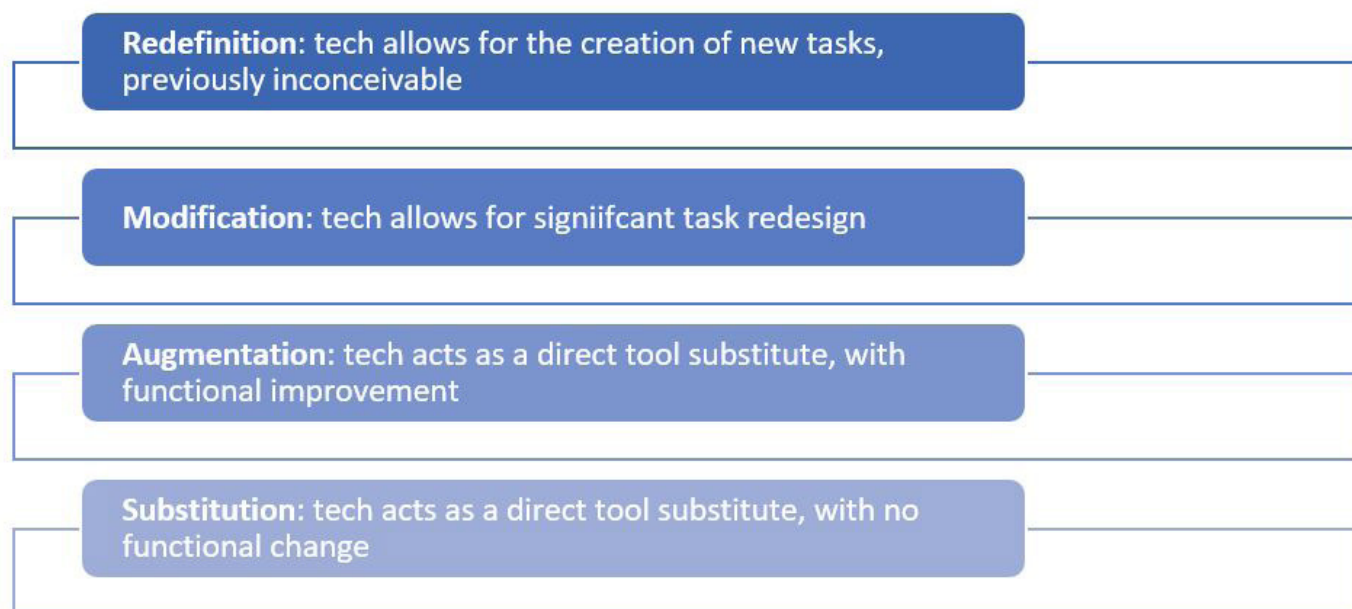
2.3 The SAMR model

The integration of technology can also be gauged through a model developed by Puentedura (2010), the SAMR model — Substitution-Augmentation-Modification-Redefinition — which establishes the level of technology integration and the approximate level of change within teaching practices (see Figure 1).

The SAMR model in the current study can identify the levels at which an educator is applying technology and whether it is meaningful and transformative or simply a substitution, just a change in the medium used for both teaching and learning. It can thus provide both a focus on the affordances or constraints of a particular technology (Hamilton et al., 2016, p. 438).

This model shows the progression developed in technology adoption in the classroom. It establishes the shift in activities from the basic enhancement level, which are substitution and augmentation wherein the educator simply uses technology to accomplish traditional tasks by substitution (with no evident change or enhancement to learning) to the transformation level, where we have modification and redefinition. At this level technology changes and redefines the teaching and learning processes, enabling the user to create, co-create, collaborate, and interact in tasks which were previously inconceivable. This interaction with the tools, with other children in the classroom and with the

Figure 1. The SAMR model, developed by Puentedura (2010)



educator creates an activity system wherein all stakeholders are aiming for the same goals/objectives.

Notwithstanding, and still keeping the SAMR model in mind, this research goes on to unpack the impact of digital resources on teaching and learning through the AT framework. As discussed further in the next section, AT is a theoretical framework which can compile the complexities inherent to technology use in the classroom, as a process meeting instructional objectives and achieving set learning outcomes.

3. Theoretical framework

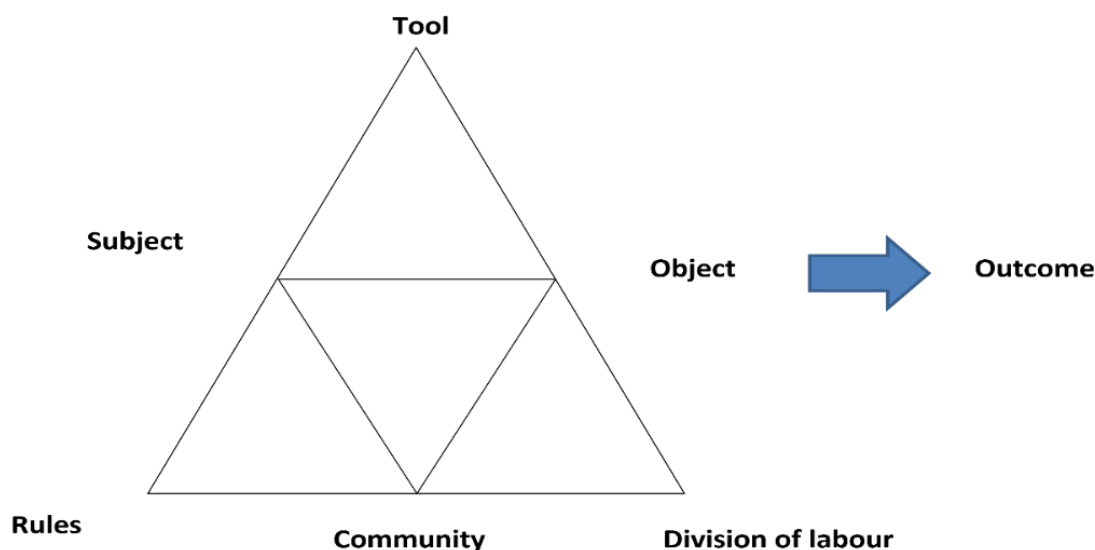
In exploring conceptual frameworks, I found activity theory provides the appropriate framework to holistically encapsulate teachers' activity when using digital tools within the classroom context. It helped reveal how technology mediates social action, supporting/challenging the teacher into reaching and reshaping her pedagogical practices and objectives. Activity theory also exposes the tensions created and if and how they are resolved. "Activity theory is a practical framework which can be used to underpin the complex and dynamic problems of human research and practice" (Hashim & Jones, 2007). Using the activity theory lens provided me with an analytical tool to study the "complex pedagogical activity embedded in and affected by a combination of multiple layers of personal, social and institutional contexts, which closely interact with each other

as they affect the activity outcomes" (Kervin et al., 2013). Consequently, with the focus in this research on contradictions and tensions, activity theory is the ideal framework to explore such scenarios and their developments especially "...in illustrating particular aspects of situational dynamics; in apprehending the complexity of the researched situation and in identifying tensions (i.e., contradictions) within that situation; and in providing a common language for description and analysis" (Bligh & Flood, 2017, p. 138).

Although the literature review reveals a multitude of studies where the activity theory framework has been adopted to study technology in primary classrooms (Lin, 2012; Yong, 2010; Zhao, 2010), in the Maltese context this is an innovative approach. AT, as a framework, has not been so widely used locally in educational studies and neither has it been used as a tool to study and conduct research with KGEs in the classroom.

Activity theory is an ideal framework to study innovation and change as it happens within a system because it takes into consideration the multitude of variables such as the context, the system rules, the community, and looks at how these interact together, between themselves and through the mediating tools. Activity theory looks at contradictions in the system which could work either against the targets to be achieved or if solutions are found, bringing about systemic change. Activity theory also looks at the crucial role of the teacher in the system who determines the processes and uses the tools appropriately to achieve pre-identified goals. The

Figure 2. The proposed activity system based on the model formulated by Engeström (1987)



complexity of the system which incorporates technical and pedagogical issues are exposed and then analysed within this lens. Central to this approach is the comprehension that learning and teaching are culturally based social undertakings, highlighting communicative aspects where knowledge is shared and co-constructed (Hardman, 2008).

3.1 Activity theory – A definition

To activity theorists, technology, change, pedagogy, and challenges are not detached isolated concepts but interrelated and are investigated as they work together within a system. Activity theory provides the framework to study classroom activity within a situated sociocultural context by understanding human behaviour and social interactions “...in their natural everyday life circumstances, through an analysis of the genesis, structure, and processes of their activities.” (Kaptelinin & Nardi, 2006).

In essence the mediated action triangle in activity theory (see Figure 2), proposed by Engeström (1987), explains how activity, enables humans to develop through interaction with tools and social others to find new meanings.

Vygotsky’s main concept revolved around the understanding of the interactions between three nodes: the subject, tool, and object. The collective subjects represent the individuals directly involved in activity, who act upon the object, which is the desired outcome/objective of the activity, transforming it through mediating artefacts, which are signs and tools (Hardman, 2007). This model triangle was further developed by Leontiev (1974) then Engeström

(1987) who related activity theory to expansive learning. Engeström added the components of rules, (e.g. expected norms of a classroom setting), community (people interested in classroom activity yet not directly involved), and the division of labour (the allocation of tasks and roles). These additions by Engeström offer a more dynamic overview of the teaching and learning processes. Waycott et al. (2005) report that there is an interchange between the tools and the learner where:

the user adapts the tools they use according to their everyday practice and preferences in order to carry out their activities; and how, in turn, the tools themselves also modify the activities that the user is engaged in (p.107).

In this study the teacher is constantly adapting the technology, the mediating tool, to best suit the learning needs of the children, the activities and teaching practices to achieve learning outcomes, the object. The challenges and contradictions presented by the technology can result in change and development (Engeström, 2001) rendering contradictions as catalysts for transformation.

3.2 Tensions and contradictions in activity theory

In activity theory the principle of contradictions helps to identify conflicts and tensions which emerge in a system. Engeström (1987) not only identifies such contradictions but also denotes four distinct levels which analyse the process of transformation (Bonneau, 2013):

- Primary contradictions occur within the same element of an activity system such as within the community.
- Secondary contradictions occur between nodes of the same activity system such as the subject and the community.
- Tertiary contradictions arise upon the introduction of a more advanced object to the system such as new technology or practices.
- Quaternary contradictions arise “between the central activity and its neighbouring activity systems” (Foot & Groleau, 2011).

The term contradiction can thus be considered as the source of development and change (Gedera & Williams, 2013, p. 34) because when confronting tensions in practice, teachers may adopt ways and means of overcoming obstacles and consequently develop such contexts into opportunities for innovative and effective solutions to tensions encountered. Engeström and Sannino (2011) argue that contradictions are not easily distinguished and “must therefore be approached through their manifestations” (p. 371).

The contradictions and tensions exposed and manifested when “practitioners articulate and construct them in words and actions” (p. 371), will be analysed to determine whether they lead to change and transformation or hinder innovation.

3.3 Activity theory application

“Nowadays, a common application of Activity Theory is for the study, analysis and interpretation of the changes required for the transformation of collective practices” (Karasavvidis, 2009, p. 438). Pedagogy is an ongoing social construct (Price & Oliver, 2007), so what better way to analyse this impact than through AT, which is a social constructivist approach?

As a conceptual lens it allows for a visualisation of the “context of the educational processes under investigation” (Gedera & Williams, 2016). These authors have managed to compile a not-so-common collection of works using activity theory in educational research, interwoven with transformations in education. This collection presents theoretical and empirical studies from various aspects of contemporary educational contexts as well as diverse continents. Engeström in his opening comments to the book states that “the model of an activity system makes visible the context of the educational processes under investigation” (p. vii),

indicating how this approach exposes insights to pedagogical practices immersed in a socio-cultural environment.

Yong (2010) studied the elements which would impact the integration of ICT in teaching and learning when introducing an innovation. Yong found that the sociocultural approach – the rules, division of labour and “strong leadership together with a high level of technical and pedagogical knowledge and skills” (p. 6) – facilitates curricular integration of ICT. Emerging contradictions identified could then lead to an expansive form of learning (Engeström, 1987). The tensions between subject and tools, resolved through commitment and perseverance in Yong’s study, are shown to lead to an expansive form of learning in the teacher’s own pedagogy and hence transformation. This current study seeks to investigate the tensions between the KGE, technology, and other elements such as the school environment, and if or how they are resolved.

Pedagogical activity, which is the main focal area of this study, is multifaceted as much as it is complex (Hardman, 2008), necessitating an approach that is situating interactions in time and place. In this case we have a KGE who is being observed in her classroom environment, studying the ways in which technology is changing or re-defining her pedagogy.

Teachers introducing new digital tools may be driven to find modifications to overcome contradictions encountered, and if they succeed continue to develop upon those teaching strategies. The rules or the tools may have to be modified to suit the activity more appropriately in the process. This continuous adjustment by the KGE and the children to meet the objectives of the activity is not a static and linear process and as such allows for development, re-thinking and re-constructing. The classroom is a live community, and the teacher seeks to find the most effective tools to bring about learning. Thus, in this context activity theory is applied to study technology as the mediating multimodal tool, for interactions between teacher, learners, and goals.

One of the studies in this collection of empirical research findings applies sociocultural historical activity theory in an elementary Singapore school to analyse how distributed leadership can facilitate the uptake of one-to-one computing (Yong & Lim, 2016). The four levels of contradictions and tensions defined in activity theory and arising during the implementation are examined. The discussions and actions which take place address the disturbances demonstrating that social mediators can be key in bringing about a successful integration of technology. The authors argue that shared leadership is central to success because it is extended to the

school's teaching community. This community is inclusive of the school principal, ICT co-ordinator, curriculum co-ordinators, and teachers. In Malta this can be taken up as an example wherein the school community – school leaders, eLSTs and other teaching staff – can come together to discuss contradictions and tensions, find solutions and be able to integrate digital resources and tools in their pedagogy in their specific context, rather than left to tackle problems individually.

The complex activity system taking place in the classroom includes interdependent elements which can come from outside the classroom. These can influence, contradict and mediate the activities. Activity theory allows researchers to explore these elements and the transformative processes, expose barriers, and provide recommendations. Verenikina et al. (2010) use activity theory to investigate the implementation of the IWB in literacy teaching in an Australian primary school. This enables them to view the IWB as a mediating tool which enhances pedagogical practices with emphasis on the tool as needed to achieve an outcome. "Technology alone is not the remedy to a quality education system rather that technology is useful relative to its need in achieving a learning outcome" (p. 2613). The authors expose the influencing role of the rules underlying the curriculum, which may hinder or encourage technology use as does the division of labour between the students and the teacher. In my study similar insights were possible through such a framework.

Lin (2012) proposes eight model kits to support kindergarten teachers' integration of technology. Lin demonstrates the importance of having practical models based on real classroom situations. In Malta KGEs also need to have the opportunity of learning how to practically apply digital resources and technology in their everyday activities. Instead of models, eLSTs could provide that support on an individual basis or through showcasing best practice, from KGEs themselves, in professional development sessions.

AT is also used to investigate pedagogical practices in mathematics in a primary school through object-oriented activity. The findings indicate that pedagogical moments could be captured and thus studied. By approaching technology integration from a sociocultural dimension, it can be viewed in its entirety, primarily as this would be including the context wherein ICT is being situated. Again, exploring how activity theory in this particular study has been used to investigate pedagogical practices, and the sociocultural dimension, helped me in applying the knowledge in the Maltese kindergarten scenario.

AT is increasingly used as an analytical tool in educational research (Hashim & Jones, 2007) primarily because it explores the mediating role of tools without depending on the participant's perspective (Scanlon & Issroff, 2005).

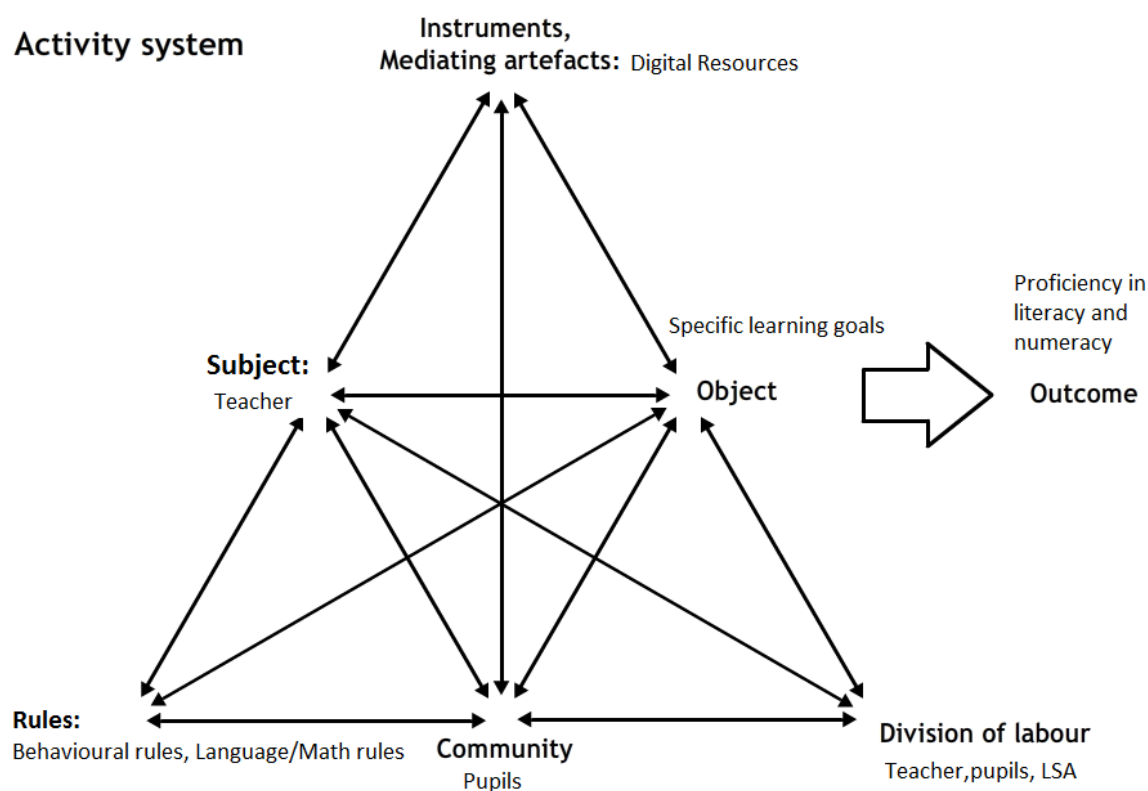
My research studies the impact of technology, in a sociocultural context, which in this case is the classroom and school environment, and its impact on pedagogical practices. Yong (2010) highlights this importance of the sociocultural aspect of situating ICT in the classroom and looks for elements which impact teaching and learning. Furthermore, activity theory is applied to highlight the barriers and challenges KGEs face bearing in mind the important factor that the KGEs are dealing with very young children, which in itself is very challenging.

3.4 Proposed activity system

The activity theory triangle model expanded by Engeström (1987) is being adapted to observe the role digital tools play in the classroom, a natural setting. My proposed activity system as shown in Figure 3 illustrates, based on my experience as a professional in similar kinds of settings, how the various components interact in a particular kindergarten classroom. The subject, the person who is the focus of the activity, is the KGE whose primary aim and role is to engage children (community) into the activity through the use of tools/artefacts which in this case included digital tools as "the mediating artefact by which the action is executed" (Hasan, 1998). When acting upon the object, a specific learning goal, it is transformed, resulting in an outcome – such as proficiency in literacy or numeracy. The rules vary but some rules are constant throughout such as behavioural rules. The teacher's dynamic capabilities include managing children's behaviour, the interruptions both from within and outside the classroom, seeing that everyone conforms to the rules and delivering the lesson, all within the classroom activity setting. The work done to achieve the outcomes is distributed between the teacher, children and LSE as shown in the division of labour. Today technology-enhanced classrooms challenge teachers to a new form of classroom management – 'orchestration' (Dillenbourg, 2011) which is the managing of digital tools, and in this case, to an already complex ecosystem of around 18 very young fidgety children with time and curricular constraints. Dillenbourg compares the energetic teacher "managing multiple actors and multiple tools" (p.7) to the conductor of an orchestra.

The present research demonstrates that when digital tools have become part of the classroom ecosystem through frequent use, and do not remain the focus of the activity,

Figure 3. The proposed activity system within a kindergarten classroom



then transformation in learning can occur. The teaching strategies used to manage the activities vary according to the tools, rules, community and division of labour. Contradictions may arise between the components leading to modifications of the activity as explained earlier on.

Some teachers may lack the pedagogical knowledge and fail to realise what the potential of these “new technological tools mean for instruction in early learning environments” (Kaumbulu, 2011, p. 3). Such challenges may serve as barriers to curricular integration and inevitably technology is used for its own intrinsic value rather than engaging constructively in the teaching and learning process – focusing on the technology itself instead of its pedagogical use (Flavin, 2017). Flavin argues that technology enhanced learning in higher education to date has been misdirected because it focused more on technologies than on practice with technologies, something which is also evident in Maltese primary and kindergarten classrooms (p. 19).

The National eLearning strategy (Government of Malta, 2008) included the Smart vision which also recognised the importance of technology as a tool. “Technology will lubricate this new industrialisation. But technology has no value in and of itself: it is a tool for people to use to realise

their vision, their aspirations, and indeed their full potential” (p. 4).

Yet, at the same time, these same barriers could be catalysts into bringing about transformation in teaching practices. Within an activity system these contradictions are seen as the drivers bringing about systemic change.

The KGE under observation shows this curricular integration of digital tools as opposed to using technology just because it happens to be available. This implies that learning cannot happen just because an educator is using a digital tool. It all depends on the way these tools are presented to the learners and the interaction that will follow that will determine its effective implementation. Flavin (2017) argues that change in teaching and learning happens through social intervention such as the change in rules or division of labour within the framework of AT.

4. Research design

The empirical evidence collected is based on one case study. Case studies provide rich instances of the phenomenon being studied and provide the opportunity

to observe and investigate activity theory in its situated environment (Eisenhardt & Graebner, 2007). Cohen et al. (2007) argue that case studies “investigate and report the complex dynamic and unfolding interactions of events, human relationships...in a unique instance” (p.253). Activity theory thus was seen to be the most adaptable framework to enable the unfolding of one particular classroom activity system because it organises and analyses actions. The chain of actions are analysed then as driven by specific goals to achieve outcomes as a dynamic whole.

4.1 The research site

The school chosen was one of the schools I regularly visit as an eLST. This made it easier to conduct as being an insider, my role as a researcher could yield more in depth data. This familiarity provided the opportunity to gain more insights into classroom activities as I could study the activity in its natural settings and closely observe and understand all the dynamics.

4.2 Sampling

Being a case-study one class was chosen based on the willingness of teachers who wanted to be part of the research. One kindergarten class was selected since this is a small scale research within a limited time frame; this teacher was chosen as she demonstrated good practice. The class is made up of 18 children aged between 4 to 5 years old. In Malta kindergarten classes have only one teacher per class and if a child with special needs is present a LSE assists the child in class, in this case there was one such child and an LSE to support him. The class is furnished, as all kindergarten classes, with one IWB, one desktop computer, with internet access and a projector. Some digital resources available in the school are shared amongst the staff.

The teacher who accepted was eager to share the challenges and changes experienced in her classroom to better understand herself the role of technology in her practice.

4.3 Instruments

The research instruments used in this case study include participant observations - taking an active role in the lesson/activity itself - and voice recordings, because ‘real-life’ interactive settings are the most realistic methods to inquiry as not all knowledge is “articulable, recountable, or constructible” (Mason, 2002, p. 85). Other instruments included images of the activities, field notes and informal conversations with the teacher. As I have the kindergarten teachers’ trust, the questions posed were more like casual

conversations rather than any formal question and answer session. Being at ease elicited more honest responses than it would with researchers who might have hidden agendas or exert power relations and thus influence the responses.

4.4 Data analysis

The research design was structured around the activity theory framework, as described earlier, and was implemented to analyse the whole activity and understand the dynamics of each particular session, breaking it up into the components of subject, tool and object.

Adopting this system for analysis of a classroom environment is conforming to a deductive research approach because the author is already envisioning the theoretical framework, a hypothesis, and through observational data will confirm theory. Phenomena is being measured against a central pattern of association (Nature, 2009). Yet this research also follows an inductive approach because it allows, from specific observations, for a pattern to emerge demonstrating broader generalisations and theories.

The qualitative data collected was also analysed using content analysis. This was manually coded and categorised accordingly into themes. The major emerging themes were: benefits of digital tools, development and improvement in learning, increased active participation, tensions, collaboration and change/transformation. The activity system is in itself an analytical lens to study the dynamics of the whole activity as the unit of analysis (Hashim & Jones, 2007), broken down into the components of subject, tool and object.

In this research, the activity checklist created by Kaptelinin et al. (1999), see appendix A, was initially used as a tool and a guide because it provided sample questions for insights into understanding and analysing use of a computer technology context emphasizing “the principle of tool mediation” (p. 270). Activity theory was then applied during the observations in which classroom activities were analysed.

4.5 Ethical consideration

Ethics has been given much thought as this involves the direct observation of a classroom of young children. Due to the fact that the teacher here is the main person under study there was no need for parental consent. Permission for research was sought for and approved from the Ministry of Education in Malta in line with regulations on research in Malta specifically from the Research Ethics Committee, the head teacher of this particular school and the teacher concerned. The latter was given a consent form to sign along

with an information sheet describing the intentions and purposes of the research. It was confirmed that all the children in the particular class being observed had their Acceptable Use Policy (AUP) - in order and signed even though the children were not the main focus of the study.

5. Findings

In this section I will be covering four aspects of classroom activity as emerging from the observations which show varying uses of digital tools and how activity theory helps participants to examine the dynamics of their activity:

- An interactive online Math game using the IWB – the focus here is on the use of the IWB and the children actively participating in their own learning including contradictions this implies
- Using Math Rabbit software – in this activity the children focused on the rules bringing about other classroom interactions.
- Creating a story with Story Maker – this activity emphasizes other contradictions which lead to development both in pedagogy and teaching skills.
- The Easi-speak – a digital microphone – this activity demonstrated how a tool can be manipulated by the subject (teacher) to reaching desired outcomes more effectively.

The four sessions observed are structured as follows:

- A short description of the activity (Description)
- The intended object of the activity for the teacher (Goals)
- The tool that was being used (Tool Mediation)
- The teacher's perceived changes of the activities (Contradictions)
- The developments that emerge from the activity (Development)

Initially when the digital tools were first being introduced in the classroom and still very innovative, the teacher spent time teaching the children skills to use the technology. Hence at that time the skill to use the technology was the object of the activity. As the children became accustomed to the skill it did not remain at the focus of the activity and the teacher moved on to use the technology as a tool to achieve outcomes of teaching numeracy and literacy, aided and mediated through digital tools. It is clear that the skills in dragging objects on the IWB, opening software, choosing levels and so on became so familiar with the children

shifting into operational skills as described earlier, moving further up in the hierarchical level of activity theory. This enabled the children to concentrate more on the learning than on the tool.

The teacher has been using the IWB, as well as other digital tools, for a number of years; consequently, they are embedded into her pedagogy. This has brought about skilful use of the tools and improvements on previous practices. Most importantly the focus has deviated from the technology to the pedagogy (Lewin et al., 2008). With reference to the research question this shows how technology has driven the teacher to change pedagogy and transform her teaching practices to be more relevant to the changing dynamics of the classroom.

5.1 Major contradictions

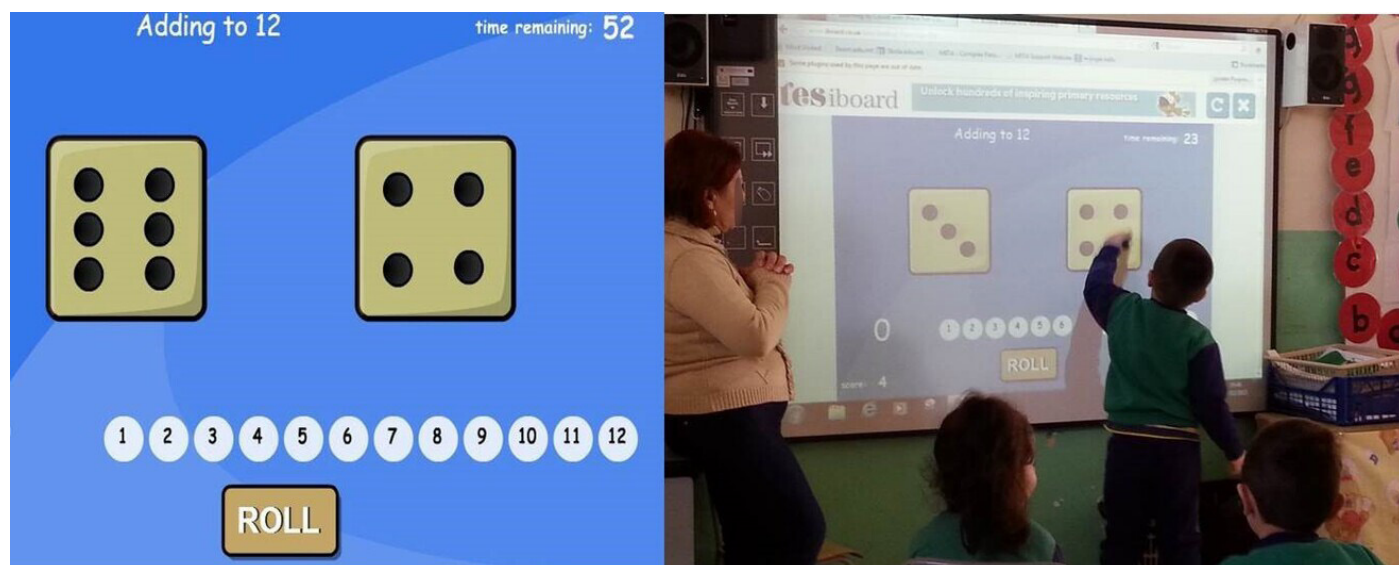
The teacher reports that the greatest hurdle she faced when first introduced to the technology was the lack of training "...you have to find out for yourself even though we had some form of training. You have to try out the activities yourself and find which works best – because in the end they are very motivating". This proves that contradictions were in themselves learning experiences and transformation opportunities.

The slow internet connection was also a major contradiction in the activity affecting interest, and easily losing children's attention. Another problem the teacher encounters is when a fault arises in the class computer or printer. The school has no technician but a system wherein a call is logged to a central call centre. Unfortunately, the system is not very efficient resulting in delays to get the problem solved. Although these barriers hinder use of technology they have not discouraged the teacher to find alternative routes to overcome them.

5.2 Using an online interactive game

5.2.1 Description

In this activity the children were playing an online game from <http://www.iboard.co.uk/activities> on the IWB: An interactive game wherein children add the two numbers shown on the dice and choose the correct answer. See Figure 4.

Figure 4. Child counting the dots to find the answer

5.2.2 Goal

The goal of this activity was demonstrating the understanding of the value and recognition of numbers.

5.2.3 Tool mediation

The tools used here; the IWB and the game, which mediate between the subject (teacher) and the object (what the teacher wants to teach) making counting for the children more visual, tangible and fun. The game here (the tool) has enhanced the way the teacher teaches and reinforces counting and adding numbers; through interaction with the IWB, teacher prompting, verbal responses as well as non-verbal gestures. The children are the actors in the community benefitting from this activity. Thus, the game (tool/technology) is enabling the children achieve the goal of recognition and value.

5.2.4 Contradictions

The teacher stresses the importance of the element of fun. “Children love to use digital tools it means having fun and if they are enjoying it then it means that they will memorise and learn the concept more easily. That’s why technology has changed my teaching practices”. The rest of the children need to wait for their turn, be patient and quiet these are the underlying rules in the activity which need to be followed – the contradictions in this activity. They too are participating by counting together and suggesting answers. This makes the interaction a learning space where the children take over their own learning, are active participants,

and the teacher’s role becomes more of a facilitator as cited earlier in the literature review.

5.2.5 Development

These new roles -where the teacher is more of a facilitator – and the new rules for the children – present themselves as contradictions at first. Yet gradually have driven the teacher to change. A notable enhancement of teaching practices followed as the activity was motivating and stimulating children’s attention. “...clicking to see the dice roll, hear the music and count, all this is multisensory: visual, auditory and tactile, so all the senses are being stimulated. It’s a game so it’s enjoyable and they can do it themselves. Knowing their turn will come makes them pay attention as everyone participates.” AT shows how the contradictions brought about a positive change in pedagogy.

5.3 Using an interactive software – Math Rabbit

5.3.1 Description

In the second activity, see Figure 5, the children mentally add numbers and chose the correct answers through the software - Math Rabbit on the IWB. In this specific lesson the children demonstrated previously acquired ICT skills such as how to open the software, choose an activity and a level.

Figure 5. Child using Math Rabbit

5.3.2 Goals

The children learn to count and add 1 to a given number, all within an attractive circus background complete with performing seals.

5.3.3 Tool mediation

The tool here is the activity embedded within the software. An underlying rule here is counting on; the child has to know how to count or add to win the game. So the rule in this context will help the child to win the game in essence becoming another tool. This displays how elements within the activity are interchangeable as the dynamics of the classroom change. By interacting with the game the children learn how to add on.

5.3.4 Contradictions

It is evident that the teacher gives the children space to be independent learners through basic ICT skills which they then use without thinking – application of what they learn which at first is difficult and tricky. The contradiction at first here is the lack of ICT skills.

5.3.5 Development

Development of practices brings about changes for the teacher and new skills for children. This was clearly observed when the children were participating in the activities. I find that this is uncommon as most teachers tend to do

these actions themselves underestimating children's' capabilities. Over time this not only gives teachers more space to stand back and observe, but nurtures in the children from this early age, a sense of confidence and responsibility for their own action a clear example of the division of labour in the activity.

The teacher has to be flexible in allowing this change as much as allowing the children to take control of their own learning. Prior to the technology being introduced the same lesson was “just doing it on the board without any fun factor and no participation or hands on” which was not so effective, pictures had to be drawn and at the end rubbed off for the next lesson, resources had to be prepared manually cut and coloured. A lot of time was taken in preparing content. The technology enables the teacher to focus on the actual teaching, while equipping the children with skills to be active learners.

5.4 Using Story Maker

5.4.1 Description

Story Maker (<http://www.communication4all.co.uk/http/storymaker.htm>) enables children to create a slide-show by providing the background image and pictures, the children then move the pictures around to create and invent their own stories - see Figure 6. The theme ‘Easter Egg Hunt’ is shown on the IWB with the various pictures to build their

Figure 6. Story Maker



story. Together the children start brainstorming a story related to the pictures.

5.4.2 Goals

The objective here was to build a story collaboratively through stimulating imagination, creativity and sparking conversation (oracy). This interaction between the elements in the activity led to achieving the object.

5.4.3 Tool mediation

Story Maker, the tool, enables the process of collaboration and internalisation – of learning by doing wherein the children are dragging the pictures and deciding where to put which. Collaboration, which is not easy at this age, is in turn bringing about effective learning through discourse – externalisation and also division of labour.

The tool (Story Maker) enables the internal processes of thinking, about creating a story through stimulating discussion and class participation while children are discussing the title, the story. The process is externalized as children physically come to the board and move pictures around according to the progression and sequence of the story/activity. The externalisation then enables an internalisation wherein understanding is happening creating a complete cycle of processes. I observed how the visual images were creating the stimulus for discussion, interaction and bringing

about creativity. Activity theory contextualizes the processes by establishing the importance of the mediating tool (the IWB) and other factors such as the teacher (the subject) facilitating the lesson and guiding the children for a holistic activity and achieve their goal of actively collaborating.

...because it is the constant transformation between external and internal that is the very basis of human cognition and activity...not only do mental representations get placed in someone's head, but the holistic activity, including motor activity and the use of artefacts, is crucial for internalization (Kaptelinin, Nardi, & Macaulay, 1999, p.29).

The language, a tool in the activity, aids the children in being creative. By expressing themselves they were building upon ideas to create their story. Describing the pictures; 'the egg with the stick means he is hurt' encouraged ideas to flow and interaction with their peers enriching their stories and their thinking skills.

5.4.4 Contradictions

A contradiction emerges as an effect of the tool being used. The teacher has to manage the class which easily gets out of control. I observed that the technology itself was attracting the children making them excited and all wanting to interact at the same time. At the same time the teacher was drawing the attention of those not participating, stop

Figure 7. Using Story Maker

ping interruptions from children, encouraging participation, correcting, or guiding.

5.4.5 Development

This contradiction led to skills the teacher has had to develop to control the class – orchestration. The children have previously been exposed to such lessons, and at this point are accustomed to the rules and what is expected from them. In the beginning it was not easy. It is not common at all for kindergarten teachers to give the children so much autonomy in discussing and controlling the technology mostly for fear of losing class control. During my professional practice I observe that most teachers are afraid of not knowing how to use the technology thus refraining from using it in such ways. They prefer to be in control and dictate the outcomes rather than let spontaneity and creativity take over in a controlled manner. The teacher remarks that “...they are used to this now and so know what is coming next”. The KGE is helping the children become critical users of the technology, to view and apply it in a meaningful context and providing the opportunity to enable creativity and discourse enabling development and learning.

Without the technology the teacher used to tell stories from a book, have them colour and draw pictures and then compile them into a booklet, it was not motivating them to think, and neither was it enhancing oracy or collaboration “...this is better because they enjoy it, it’s a different activity involving teamwork because to build a story you need ideas from everyone. And they do come up with new ideas”. The technology served as an effective teaching tool to encourage, stimulate conversation and participation, giving the children a sense of empowerment and fulfilment. See Figure 7.

In this case the teacher took the initiative forced by contradictions in not being able to reach her objective using traditional practices “...you have to try out the activities yourself and find which works best”. Thus, the activity changed as teaching practices were transformed through the tool.

5.5 Using Easi-speak

5.5.1 Description

In this session the teacher used the Easi-speak which is a digital microphone to record and play children’s recordings, see Figure 8.

5.5.2 Goals

The main objectives of this activity were to enhance speaking and listening skills boosting self-confidence in the process.

5.5.3 Tool mediation

When using the Easi-speak, the teacher observed a development and enhancement in children’s speaking abilities because the tool was stimulating conversation. I observed that every now and then the teacher turns on the Easi-speak and the class listen to some of their recordings. This was motivating the children to improve their speaking as they want their recordings to sound good. It was exciting and they became very enthusiastic about it. This was helping in enhancing their listening skills.

Figure 8. Using the Easi-speak

Use of the tool initially caused a contradiction as children were rather closing up, and not talking, as they became more self-aware. It seemed that the technology was not helping, but through repeated use and the teacher's professional expertise in continually prompting the children, they finally came forward and participated. This stresses the important role the teacher has in the activity to achieve the object confirming the ideas of Sutherland et al. (2009) as discussed in the literature review.

The social interaction between the children was driving them to engage in the activity, demonstrating practically how a sociocultural phenomenon, encourages thinking and active participation, the division of labour in the activity as is what occurred when using the Story Maker software. The tool is enabling the children achieve the goal of enhancing their speaking and listening skills.

5.5.4 Contradictions

The contradiction of children not wanting to speak, and lacking self-confidence, drove the teacher to use the Easi-speak. The teacher acknowledges how it has enabled the children to be more self-conscious and aware of what they say and how they say it, realising that the whole class will be listening to those recordings.

5.5.5 Development

The Easi-speak has aided the teacher's method in attaining the desired goal, and enabled substantial development in speech, which was not possible or very limited and slow without the technology.

6. Discussion

The results clearly inform the research questions set. The role of the different technologies has been shown in each activity to contribute to a change in the way the teacher delivers her lessons, her practices. The contradictions in most instances have forced the teacher to find alternative ways at times leading to transformation of practice. Table 1 illustrates the various nodes in activity theory and what they mean as emerged from the research findings.

To summarise in brief, research with an activity theoretical approach has helped surface and identify the following main elements:

- *Goals:* The teacher has succeeded in achieving her goals more effectively through the tools and the children now are not merely passive listeners but active participants collaborating in and creating their own learning.
- *Tool mediation:* The tools and digital artefacts all had a very critical role in enabling the teacher to achieve her goals and objectives.
- *Contradictions:* The contradictions presented by the classroom environment or by the tools themselves where in most cases the driving forces and incentives for reflection on practices to find solutions.
- *Developments:* In effect the solutions improved practice and brought about pedagogical innovation and change.

AT has given the possibility of a bird's eye-view of the classroom dynamics and exposed the complex eco-system

with varying inter-dependent factors. It has also clearly identified that all these elements could be brought together to achieve set goals by one very significant key element – the teacher. Appendix B summarises the sessions one by one identifying the contradictions and developments arising from the findings and emerging themes (in italics).

This paper through the framework has evidenced the path from enhancement to transformative teaching practices (Puentedura, 2013). The teacher under study has demonstrated this in an actual classroom setting and has perceived that technology is supporting her in bringing about this transformation. In addition to the SAMR model, AT has also supported the analysis of technology use and its impact as a process and how it has lead to extended student learning. AT analysis has been beneficial in this study because rather than remaining on the level of the affordances/constraints of the actual digital resource or technology, it has enabled a look into the deeper level of engagement in the actual learning and teaching itself. The use of AT has exposed pedagogical implications and the complex interactions between the individuals in the activity system as well as the interactions with the tools. This would not have been possible if I had adopted the SAMR model solely to carry out such a study. The reality and actual lived experiences inside a classroom can be dissected and put under the lens in all its entirety.

Researchers undergoing studies in such similar complex teaching and learning ecosystems would find AT advantageous to viewing how the developmental processes shape the individuals and or institutions.

Activity theory has highlighted the interactions occurring within the classroom. It is clear that the main components—subject, tool and object—are interchangeable depending upon the tool used, the context, the subject and any tensions which happen ad hoc in any classroom environment especially with young children. The classroom has a complex setting which changes continually because it is a live environment. Activity theory being so dynamic could capture the complexities as they happened and help to understand the nature of technology as a tool, integrated within the classroom to support pedagogy and bring about change. It presented a multimodal tool which the teacher manipulated skilfully to motivate and engage the children highlighting the teacher as key in such a system. This small-scale research demonstrated how system tensions did not stunt development but were the driving force in bringing about change and transformation in teaching practices. The most notorious contradictions observed were the primary and secondary contradictions as identified by Engeström (1987)

and as discussed in the literature review. This paper has also shown the small and gradual changes the teacher applied in her pedagogy for the transformation to occur. This implies that teachers do not need to develop high technical expertise to transform their pedagogical practices. The multimodal functionality of technology assist the educator in structuring teaching practices, shaping and re-shaping activities, to present children with multisensory tools to actively involve them in the creation of their own learning and equipping them with 21st century skills.

The literature reviewed was very limited in providing actual detailed examples of the interaction happening in a live classroom. This research, as described above, has managed to give rich insights to the challenges faced in the early years classroom and shown the ways the teacher overcomes common contradictions to bring about development and change in pedagogy through the affordances of technology. In other words I have attempted to fill a void and throw light in this area of education through presenting the reality and data as actually observed.

7. Conclusion

This research project has mainly demonstrated how activity theory helped me to examine and analyse the pedagogical activity within this specific sociocultural context. The tools/artefacts were perceived as important mediating tools to stimulate, engage and motivate learning while supporting and transforming teaching and learning processes. Tensions and challenges which emerged acted in most instances as driving forces behind the change in pedagogy.

The limitations of sample size were not so much an issue because this research has no intention of generalising. My role as an eLST for so many years has provided me with experiences and expertise to speculate that what I observed during this study did in essence provide a snapshot of the realities these teachers are facing, as well as highlighting how they are truly addressing these new changes. AT within technology enhanced learning, has been instrumental in my grasp of the complex social interactions within this specific Maltese kindergarten classroom. I have shown how activity theory can also be situated within the early years and not only in higher education. Activity theory assisted me in exposing the cultural context, tensions, change and mediating role of technologies in kindergarten through the teacher – the key element. Activity theory has also helped me understand the process of transformation brought about by the tensions and challenges.

Table 1. Nodes of the activity system as identified in this research project

Subject	Teachers (KGEs) with their epistemic assumptions of learning and teaching and the understanding/ beliefs of how technology can be used as a tool.
Mediating artefacts (tools)	<i>Tools</i> which mediate thought during interaction: • IWB • Easi-speak • Language • Teacher prompting • Software: Story Maker, Math Rabbit, online games • Value of numbers • ICT skills
Object	<i>Objectives/goals/learning outcomes</i> the teacher targets to accomplish using the technology namely: • Speaking and listening skills • Collaboration & teamwork • Thinking skills • Sense fulfilment on achievement • Value and recognition of numbers
Rules	<i>The norms/rules/policies/expected behaviour</i> in the classroom/school setup, rules of technology use, skills, curriculum requirements. What is expected in a particular context? The socio-cultural influences play a major role here. • Listen to each other's recordings, speak when the device is switched on, keep quiet while others are recording • Know how to drag pictures to the slide, use the mouse, wait for their turns, remember story sequence, be attentive • Know how to open the software, find the appropriate level and game, counting in sequence • Wait for their turn, be attentive and participate
Contradictions	• Unwillingness to participate or talk • Disruptions – Orchestration, lack of motivation from children, interruptions by others • Lack of support • Lack of ICT skills
Division of labour	Division of <i>responsibilities</i> , tasks and power relations of teachers and pupils in the classroom.
Outcomes	What was actually achieved through using the digital <i>tools</i> in the learning and teaching process
Community	The social context within which <i>teachers, children and school staff</i> work. These can include the LSEs, eLSTs, and school leaders.

The driving motivation that initially inspired me to conduct this study was the existing gap in local literature as to how technology integration in kindergarten classrooms could be unpacked specifically with the use of activity theory. Such a framework enabled me also to constructively provide important empirical data, examples and findings of how the educator in kindergarten makes use of the potential of technology /digital resources to enable transformation.

References

- Bligh, B., & Flood, M. (2015). The Change Laboratory in Higher Education: Research-Intervention using Activity Theory (pp. 141–168). <https://doi.org/10.1108/s2056-375220150000001007>
- Bligh, B., & Flood, M. (2017). Activity theory in empirical higher education research: choices, uses and values. *Tertiary Education and Management*, 23(2), 125–152. <https://doi.org/10.1080/13583883.2017.1284258>
- Bonneau, C. (2013). Contradictions and their concrete manifestations : an activity-theoretical analysis of the intra-organizational co-configuration of open source software. *Activity Theory and Organizations*, 1–28.
- Cohen, L., Manion, L., & Morrison, K. (2007). *Research Methods in Education* (6th ed.). Routledge.
- Dillenbourg, P. (2011). Trends in Orchestration. Second Research and Technology Scouting Report, D1(5), 1–61.
- Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of Management Journal*, 50(1), 25–32. <https://doi.org/10.5465/AMJ.2007.24160888>
- Engeström, Y. (1987). Learning by expanding: An activity-theoretical approach to developmental research. *Oriente-Konsultit*.
- Engeström, Y. (2001). Expansive Learning at Work: Toward an activity theoretical reconceptualization. *Journal of Education and Work*, 14(1), 133–156. <https://doi.org/10.1080/13639080020028747>
- Engeström, Y., & Sannino, A. (2011). Discursive manifestations of contradictions in organizational change efforts A methodological framework. *Journal of Organizational Change Management*, 24(3), 368–387. <https://doi.org/10.1108/095348111111132758>
- Ertmer, P. A., Ottenbreit-Leftwich, A. T., Sadik, O., Sendurur, E., & Sendurur, P. (2012). Teacher beliefs and technology integration practices: A critical relationship. *Computers & Education*, 59(2), 423–435. <https://doi.org/10.1016/j.compedu.2012.02.001>
- Flavin, M. (2017). Disruptive Technologies, Disruptive Innovation and Technology Enhanced Learning. In *Disruptive Technology Enhanced Learning*. https://doi.org/10.1057/978-1-137-57284-4_2
- Foot, K., & Groleau, C. (2011). Contradictions, transitions, and materiality in organizing processes: An activity theory perspective. *First Monday*, 16(6), 1–18.
- Gedera, D. S. P., & Williams, P. J. (Eds.). (2016). *Activity Theory in Education - Research and Practice*. Sense Publishers.
- Government of Malta. (2008). *Smartlearning -Malta's National e-Learning Strategy 2008-2010*.
- Hansen, C. C. (2008). Observing technology enhanced literacy learning. *Contemporary Issues in Technology and Teacher Education*, 8, 108–121.
- Hardman, J. (2007). An Activity Theory approach to surfacing the pedagogical object in a primary school mathematics classroom. *Critical Social Studies*, 1.
- Hardman, J. (2008). Researching pedagogy: an Activity Theory approach. *Periodical of the Kenton Education Association*, 65–95.
- Hamilton, E. R., Rosenberg, J. M., & Akcaoglu, M. (2016). The Substitution Augmentation Modification Redefinition (SAMR) Model: a Critical Review and Suggestions for its Use. *TechTrends*, 60(5), 433–441. <https://doi.org/10.1007/s11528-016-0091-y>
- Hasan, H. (1998). Activity theory: A basis for the contextual study of information systems in organisations. *Information Systems and Activity Theory: Tools in Context*, 19–38.
- Hashim, N. H., & Jones, M. L. (2007). Activity theory: a framework for qualitative analysis. *International Qualitative Research Convention*, 4.
- Hundeland, P. S., Carlsen, M., & Erfjord, I. (2014). Children's engagement with mathematics in kindergarten mediated

- by the use of digital tools. *Early Mathematics Learning*, 207–221.
- Hutchison, A., Beschoner, B., & Schmidt-Crawford, D. (2012). Exploring the Use of the iPad for Literacy Learning. *The Reading Teacher*, 66(1), 15–23. <https://doi.org/10.1002/TRTR.01090>
- Kaptelinin, V., & Nardi, B. A. (2006). Historical Currents in the Development of Activity Theory. In *Acting with Technology: Activity Theory and Interaction Design* (pp. 173–192). MIT Press.
- Kaptelinin, V., Nardi, B., & Macaulay, C. (1999). Methods & tools: The activity checklist: a tool for representing the “space” of context. *Interactions*, 6(4), 27–39. <https://doi.org/10.1145/306412.306431>
- Karasavvidis, I. (2009). Activity Theory as a conceptual framework for understanding teacher approaches to Information and Communication Technologies. *Computers & Education*, 53(2), 436–444. <https://doi.org/10.1016/j.compedu.2009.03.003>
- Kent, P. (2006). Using Interactive Whiteboards To Enhance Mathematics Teaching. *Australian Primary Mathematics Classroom*, 11(2), 23–26.
- Kervin, L., Verenikina, I., Jones, P., & Beath, O. (2013). Investing synergies between literacy, technology and classroom practice. *Australian Journal of Language and Literacy*, 36(3), 135–147.
- Kim, C., Kim, M. K., Lee, C., Spector, J. M., & DeMeester, K. (2013). Teacher beliefs and technology integration. *Teaching and Teacher Education*, 29, 76–85. <https://doi.org/10.1016/j.tate.2012.08.005>
- Leontiev, A. N. (1974). The problem of activity in psychology. *Soviet Psychology*, 13(2), 4–33.
- Lewin, C., Somekh, B., & Steadman, S. (2008). Embedding interactive whiteboards in teaching and learning: The process of change in pedagogic practice. In *Education and Information Technologies* (Vol. 13, Issue 4, pp. 291–303). <https://doi.org/10.1007/s10639-008-9070-z>
- Lin, C.-H. (2012). Application of a Model for the Integration of Technology in Kindergarten: An Empirical Investigation in Taiwan. *Early Childhood Education Journal*, 40(1), 5–17. <https://doi.org/10.1007/s10643-011-0494-5>
- Luckin, R., Bligh, B., Manches, A., Ainsworth, S., Crook, C., & Noss, R. (2012). *Decoding Learning: The proof, promise and potential of digital education* (Issue November). Nesta.
- Ministry for Education and Employment. (2012). *A National Curriculum Framework for All*.
- Moos, D. C., & Marroquin, E. (2010). Multimedia, hypermedia, and hypertext: Motivation considered and reconsidered. *Computers in Human Behaviour*, 26(3), 265–276. <https://doi.org/10.1016/j.chb.2009.11.004>
- Mumtaz, S. (2000). Factors affecting teachers’ use of information and communications technology: a review of the literature. *Journal of Information Technology for Teacher Education*, 9(3), 319–342. <https://doi.org/10.1080/14759390000200096>
- Nature, T. (2009). The Nature and Design of Mixed Methods Research. 4–10.
- Nisser, A., Braun, A., Marz, A., & Mertens, F. (2020). Rethinking education in the digital age (pp. 1–20). European Union. <https://doi.org/10.2861/84330>
- OECD. (2017). *Starting Strong V: Transitions from Early Childhood Education and Care to Primary Education*. In *Starting Strong*. OECD Publishing. <https://doi.org/10.1787/9789264276253-en>
- Plowman, L., & Stephen, C. (2003). A “Benign Addiction”? Research on ICT and pre-school children. *Journal of Computer Assisted Learning*, 19(2), 149–164. <https://doi.org/10.1046/j.0266-4909.2003.00016.x>
- Price, S., & Oliver, M. (2007). A framework for conceptualising the impact of technology on teaching and learning. *Educational Technology & Society*, 10(1), 16–27.
- Puentedura, R. (2013). SAMR: Moving from enhancement to transformation. Presentation Delivered at the Strengthening Your District Through Technology Workshops. <http://www.hippasus.com/resources/tte/>
- Rideout, V. J., Vandewater, E. A., & Wartella, E. A. (2003). *Zero to Six: Electronic Media in the Lives of Infants, Toddlers and Preschoolers*. In *Electronic Media in the Lives of Infants, Toddlers and Preschoolers: The Henry J. Kaiser Family Foundation*.

- Scanlon, E., & Issroff, K. (2005). Activity Theory and Higher Education: Evaluating learning technologies. *Journal of Computer Assisted Learning*, 21(6), 430–439. <https://doi.org/10.1111/j.1365-2729.2005.00153.x>
- Sutherland, R., Lindstrom, B., & Lahn, L. (2009). Sociocultural Perspectives on Technology Enhanced Learning and Knowing. In *Technology-enhanced learning: principles and products* (pp. 39–53). Dordrecht, Springer.
- Verenikina, I., Wrona, K., Jones, P., & Kervin, L. (2010). Interactive whiteboards: interactivity, activity and literacy teaching. *World Conference on ...*, 2605–2614.
- Waycott, J., Jones, A., & Scanlon, E. (2005). PDAs as lifelong learning tools: an activity theory-based analysis. *Learning, Media and Technology*, 30(2), 107–130. <https://doi.org/10.1080/17439880500093513>
- Yong, T. L. (2010). Integrating the Technological Dimension into Teaching and Learning — A Sociocultural Perspective. *Education*.
- Yong, T. L., & Lim, C. P. (2016). An Activity Theoretical Approach Towards Distributed Leadership For One-To-One Computing in a Singapore Elementary School. In D. S. P. Gedera & P. J. Williams (Eds.), *Activity Theory in Education: Research and Practice* (pp. 87–104). Sense Publishers.
- Zevenbergen, R., & Lerman, S. (2007). Pedagogy and Interactive Whiteboards: Using an Activity Theory Approach to Understand Tensions in Practice. *Proceedings of the 30th Annual Conference of the Mathematics Education Research Group of Australasia*, 2, 853–862.
- Zhao, Y. (2010). Preparing Globally Competent Teachers: A New Imperative for Teacher Education. *Journal of Teacher Education*, 61(5), 422–431. <https://doi.org/10.1177/0022487110375802>

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Appendix A. The Activity Checklist

The activity checklist presented by Kaptelinin et al. (1999) was designed to guide researchers to “specific areas they should be paying attention to when trying to understand the context in which a tool will be or is used” (p.28):

1. Means and ends – how the technology facilitates or constrains the attainment of the users’ goals and the impact of technology on resolving or provoking conflicts between different goals.
2. Structure of the environment – Integration of target technology with requirements, tools, resources, and social norms of the environment.
3. Learning, cognition and articulation – Internal vs. external components of activity and support of their mutual transformations with the target technology.
4. Development – developmental transformation of the foregoing components as a whole.

Appendix B. Summary of findings as per activity

Activities	Results/emerging themes	Contradictions and developments
Session 1 Using an online interactive game	Value and recognition of numbers through a game. Basic ICT skills. Fun, motivation, active participation. The element of games for learning. Increased learning. <i>Increased participation,</i> <i>Benefits of digital tools learning, efficiency</i>	Teacher's role changed to that of a facilitator of learning. Children learn to adopt new behaviour patterns. Positive development in pedagogy.
Session 2 Using an interactive software: Math Rabbit	Value and recognition of numbers. Multisensory media motivating, engaging, competitive. <i>Benefits of digital tools</i> <i>Development and improvement in learning</i> <i>Benefits of digital tools</i> <i>Change</i>	Lack of basic ICT skills leading to learning and mastering new skills as independent learners. Teacher adopts new teaching methodologies.
Session 3 Using Story Maker	Thinking, speaking and listening skills, team work, active participation, more interaction. <i>Collaboration</i> <i>Increased participation</i> <i>Social interaction</i> <i>Transformation</i> <i>Benefits of digital tools</i>	Change in pedagogy, classroom management a challenge at first Children learn to work as a team, socially interact, collaborate, and decide.
Session 4 Using the Easi-speak	Enhance speaking and listening skills. Stimulates oracy, motivates children to speak and listen. <i>Benefits of digital tools</i> <i>Change</i> <i>Increased participation</i>	Difficulty in initiating the activity, children not used to speaking in front of the class. Children build self-confidence, learn to interact and build social skills. Digital tools assist in achieving outcomes.